Application for Review

to the

Ministry of Municipal Affairs and Housing

Date: September 26, 2016

Canadian Environmental Law Association

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29	Canadian Nuclear Safety Commission, *Canadian National Report for the Convention on Nuclear Safety, Seventh Report*, August 2016
30	International Atomic Energy Agency, *Site Evaluation for Nuclear Installations*, Safety

TAB DOCUMENT

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31 R.A. Brown and Associates, *ACR Licensing Basis Project, Licensing Guide: Design, Submitted to Canadian Nuclear Safety Commission*, September 2004 (Excerpts)

32 John W. Beare, *Review of ACR-LBD-001, Licensing Basis Document for New Nuclear Power Plants in Canada*, Draft dated December 2004

33 Regulatory Site Requirements Needed for New Nuclear Power Plants in Canada, Licence to Prepare Site, June 2007

34 Dr. Aadu Pilt, *A Technical Assessment of the Enhanced Planning and Preparedness Arrangements in the Contiguous Zone Surrounding Ontario Power Generation Inc. Nuclear Generating Stations*, May 2002

35 German Commission on Radiological Protection (SSC), *Planning areas for emergency response near nuclear power plants: Recommendation by the German commission on Radiological Protection*, February 2014

36 Florian Gering, *Updated emergency planning zones in Germany and the importance of release source term*, presentation by emergency management division, Federal Office for Radiation Protection

37 Laurène Debesse, *The Use of Frequency-Consequence Curves in Future Reactor Licensing*, submitted in Partial Fulfillment of the Requirements for the Degrees of Master of Science in Technology and Policy and Master of Science in Nuclear Science and Engineering at the Massachusetts Institute of Technology, February 2007

38 Honorable Gregory B. Jaczko, Chairman of the U.S. Nuclear Regulatory Commission, "*Looking to the Future*," Platts 8th, Rockville, MD Annual Nuclear Energy Conference February 9, 2012

39 International Atomic Energy Association, *Safety Standard for Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants,* Safety Guide No. NS-G-3.2, March 2002

40 United Nations, *Sendai Framework for Disaster Risk Reduction 2015-2030*

41 International Atomic Energy Agency, *The Fukushima Daiichi Accident*, Technical Volume 3/5 – Emergency Preparedness and Response (Excerpts)

Application for Review Form

(also accessible online on the ECO's website)

Environmental
Commissioner
of Ontario

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Environmental Commissioner of Ontario

Application for Review

Part IV, *Environmental Bill of Rights*

General Information About This Application

Under section 67 of the *Environmental Bill of Rights, 1993* (*EBR*), the minister must consider each Application for Review in a preliminary way to determine whether the public interest warrants a Review of the issues raised in your Application. Among other factors, the minister must consider:

1. The ministry Statement of Environmental Values;
2. The potential for harm to the environment if the Review applied for is not undertaken;
3. The fact that matters sought to be reviewed are otherwise subject to periodic review;
4. Any social, scientific or other evidence that the minister considers relevant;
5. Any submission from a person who may be directly interested in the Review who has been notified about the Review;
6. The resources required to conduct the Review; and
7. Any other matter the minister considers relevant.

If the decision asked to be reviewed was made within the last five years with public participation consistent with the *EBR*, the minister will not determine that the public interest warrants a Review. This provision does not apply where it appears to the minister that there is other evidence that failure to review the decision could result in significant harm to the environment and that this evidence was not considered when the decision sought to be reviewed was made.

The personal information requested in this Application is gathered under the legislative authority of the *EBR*. All the information on this form is required by the *EBR* for the minister to determine whether an existing policy, act, regulation or instrument of Ontario should be reviewed, or to decide whether there is a need for a new policy, act or regulation.

The *EBR* does not allow the Environmental Commissioner of Ontario or the ministry to disclose personal information about applicants. The *EBR* protects the personal information provided by applicants. Applicants' personal information may be disclosed if the Review results in further government action outside of the *EBR* such as:

- A prosecution, or
- Other administrative action

For more information on the requirements of this Application and how to use the EBR *please contact:*

Public Information and Outreach Officer
Environmental Commissioner of Ontario
1075 Bay Street, Suite 605
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Phone: 416-325-3377
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Instructions

1. Type or print clearly in ink.
2. Ensure both applicants sign and date the Application.
3. Complete all the sections.
4. Answer all the questions.
5. Clearly indicate the section of the Application to which any additional documentation applies.
6. Keep a copy of the Application for your files.
7. Submit your original Application and supporting documents to the Environmental Commissioner of Ontario at the address above.

1. APPLICANTS

Please complete 1(a) and 1(b) ***OR*** complete 1(a) and 1(c) if one of the applicants is a corporation. If both applicants are corporations, please copy the declaration form for 1(c) and attach the second completed declaration form to this application.

1. a) Applicant Number One

Cockburn | Gail | F
Last Name | First Name | Initial

206 BYRON St. North
Address | Apartment

Whitby | ONTARIO | L1N 4N1
City | Province | Postal Code

(905) 668-8986 | ( )
Residence Telephone | Business Telephone

Declaration of Ontario Residency:

I Gail Cockburn am an Ontario resident and have been since March 12 1943
(Print Name) (Month, Year)

Gail Cockburn | Sept 19/16
Signature | Date

1. b) Applicant Number Two

Last Name | First Name | Initial

Address | Apartment

City | Province: ONTARIO | Postal Code

Residence Telephone: ( ) | Business Telephone: ( )

Declaration of Ontario Residency:

I ______________________ am an Ontario resident and have been since ______________
(Print Name) (Month, Year)

Signature | Date

1. c) Corporate Applicant

Name of Corporation: Canadian Environmental Law Association

Name of Position of Corporate Officer: Jacqueline Wilson, Counsel

Address: 1500 - 55 University Ave

City: Toronto

Province: ONTARIO

Postal Code: M5J 2H7

Business Telephone: (416 - 960 - 2284 ex 7213

Declaration of Incorporation in Ontario:

The Canadian Environmental Law Association (Name of Corporation) is an Ontario or Canadian Federal Corporation, carrying on business with its head office in Ontario, established by articles of incorporation in 09, 1981 (Month, Year)

Date: Sept. 22, 2016

Name of Officer and Position: Jacqueline Wilson, Counsel

Company Number: 121124-2

Signature: [signature]

1. b) Applicant Number Two

Last Name	First Name	Initial
Address		Apartment
City	ONTARIO Province	Postal Code
( ) Residence Telephone	( ) Business Telephone	

Declaration of Ontario Residency:

I ______________________ am an Ontario resident and have been since ______________
(Print Name) (Month, Year)

Signature Date

1. c) Corporate Applicant

Greenpeace Canada Name of Corporation	Senior Energy Analyst Name of Position of Corporate Officer	
33 Cecil St. Address	Toronto City	ONTARIO Province
M5T 1N1 Postal Code	(416 884-7053 Business Telephone	

Declaration of Incorporation in Ontario:

The Greenpeace Canada (Name of Corporation) is an Ontario or Canadian Federal Corporation, carrying on business with its head office in Ontario, established by articles of incorporation in May 31 1989 (Month, Year)

September 20 2016 Date	Shawn-Patrick Stensil Senior Energy Analyst Name of Officer and Position
247125-6 Company Number	[signature] Signature

2. REQUEST FOR APPLICATION FOR REVIEW

Please complete section 2(a) ***OR*** 2(b) below. Only complete both sections if you are requesting a review of an existing policy, act, regulation or instrument ***AND*** the need for a new policy, act or regulation.

2. a) We request a Review of an existing policy, act, regulation or instrument (please check at least one).

☑ Policy ☑ Act ☑ Regulation ☐ Instrument

Clearly identify the name of the policy, act, regulation and/or instrument that you wish to be reviewed. Please provide as much detail as possible, including the name, section numbers and instrument numbers where possible.

Please see attached.

To confirm that the EBR's application for review provisions apply to the policy, act, regulation or instrument that you are seeking to be reviewed, check the ECO's website for a list of ministries prescribed under the EBR and a list of acts subject to the EBR, as well as O. Reg. 73/94 (ministries, acts, and regulations) or O. Reg. 681/94 (instruments).

2. b) We request a Review of the need for a new policy, act and/or regulation (please check at least one).

☑ Policy ☑ Act ☑ Regulation

Description of policy, act or regulation:

Please see attached

To confirm that the EBR's application for review provisions apply to the ministry that would be responsible for your proposed new policy, act or regulation, check the ECO's website for a list of ministries prescribed under the EBR or O. Reg. 73/94.

3. We believe that the ministry should undertake our Review to protect the environment because:

Please see attached

If you need more space, attach additional pages, each referenced with "Question #3".

4. The following is a summary of the evidence that supports our Application for Review (for example, scientific studies and reports):

Please see attached.

If you need more space, attach additional pages, each referenced with "Question #4".

Attach copies of all written materials and photographs referred to in your summary above to this Application, or contact commissioner@eco.on.ca to submit the documents and photographs electronically. Reference each document and photograph against the list you have created above and indicate that they are part of your answer to "Question #4".

B. SUBJECT MATTER OF REQUESTED REVIEW

Ontario’s land use planning regime is improperly encouraging population growth in areas surrounding nuclear power plants with no apparent concern about the negative impact of such growth on the risk to the public and on the viability of emergency planning. There is a serious public safety risk because Ontario has also approved plans to continue operating ten aging reactors sited in the Greater Toronto Area (“GTA”) at the Darlington and Pickering nuclear stations. Six million Ontarians live within the GTA.

We request that the Ministry of Municipal Affairs and Housing (“MMAH”) review their current acts, regulations and policies, and create new acts, regulations and policies, to restrict land use and population growth around nuclear power plants. This review has become increasingly urgent in light of the lessons learned from the Fukushima Daiichi nuclear accident and the projected consequences of a Fukushima-scale accident in Ontario.

The Applicants request a review of the following existing legislation, regulation or policy pursuant to subsection 61(1) of the *Environmental Bill of Rights, 1993,* SO 1993, c 28 (“*EBR*”):

- Subsection 5.1(2) of the *Emergency Management and Civil Protection Act*, RSO 1990, c E9, which provides that each Minister of the Crown must "assess the various hazards and risks to public safety that could give rise to emergencies and identify the facilities and other elements of the infrastructure for which the Minister .... is responsible that are at risk of being affected by emergencies".

- Sections 3, 4 and 6 of the *Places to Grow Act, 2005,* SO 2005, c 13, which provides for preparation of growth plans. The Applicants request a review of all current and proposed growth plans that apply to areas surrounding Ontario’s nuclear power plants, including the Proposed Growth Plan for the Greater Golden Horseshoe, 2016.

- *Planning Act*, RSO 1990, ch P13, which provides the overall framework for land use planning in Ontario and the Provincial Policy Statement, 2014.

The Applicants also request a review of the need for a new act, regulation or policy pursuant to subsection 61(2) of the *EBR* by the Minister of Municipal Affairs and Housing to properly account for the impact of the risk of accidents at nuclear power plants on siting of nuclear power plants and land use planning in Ontario. It is imperative that restrictions on land use are put in place surrounding nuclear power plants in Ontario.

REASONS FOR THE REVIEW

A. Jurisdiction of the Ministry of Municipal Affairs and Housing

The MMAH is responsible for land use planning pursuant to the *Planning Act*.[1] It is responsible for the Proposed Growth Plan for the Greater Golden Horseshoe, 2016 pursuant to the *Places to Grow Act, 2005*. Pursuant to subsection 5.1(2) of the *Emergency Management and Civil Protection Act*, the MMAH must consider the various hazards and risks to public safety that could affect land use planning.

B. Current Status of Canadian Siting Requirements and Population Growth near Ontario Nuclear Power Plants

i. Ontario's land use planning regime is encouraging population growth near nuclear power plants

Ontario's land use planning regime actually encourages increased growth near both the Darlington and Pickering nuclear power plants, rather than heeding the advice of experts to restrict land use in those areas.

The Finnish Radiation and Nuclear Safety Authority accurately summarized why nuclear power plants should be sited far away from large population centres in its 2001 *Safety Criteria for Siting a Nuclear Power Plant*:

> The general principle in the siting of nuclear power plants is to have the facilities in a sparsely populated area and far away from large population centres. What justifies placement in a sparsely populated area is that emergency planning will then be directed at a smaller population group and will thus be easier to implement.[2]

As early as 1988, Provincial Working Group # 8, an arms-length committee struck to advise government, recommended that Ontario examine "the advisability of restricting new housing construction near nuclear facilities."[3] In November 1996, the Royal Society of Canada and Canadian Academy of Engineering ("RSC") advised that the Contiguous Zone, the priority emergency planning area surrounding nuclear power plants, have a small population and that it preferably be restricted to parkland or industrial use:

> The Contiguous Zone, with a boundary approximately 3 km radius around the plant, is an area for which detailed plans can be developed. Because of its limited size relatively fast action is possible. High population density and possible bad weather could make

[1] *Planning Act*, RSO 1990, c P13, s 1; Canadian Nuclear Safety Commission, Notice of Meeting, *Engagement with Stakeholders: DNNP Joint Review Panel (JRP) Recommendation #43: Land Use Policy,* February 6, 2013 ("CNSC Notice of Meeting – February 6, 2013") (Tab C1)
[2] STUK (Radiation and Nuclear Safety Authority), *Safety Criteria for Siting of Nuclear Power Plant,* 2001, p 4 (Tab C2)
[3] Provincial Working Group #8, *The Upper Limit for Detailed Nuclear Emergency Planning,* June 30, 1998, p iv (Tab C3)

> evacuation difficult and this zone should have a small population and preferably be restricted to parkland or industrial park use.[4]

Although Canadian Nuclear Safety Commission ("CNSC") staff recently highlighted the Provincial Policy Statement, 2014 ("PPS, 2014"), the Municipality of Clarington's Official Plan, and the Region of Durham's commitment to update its Official Plan to comply with the PPS, 2014 as advancements on previous land use guidance, these are insufficient tools to truly address siting issues surrounding nuclear power plants.[5]

The PPS, 2014 does not limit population density near nuclear power plants. Nuclear hazards or nuclear power plants are not specifically mentioned. Any land use restrictions that are mentioned are vague. Major facilities, which include energy generation facilities, and sensitive land uses, are to be planned to ensure that they are "appropriately designed, buffered and/or separated from each other" to minimize risks to public health and safety.[6] But, this restriction has not been used to limit population growth near nuclear facilities.

Furthermore, CNSC, Emergency Management Ontario, MMAH, the Ministry of the Environment and Climate Change, relevant municipalities and OPG met to discuss land use planning around the Darlington nuclear power plant in 2013. A September 27, 2013 report, acquired through the *Freedom of Information and Protection of Privacy Act,* stated that the PPS, 2014 alone could not adequately address land use issues near nuclear stations.[7]

The proposed change to the Municipality of Clarington's 2016 Official Plan provides that "sensitive land uses" in the vicinity of the Darlington nuclear generation station will be reviewed in the context of emergency measures planning.[8] This amendment does not limit population growth near the nuclear site.

In fact, the Ontario government is actively encouraging population growth in areas surrounding nuclear power plants through its growth plans.

The 2006 Growth Plan identified downtown Oshawa and downtown Pickering as urban growth areas.[9] Both areas are located within the 10 km Primary Zone for nuclear emergency planning and preparedness surrounding nuclear reactors. The reactors are not mentioned in the growth plan.

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[4] Royal Society of Canada and Canadian Academy of Engineering, *Report to the Ministry of Energy and Environment Concerning Two Technical Matters in the Province of Ontario's Nuclear Emergency Plan*, November 1996, section 6.2, p 31 ("RSC Report") (Tab C4)
[5] Canadian Nuclear Safety Commission, Transcript of Public Meeting, August 18, 2016, pp 50-51 (Tab C5)
[6] Ministry of Municipal Affairs and Housing, *Provincial Policy Statement, 2014*, ss 1.2.6.1, 6.0, pp 13, 44, 48 (Tab C6)
[7] Hardy, Stevenson and Associates, Land Use Planning Workshop: Darlington New Nuclear Project, Discussion and Summary Agreement, September 27, 2013 ("Hardy Workshop Report"), s 5.1.3, p 12 (Tab C7)
[8] Municipality of Clarington, Draft Official Plan 2016, s 3.7.11 (Tab C8)
[9] Ministry of Infrastructure, *Growth Plan for the Greater Golden Horseshoe, 2006,* Office Consolidation June 2013, pp 16-17, 65 (Tab C9)

In the *Proposed Growth Plan for the Greater Golden Horseshoe, 2016,* both downtown Pickering and downtown Oshawa are still listed as urban growth centres under the *Places to Grow Act, 2005*.[10] The Darlington and Pickering nuclear power plants are still not mentioned in the growth plan.

Nuclear hazards and emergency planning have not been mentioned during MMAH's consultation regarding the Growth Plan for the Greater Golden Horseshoe, the Greenbelt Plan, the Oak Ridges Moraine Conservation Plan and the Niagara Escarpment Plan.

The Provincial Nuclear Emergency Response Plan ("PNERP") does not address land use planning.[11] Emergency Management Ontario noted in 2013 that there was "little to no interaction" between it and MMAH on land use policy matters.[12]

ii. Ontario's land use planning has resulted in increasingly dense populations surrounding the Pickering Nuclear Power Plant

The Pickering nuclear site is located in a highly populated region, which will hinder any effort to evacuate the area in case of emergency. The hazard is increasing as land use planning continues to direct further population growth close to the site.

The Ministry of Energy recognized in a January 2010 Briefing Note relating to the continued operation of the Pickering nuclear power plant that its ability to operate for 30 years in a "targeted population growth area" carries the potential for significant regulatory sanction in response to public intervention.[13] The province has taken no action to address this concern.

There are simply too many people living in close proximity to the Pickering nuclear generating station. The population in Durham Region has increased significantly since the Pickering site was chosen.[14] Durham Region's population in 2009 was 614,970 and was projected to grow to 949,100 by 2026. In 2011, there were 280,591 people living in the 10 km Primary Zone.[15] There is also a considerable workforce in the area.[16]

Estimated evacuation times in the 10 km Primary Zone already increased between 2008 and 2016 because of a 14% increase in residential population and additional vehicles from transient

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[10] Ministry of Municipal Affairs and Housing, *Proposed Growth Plan for the Greater Golden Horseshoe, 2016,* May 2016, pp 17-18, 95 (Tab C10)
[11] Canadian Nuclear Safety Commission, Notice of Meeting, *Teleconference – Next Steps on JRP Recommendation #43 – Land Use Policy – Engagement with Stakeholders,* April 23, 2013 ("CNSC Notice of Meeting – April 23, 2013") (Tab C11)
[12] CNSC Notice of Meeting – February 6, 2013, p 2
[13] Cedric Jobe and Rick Jennings (Ministry of Energy), Briefing Note, January 2010 (Tab C12)
[14] Ontario Power Generation, Pickering B Safety Report – Part 1, 2009, Figure 2-3: Historical Population Trends of Ontario and Municipalities around Pickering NGS, p 87 ("Pickering B Safety Report") (Tab C13)
[15] Durham Emergency Management Office, *Durham Nuclear Emergency Response Plan*, May 2016, Table 4, p 23 ("Durham Nuclear Emergency Response Plan") (Tab C14)
[16] Pickering B Safety Report, Section 2.2.2: Industry, pp 39-40

populations travelling through the area, special facilities, schools, day camps, college populations and correctional facilities, which the previous study did not take into account.[17]

Amendment 26 to the City of Pickering's Official Plan, approved by the Ontario Municipal Board on March 4, 2015, targets City Centre South for new residential development to accommodate 6,300 people or 3,400 units by 2031.[18]

The City of Pickering has received an application for a zoning by-law amendment for the former Holy Redeemer Catholic Elementary School to permit condominium development. This site is less than 2 kilometres from the Pickering Nuclear Generation Station.[19]

Durham Regional Official Plan amendment (ROPA 128) approved January 9, 2013 by the Ontario Municipal Board (OMB) designates an area which lies within 3 km of the Pickering Nuclear Generation Station as a Regional Corridor, which are to be planned and developed as higher density mixed-use areas. This 3 km area overlaps with the Contiguous Zone, which requires increased emergency planning due to its proximity to the nuclear station.[20] Along with Highway 401, there are other major transportation routes of national importance that would be disrupted in the event of a severe accident at Pickering, including Highway 2 and the CN and CP Rail lines.[21]

In addition, there are a large number of major airstrips and airports in the area.[22] A nuclear accident would disrupt commercial aviation, and also poses an ongoing risk to the plant itself. International Atomic Energy Agency ("IAEA") Safety Guide NS-G-3.1 states that "the potential for aircraft crashes that may affect the plant site should be considered in the early stages of the site evaluation process and it should be assessed over the entire lifetime of the plant."[23]

iii. Darlington Nuclear Power Plant: land use planning and the Darlington site are on a collision course

Land use planning surrounding the Darlington site has resulted in increased population growth. The Joint Review Panel studying the proposal for new nuclear power plants at Darlington raised significant concerns about land use planning affecting the Darlington site. Those concerns have not been addressed.

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[17] Ontario Power Generation, Pickering NGS Development of Evacuation Time Estimates, April 12, 2016, p ES-2 (Tab C15)
[18] Amendment 26 to the City of Pickering Official Plan, approved by the Ontario Municipal Board on March 4, 2015, s 11.10K(b), p 22 (Tab C16)
[19] City of Pickering, Notice of Public Open House, Applications for Zoning By-law Amendment, and Draft Plan of Condominium, submitted by Madison Liverpool Limited, for the former Holy Redeemer Catholic Elementary School located at 747 Liverpool Road, May 17, 2016 (Tab C17); Google Map, Holy Redeemer Catholic School to Pickering Nuclear Generation Station, September 2016 (Tab C18)
[20] Durham Regional Official Plan Amendment (ROPA 128), approved January 9, 2013, s 8A.2.9, p 59 (Tab C19)
[21] Pickering B Safety Report, s 2.2.4, pp 42-43
[22] Ontario Power Generation, Pickering A Safety Report, 2010, Table 15 (Tab C20)
[23] International Atomic Energy Agency, Safety Guide No. NS-G-3.1, *External Human Induced Events in Site Evaluation for Nuclear Power Plants*, 2002, p 22 (Tab C21)

A November 28, 2005 CNSC Briefing Note contemplated siting concerns with respect to two potential sites for the new Darlington nuclear power plant. The Briefing Note highlighted that the new plant could be located at the existing Darlington site, however major population areas were beginning to encroach on the site. The option of locating the site at Wesleyville was considered advantageous because it was further removed from major population areas.[24]

The population in the current 10 km Primary Zone of the Darlington site is projected to almost double between 2011 and 2055.[25]

The Joint Review Panel assessing the proposal for a new nuclear power plant at Darlington identified significant defects regarding current siting requirements. The Panel recommended that appropriate steps be taken to "evaluate and define buffer zones around nuclear facilities in Canada, taking into consideration the lessons learned from the Fukushima Daiichi nuclear accident. <u>The Panel believes that the Government of Ontario should take appropriate measures to ensure that no residential development takes place in the Contiguous Zone.</u>"[26] [emphasis added] No such steps have been taken.

The Panel also made the following recommendations regarding siting requirements, including that the Ontario government prevent sensitive and residential development near the Darlington site boundary:

> Recommendation #43: The Panel recommends that the Canadian Nuclear Safety Commission engage appropriate stakeholders, including OPG, Emergency Management Ontario, municipal governments and the Government of Ontario to develop a policy for land use around nuclear generating stations.
>
> Recommendation #44: The Panel recommends that the Government of Ontario take appropriate measures to prevent sensitive and residential development within three kilometers of the site boundary.
>
> Recommendation #45: The Panel recommends that the Municipality of Clarington prevent, for the lifetime of the nuclear facility, the establishment of sensitive public facilities, such as school, hospitals and residences for vulnerable clienteles within the three kilometer zone around the site boundary.
>
> …
>
> Recommendation #59: The Panel recommends that the Municipality of Clarington manage development in the vicinity of the Project site to ensure that there is no

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[24] Canadian Nuclear Safety Commission, *Briefing Note – Darlington NGS*, November 28, 2005 (Tab C22)
[25] Ontario Power Generation, *Darlington NGS Development of Evacuation Time Estimates*, December 20, 2015, Table M-4: PZ Population by Study Year, p M-9 (Tab C23)
[26] Joint Review Panel, *Environmental Assessment Report: Darlington New Nuclear Power Plant Project,* August 2011, p 105. (Tab C24) ("Darlington Joint Review Panel")

> deterioration in the capacity to evacuate members of the public for the protection of human health and safety.[27]

The Panel also found that OPG and the Municipality of Clarington may be on a ‘collision course’ regarding the development of land neighbouring the Darlington site. The Region of Durham growth scenario up to 2056 includes several residential areas contemplated, or being built, very close to the site. Some of the developments are in the contiguous or primary evacuation zones of the Darlington site. Two schools are located within 2.8 kilometres and 3.1 kilometres of the closest planned location for the new reactors at the Darlington site.[28]

Although the Panel ultimately found that appropriate measures are in place to ensure that vulnerable populations including hospitals, schools and retirement homes can be safely evacuated, it also highlighted that it would be prudent to avoid such developments, and other residential developments, within a three-kilometre zone around the project site. The Panel recommended avoiding any further residential development north of Highway 401 in several emergency response sectors, in light of the challenges encountered during the evacuation following the Fukushima Daiichi nuclear disaster. The Panel pointed out that a situation similar to that at the Pickering site, where residential areas are found within three kilometers of the nuclear site, must be avoided.[29]

CNSC, Emergency Management Ontario, MMAH, Ministry of the Environment, relevant municipalities and OPG met to discuss the JRP recommendations in 2013. According to a meeting report, responding to the JRP’s recommendation on land use planning requires a “suite of tools from all levels of government with consistent direction”. No final report has been released publicly.[30]

iv. CNSC does not regulate land use planning surrounding existing nuclear sites

The CNSC’s guidance on siting of nuclear power plants all relate to new nuclear power plants. It does not apply to existing nuclear sites.

Following the Fukushima Daiichi nuclear accident, the CNSC committed to updating its *Integrated Action Plan on the Lessons Learned from the Fukushima Daiichi Nuclear Accident* for both existing and new nuclear power plants. The CNSC commitment included consulting the public on proposed amendments for RD-346: Site Evaluation for New Nuclear Power Plants (“RD-346”) before submitting a revised guide to the Commission for approval before the end of December 2013.[31]

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[27] Darlington Joint Review Panel, pp 105, 127
[28] Darlington Joint Review Panel, pp 101, 105
[29] Darlington Joint Review Panel, p 105
[30] Hardy Workshop Report, pp 20-23
[31] Canadian Nuclear Safety Commission, *CNSC Integrated Action Plan on the Lessons Learned From the Fukushima Daiichi Nuclear Accident,* August 2013, p 23 (Tab C25)

In August 2016, the CNSC finally published for consultation its proposed post-Fukushima siting requirements in *REGDOC-1.1.1: Licence to Prepare Site and Site Evaluation for New Reactor Facilities*. The preface states that the amendments aim to ensure that there are "… discussions around emergency planning and preparations for extreme events earlier in a project." However, the guide does not apply to existing facilities unless it is included in the licence or licensing basis for the facility and is instead to be used to assess "new licence applications for reactor facilities."[32]

The pre-Fukushima CNSC guidance, RD-346 and RD-337: Design of New Nuclear Power Plants ("RD-337"), only applies only to new nuclear power plants.[33]

RD-346 identifies key characteristics to consider in siting a nuclear power plant, including population density and population distribution, especially as they relate to emergency planning, and the evolution of population factors over the lifetime of the plant.[34] In particular, RD-346 identifies the planning considerations related to population that must be considered in evaluating the site of a new nuclear power plant:

1. Population density and distribution within the protective zone, with particular focus on existing and projected population densities and distributions in the region including resident populations and transient populations. This data is kept up to date over the lifetime of the NPP;
2. Present and future use of land and resources;
3. Physical site characteristics that could impede the development and implementation of emergency plans;
4. Populations in the vicinity of the NPP that are difficult to evacuate or shelter (for example, schools, prisons, hospitals); and
5. Ability to maintain population and land-use activities in the protective zone at levels that will not impede implementation of the emergency plans.[35]

However, RD-346 offers no criteria for assessing the merits of a site from a safety perspective. As noted, the Darlington Joint Review Panel recommended restrictions on population growth and development of sensitive infrastructure, such as schools, near the facilities. A follow up meeting in September 2013 of federal, provincial and municipal governments concluded that RD-346 and RD-337 are not sufficient for managing land use around nuclear power plants.[36]

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[32] Canadian Nuclear Safety Commission, *REGDOC-1.1.1, Licence to Prepare Site and Site Evaluation for New Reactor Facilities*, August 2013, p I (Tab C26)
[33] Canadian Nuclear Safety Commission, *RD-346: Site Evaluation for New Nuclear Power Plants*, dated modified February 3, 2014, p 1 ("RD-346: Site Evaluation") (Tab C27); Canadian Nuclear Safety Commission, *RD-337: Design of New Nuclear Power Plants,* dated modified February 3, 2014, p 1 ("RD-337: Design of New Nuclear Power Plants") (Tab C28)
[34] RD-346: Site Evaluation, ss 4.0, 5.0, pp 4-6
[35] RD-346: Site Evaluation, s 5.5.3, p 8
[36] Hardy Workshop Report, p 17

RD-337 does not provide better guidance for siting requirements. It notes only that the exclusion zone is based on evacuation needs, land usage needs, security requirements and environmental factors.[37] The plant design is also to consider the population in the surrounding area.[38]

The CNSC's submission to the Convention on Nuclear Safety indicates that it uses the accidents assessed during initial environmental assessments to evaluate site suitability. CNSC does not consider worst-case accidents in environmental assessments and only reviews "accident sequences that could occur with a frequency greater than 10^{-6} per reactor-year of operation."[39] CNSC's RD-337 provides that accidents with a frequency greater than 10^{-6} release less than 10^{14} becquerel of Cesium-137,[40] which corresponds to only 1% of the releases that occurred during the Chernobyl nuclear accident.[41]

The 10^{-6} cut-off is also not aligned with the province's current criteria for detailed off-site emergency planning, which remains the standard of 10^{-7} recommended by the RSC in 1996.[42]

As a result, there is no public information that considers the potential social, economic, environmental and human health consequences of worst-case nuclear accident scenarios at Canadian nuclear sites. There is also no corresponding information available to assess how population density and land use planning may hinder provincial emergency measures in the event of a Chernobyl or Fukushima-scale accident.

The CNSC's use of environmental assessments for siting assessments also implies that siting requirements will only be reviewed at the outset of a nuclear power plant project, not throughout the life of the project as is required by the IAEA.[43] The *Canadian Environmental Assessment Act*, *2012* removed the requirement for reactor life-extensions to undergo an EA. There is also no requirement for an environmental assessment for proposals to operate reactors beyond their original design-life.

v. An Act of faith or hubris? CNSC consultants have long been concerned about the siting of nuclear power plants in Ontario.

Ontario's inappropriate siting decisions regarding placement of nuclear power plants near population centres, and growing populations in those areas, have been criticized repeatedly by CNSC consultants.

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[37] RD-337: Design of New Nuclear Power Plants, s 6.5, p 11
[38] RD-337: Design of New Nuclear Power Plants, s 7.4.2, p 14
[39] Canadian Nuclear Safety Commission, *Canadian National Report for the Convention on Nuclear Safety, Seventh Report*, August 2016, p 155 ("Canadian National Report") (Tab C29)
[40] RD-337: Design of New Nuclear Power Plants, s 4.2.2, p 6
[41] Canadian National Report, p 119
[42] RSC Report, section 7.1, p 33
[43] International Atomic Energy Agency, *Site Evaluation for Nuclear Installations*, Safety Requirements No. NS-R-3 (Rev. 1), February 2016, s 5.1, pp 20-21 ("IAEA Safety Standard for Site Evaluation") (Tab C30)

In 2004, R.A. Brown and Associates noted that in determining the design of a nuclear power plant, interactions between the plant and the environment, the availability of off-site services and the population must be taken into account.[44]

In 2005, John W. Beare identified that siting considerations for nuclear power plants were not being considered and had resulted in problematic decisions:

> 19. There are two significant gaps in the Licensing Basis Document. … The safety goals are independent of the site, the size of the exclusion area (if any) and the demographics of the area around the site. I was advised that site considerations do not affect the design requirements for the nuclear power plant but that explanation is difficult to accept.
>
> 20. Before issuing this Licensing Basis Document the Canadian Nuclear Safety Commission should document and publish its siting policy giving quantitative values for the tolerable risk (not unreasonable to use the wording of the Nuclear Safety and Control Act) to individuals and the population around a nuclear power plant site. One weakness of the current siting policy in AECB-1059 is that only radiological risks are addressed. In AECB- 1059 the frequency and radiological consequences of process failures alone and in combination with safety system failures are addressed for individuals and the population, but only the risk to individuals from more serious accidents. These weaknesses in the current siting policy should be remedied.
>
> …
>
> 27. The main elements of the Canadian approach were in place by 1964. The next year the site for the first two units of Pickering was approved and it was evident then that Ontario Hydro intended to build two more. At the time the only operating experience with CANDU was with the small NPD reactor which had begun operation in 1962. The Douglas Point reactor did not commence operation until 1967 and its initial operating history was anything but smooth. <u>Depending on one's perspective, from the safety point of view the approval of the Pickering site was an act of faith or hubris</u>. At the time, the Pickering site had the highest population density in the world, a population density that has been exceeded by only a few other sites since then. [emphasis added]
>
> …
>
> 49. … The risk to the population from a catastrophic failure, including all societal effects such as effects on the economy, environment and land use as well as health, is basically a siting issue. The Reactor Safety Advisory Committee issued what it called the Siting Guide which did not address this basic siting issue.
>
> …

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[44] R.A. Brown and Associates, ACR Licensing Basis Project, Licensing Guide: Design, Submitted to Canadian Nuclear Safety Commission, September 2004, ss 5.57, 5.58, p 28 (Tab C31)

> 122. Because this Licensing Basis Document is for the design of nuclear power plants siting considerations have not been included in the safety goals. If siting factors, such as the size of the exclusion zone and demographics, are not included there is no logical connection between the safety objectives in paragraph 2.2 of the Licensing Basis Document and the safety goals.[45]

A 2007 report commissioned by CNSC on siting requirements found important gaps not addressed in the CNSC documents or anywhere else in its licensing framework, including "criteria for the rejection of a proposed site if it is deemed unsuitable", "monitoring of site characteristics over the lifetime of the nuclear facility", and "that there are no insurmountable obstacles to the establishment of suitable emergency measures."[46]

vi. Ontario's emergency response plans only deal with smaller-scale nuclear accidents

The seriousness of the issue of siting requirements near nuclear power plants is compounded by Ontario's current use of smaller-scale accidents as the basis for its emergency plans. The RSC recommended in a 1996 report that "…detailed emergency planning should be done for accidents resulting from a credible series of events which could occur with a probability of approximately 10^{-7} per reactor year."[47] At that time, the RSC relied on a 1995 Pickering A risk assessment, which concluded a Fukushima-scale radiation release was highly unlikely, to choose the basis for offsite emergency planning.[48]

Emergency Management Ontario observed that emergency plans would not be affected by consideration of the accident scenarios outlined in environmental assessments, which CNSC uses to perform siting assessments.[49] Those accidents are much smaller than a Fukushima-scale accident. The Fukushima disaster has shown that industry probability estimates are too unreliable and uncertain to justify excluding major radioactive releases from detailed emergency plans. A precautionary approach, which considers consequences to the public instead of relying on uncertain estimates about the likelihood of an accident, is necessary in light of the lessons learned from the Fukushima accident.

For example, following the Fukushima accident, the German Commission on Radiological Protection (SSK) recommended a more precautionary approach to emergency planning which would reflect an accident's potential to cause harm, rather than its likelihood of occurring:

> …that the range of accidents included in emergency response planning should be

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[45] John W. Beare, *Review of ACR-LBD-001, Licensing Basis Document for New Nuclear Power Plants in Canada*, Draft dated December 2004, paras 19-20, 27, 49, 122, pp 4-6, 13, 31 ("Beare Draft Review") (Tab C32)

[46] Regulatory Site Requirements Needed for New Nuclear Power Plants in Canada, Licence to Prepare Site, June 2007 ("Regulatory Site Requirements"), s 4.8, p 8 (Tab C33)

[47] RSC Report, section 7.1, p 33

[48] Dr. Aadu Pilt, *A Technical Assessment of the Enhanced Planning and Preparedness Arrangements in the Contiguous Zone Surrounding Ontario Power Generation Inc. Nuclear Generating Stations*, May 2002, pp 1-2 (Tab C34)

[49] CNSC Notice of Meeting – February 6, 2013, p 3

> redefined to more closely reflect an accident's potential impact rather than its likelihood. The SSK therefore considers it necessary to expand the range of accidents included in the contingency planning and also add to emergency response planning and planning area considerations the INES 7 accidents whose radiological effects mirrors those of Fukushima.[50]

Germany reassessed the adequacy of its emergency planning zones against Fukushima-scale radioactive releases. The modelling of these accidents lead to recommendations to significantly expand emergency planning zones, including extending the "Central Zone" (similar to Ontario's Contiguous Zone) from 2 to 10 km, extending the "Middle Zone" from 10 to 20 km, and extending the Outer Zone from 25 to 100 km (similar to Ontario's Secondary Zone).[51] These results are similar to the actual use of offsite emergency measures in Japan during the first month of the Fukushima disaster.

Given the RSC and Joint Review Panel's recommendations regarding restricting land use in the 3 km Contiguous Zone were based on maintaining the province's ability to safely evacuate the public in the event of accidents significantly smaller than a Fukushima-scale release, population growth should actually be restricted and managed far beyond the current 3 km Contiguous Zone and 10 km Primary Zone.

vii. Lessons from Fukushima: the social effects of major nuclear accidents are ignored in current siting criteria

The current risk of incompatible land use planning and siting of nuclear power plants without concern for population density in surrounding areas is also compounded because individual risk, but not societal risk, are being considered by Canadian regulators.

The Chernobyl and Fukushima accidents highlighted that nuclear accidents can displace large populations and create significant societal disruption. However, there are no limits on the potential social disruption from a large-scale nuclear accident at an Ontario nuclear site because Ontario's land use planning regime does not restrict population in areas most affected by nuclear accidents.

The limits on risk of social disruption are currently not considered in provincial land use planning requirements. Individual risk calculations do not take into account the total number of people exposed to the hazard, while societal risk looks at the total population exposed. Even if an entity complies with individual risk limits, there may still be significant societal risk.[52] For

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[50] German Commission on Radiological Protection (SSC), *Planning areas for emergency response near nuclear power plants: Recommendation by the German commission on Radiological Protection*, February 2014, p 10 (Tab C35)

[51] Florian Gering, *Updated emergency planning zones in Germany and the importance of release source term,* presentation by emergency management division, Federal Office for Radiation Protection (Tab C36)

[52] Laurène Debesse, *The Use of Frequency-Consequence Curves in Future Reactor Licensing,* submitted in Partial Fulfillment of the Requirements for the Degrees of Master of Science in Technology and Policy and Master of Science in Nuclear Science and Engineering at the Massachusetts Institute of Technology, February 2007, pp 53-54 ("The Use of Frequency-Consequence Curves") (Tab C37)

nuclear power plants, there are three main sources of societal risk: degradation of plant safety, increase of the core inventory, and an increase in the number of people around the plant.[53]

As observed by John W. Beare prior to the Fukushima accident, there are no risk metrics to limit social impacts in the event of a nuclear accident. Federal reactor design criteria only limit the risk of individual fatalities and cancer:

> Limits were placed on the individual and total dose to the surrounding population for postulated serious process failures and dual failures. Dose in the stochastic (probabilistic) range implies a risk of fatal cancer in the future from that dose. Therefore, there were three quantitative safety goals established based on risk. Although this approach put a limit on the risk of early fatality to individuals from a catastrophic failure, no consideration was given to the total risk to the population or to the social and economic effects from a catastrophic failure. The risk of early fatality to an individual from a catastrophic failure is basically a design issue. The risk to the population from a catastrophic failure, including all societal effects such as effects on the economy, environment and land use as well as health, is basically a siting issue. The Reactor Safety Advisory Committee issued what it called the Siting Guide which did not address this basic siting issue. [emphasis added][54]

Former Chairman of the U.S. Nuclear Regulatory Commission Gregory B. Jaczko's observed after the Fukushima accident that according to the industry's individual risk metrics - prompt radiation health and latent radiation health effects – the Fukushima nuclear disaster would not be considered "an unacceptable event":[55]

> So if we look today at our risk models, the most fundamentally missing piece, I believe, is the right way to characterize what we believe as societies are the unacceptable things about nuclear power accidents. But it is a very different way to think about these things than we have done in the past.
>
> And by that, I mean it is the real human consequences that we are dealing with -- evacuations of large populations, perhaps extended relocation of populations; significant effort to clean up, decommission and decontaminate perhaps significant areas of land; the redevelopment and the loss of significant energy infrastructure; and the societal consequences that entails.
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> …

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[53] The Use of Frequency-Consequence Curves, p 59
[54] Beare Draft Review, para 49, p 13
[55] Honorable Gregory B. Jaczko, Chairman of the U.S. Nuclear Regulatory Commission, "*Looking to the Future*," Platts 8th, Rockville, MD Annual Nuclear Energy Conference February 9, 2012, p 5 ("Looking to the Future") (Tab C38)

> It is the intangible health effects of displacing a population from their homes, from their friends, their families, from the schools their children attend -- those are the kinds of intangibles that we don't account for right now in our understanding of consequences.[56]

C. International Standards

IAEA safety standards clearly identify population density and population characteristics near a nuclear power plant as important considerations in decisions about siting nuclear power plants and emergency planning. Ontario is not currently complying with IAEA standards and is instead encouraging population growth in locations near nuclear power plants.

The IAEA's safety standard for *Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants* states:

> The presence of large populations in the region or the proximity of a city to the nuclear power plant site may diminish the effectiveness and viability of an emergency plan.[57]

The IAEA standard requires study of the regional population near the site of a nuclear power plant to evaluate the potential radiological impacts of normal radioactive discharges and accidental releases, and to assist in the demonstration of the feasibility of emergency response plans.[58] Section 5.3 provides that emergency plans must account for the characteristics of the population around the site:

> The external zone includes an area immediately surrounding the site of a nuclear power plant in which population distribution, population density, population growth rate, industrial activity, and land and water uses are considered in relation to the feasibility of implementing emergency measures.[59]

There should be no adverse site conditions which could hinder sheltering or evacuation of the population.[60] The Safety Guide identified factors that may diminish the effectiveness and viability of emergency plans, including population density and distribution in the region, distance of the site from population centres and special groups of the population who are difficult to evacuate or shelter.[61] Site related factors must be reviewed periodically.[62]

Section 5.1 of the IAEA's safety standard for *Site Evaluation for Nuclear Installations* highlights Ontario's responsibility to monitor demographic conditions around a nuclear installation over its

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[56] Looking to the Future, pp 5-6
[57] International Atomic Energy Association, *Safety Standard for Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants*, Safety Guide No. NS-G-3.2, March 2002, s 6.4, p 28 ("IAEA Safety Standard for Dispersion of Radioactive Material") (Tab C39)
[58] IAEA Safety Standard for Dispersion of Radioactive Material, s 5.1, p 25
[59] IAEA Safety Standard for Dispersion of Radioactive Material, s 5.3, p 25
[60] IAEA Safety Standard for Dispersion of Radioactive Material, s.6.1, p 27
[61] IAEA Safety Standard for Dispersion of Radioactive Material, ss 6.3 and 6.4, pp 27-28
[62] IAEA Safety Standard for Dispersion of Radioactive Material, s 6.7, p 28

lifetime.[63] Population density near the nuclear plant is to be closely monitored, with particular attention to densely populated areas and residential centres in the region, and to residential institutions such as schools, hospitals and prisons.[64]

The recent United Nations Sendai Framework for Disaster Risk Reduction 2015 – 2030 also highlights the need for land use planning to account for the risk of a nuclear accident and emergency planning. In particular, disaster risk assessments should be incorporated into land-use policy development and implementation, including urban planning.[65] It is important to formulate public policies aimed at addressing the issues of prevention or relocation of human settlements in disaster risk-prone zones[66], rather than encouraging population growth in these areas.

The IAEA Report on the Fukushima Daiichi Accident recommended that emergency planning zones and areas need to be established with severe nuclear emergencies taken into account. Preparations are necessary to ensure the safe evacuation of special facilities, including hospitals and nursing homes.[67]

All of which is respectfully submitted.

Jacqueline Wilson	Shawn-Patrick Stensil	Gail Cockburn
CELA Counsel	Greenpeace Canada	Durham Nuclear Awareness

[63] IAEA Safety Standard for Site Evaluation, s 5.1, pp 20-21
[64] IAEA Safety Standard for Site Evaluation , s 4.11, pp 19-20
[65] United Nations, *Sendai Framework for Disaster Risk Reduction 2015-2030*, para 30(f), p 19 ("Sendai Framework") (Tab C40)
[66] Sendai Framework, para 27(k), p 18
[67] International Atomic Energy Agency, *The Fukushima Daiichi Accident*, Technical Volume 3/5 – Emergency Preparedness and Response, s 3.3.10, p 99-100 ("*Fukushima Daiichi Accident*") (Tab C41)

C. EVIDENCE SUPPORTING THE REQUESTED REVIEW

The documentary evidence supporting the requested review is attached.

TAB C	DOCUMENT
1	Canadian Nuclear Safety Commission, Notice of Meeting, *Engagement with Stakeholders: DNNP Joint Review Panel (JRP) Recommendation #43: Land Use Policy*, February 6, 2013
2	STUK (Radiation and Nuclear Safety Authority), *Safety Criteria for Siting of Nuclear Power Plant*, 2001
3	Provincial Working Group #8, *The Upper Limit for Detailed Nuclear Emergency Planning,* June 30, 1998 (Excerpts)
4	Royal Society of Canada and Canadian Academy of Engineering, *Report to the Ministry of Energy and Environment Concerning Two Technical Matters in the Province of Ontario's Nuclear Emergency Plan*, November 1996 (Excerpts)
5	Canadian Nuclear Safety Commission, Transcript of Public Meeting, August 18, 2016 (Excerpts)
6	Ministry of Municipal Affairs and Housing, *Provincial Policy Statement, 2014* (Excerpts)
7	Hardy, Stevenson and Associates, Land Use Planning Workshop: Darlington New Nuclear Project, Discussion and Summary Agreement, September 27, 2013
8	Municipality of Clarington, *Draft Official Plan 2016* (Excerpts)
9	Ministry of Infrastructure, *Growth Plan for the Greater Golden Horseshoe, 2006,* Office Consolidation June 2013
10	Ministry of Municipal Affairs and Housing, Proposed Growth Plan for the Greater Golden Horseshoe, 2016, May 2016
11	Canadian Nuclear Safety Commission, Notice of Meeting, *Teleconference – Next Steps on JRP Recommendation #43 – Land Use Policy – Engagement with Stakeholders*, April 23, 2013
12	Cedric Jobe and Rick Jennings (Ministry of Energy), Briefing Note, January 2010
13	Ontario Power Generation, *Pickering B Safety Report – Part 1*, 2009 (Excerpts)
14	Durham Emergency Management Office, *Durham Nuclear Emergency Response Plan*, May 2016
15	Ontario Power Generation, *Pickering NGS Development of Evacuation Time Estimates*, April 12, 2016 (Excerpts)
16	Amendment 26 to the City of Pickering Official Plan, approved by the Ontario Municipal Board on March 4, 2015
17	City of Pickering, Notice of Public Open House, Applications for Zoning By-law Amendment, and Draft Plan of Condominium, submitted by Madison Liverpool Limited, for the former Holy Redeemer Catholic Elementary School located at 747 Liverpool Road, May 17, 2016
18	Google Map, Holy Redeemer Catholic School to Pickering Nuclear Generation Station, September 2016
19	Durham Regional Official Plan Amendment (ROPA 128), approved January 9, 2013 (Excerpts)
20	Ontario Power Generation, *Pickering A Safety Report,* 2010 (Excerpts)

21	International Atomic Energy Agency, Safety Guide No. NS-G-3.1, *External Human Induced Events in Site Evaluation for Nuclear Power Plants*, 2002
22	Canadian Nuclear Safety Commission, *Briefing Note – Darlington NGS*, November 28, 2005
23	Ontario Power Generation, *Darlington NGS Development of Evacuation Time Estimates*, December 20, 2015 (Excerpts)
24	Joint Review Panel, *Environmental Assessment Report: Darlington New Nuclear Power Plant Project*, August 2011 (Excerpts)
25	Canadian Nuclear Safety Commission, *CNSC Integrated Action Plan on the Lessons Learned From the Fukushima Daiichi Nuclear Accident*, August 2013
26	Canadian Nuclear Safety Commission, *REGDOC-1.1.1, Licence to Prepare Site and Site Evaluation for New Reactor Facilities*, August 2013 (Excerpts)
27	Canadian Nuclear Safety Commission, *RD-346: Site Evaluation for New Nuclear Power Plants*, dated modified February 3, 2014
28	Canadian Nuclear Safety Commission, *RD-337: Design of New Nuclear Power Plants*, dated modified February 3, 2014
29	Canadian Nuclear Safety Commission, *Canadian National Report for the Convention on Nuclear Safety, Seventh Report*, August 2016
30	International Atomic Energy Agency, *Site Evaluation for Nuclear Installations*, Safety Requirements No. NS-R-3 (Rev. 1), February 2016
31	R.A. Brown and Associates, *ACR Licensing Basis Project, Licensing Guide: Design, Submitted to Canadian Nuclear Safety Commission*, September 2004 (Excerpts)
32	John W. Beare, *Review of ACR-LBD-001, Licensing Basis Document for New Nuclear Power Plants in Canada*, Draft dated December 2004
33	Regulatory Site Requirements Needed for New Nuclear Power Plants in Canada, Licence to Prepare Site, June 2007
34	Dr. Aadu Pilt, *A Technical Assessment of the Enhanced Planning and Preparedness Arrangements in the Contiguous Zone Surrounding Ontario Power Generation Inc. Nuclear Generating Stations*, May 2002
35	German Commission on Radiological Protection (SSC), *Planning areas for emergency response near nuclear power plants: Recommendation by the German commission on Radiological Protection*, February 2014
36	Florian Gering, *Updated emergency planning zones in Germany and the importance of release source term*, presentation by emergency management division, Federal Office for Radiation Protection
37	Laurène Debesse, *The Use of Frequency-Consequence Curves in Future Reactor Licensing*, submitted in Partial Fulfillment of the Requirements for the Degrees of Master of Science in Technology and Policy and Master of Science in Nuclear Science and Engineering at the Massachusetts Institute of Technology, February 2007
38	Honorable Gregory B. Jaczko, Chairman of the U.S. Nuclear Regulatory Commission, "*Looking to the Future*," Platts 8th, Rockville, MD Annual Nuclear Energy Conference February 9, 2012
39	International Atomic Energy Association, *Safety Standard for Dispersion of Radioactive Material in Air and Water and Consideration of Population*

	Distribution in Site Evaluation for Nuclear Power Plants, Safety Guide No. NS-G-3.2, March 2002
40	United Nations, *Sendai Framework for Disaster Risk Reduction 2015-2030*
41	International Atomic Energy Agency, *The Fukushima Daiichi Accident*, Technical Volume 3/5 – Emergency Preparedness and Response (Excerpts)

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

File/Dossier: 2.01
e-Docs: 4070956

NOTICE OF MEETING – AVIS DE RÉUNION

TO *A*	**CNSC staff** B. Howden, D. Newland, R. Richardson, L. Andrews, F. Martel **Emergency Management Ontario** Kathy Bleyer, Tom Kontra, Dave Nodwell
SUBJECT *OBJET*	**Engagement with Stakeholders:** **DNNP Joint Review Panel (JRP) Recommendation #43: Land Use Policy** JRP Report: http://www.ceaa.gc.ca/052/document-eng.cfm?did=55381 Government of Canada Response: http://www.ceaa.gc.ca/052/document-html-eng.cfm?did=55542
AGENDA OR REMARKS *ORDRE DU JOUR OU REMARQUES*	1. Welcome & Introductions 2. Background/Context – CNSC staff (see attached presentation) 3. Discussion points - Land use planning roles and responsibilities - Views on applicable JRP recommendations on land use - Views on the development of a land use policy - Other matters of interest - Next steps 4. Meeting closeout
LOCATION OF MEETING *ENDROIT DE LA RÉUNION*	Location/ Endroit: 25 Grosvenor Street - Toronto Date: February 6, 2013 Time/Heure: 10:00 am — Duration/Durée: 1.5 - 2 hours
ARRANGED BY *ORGANISÉ PAR*	Name/Nom: R. Richardson — Tel: 943-0241

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

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Meeting Summary

E-Docs #4084839
File/Dossier: 2.01
***Date:** February 6, 2013*

SUBJECT *OBJET*	**EMO/CNSC Meeting – Darlington New Nuclear Project – Joint Review Panel Recommendation #43 - Land Use Policy**	
ATTENDEES *PARTICIPANTS*	**CNSC** Barclay Howden Dave Newland Ross Richardson Francis Martel Laura Andrews	**EMO** Tom Kontra Kathy Bleyer Dave Nodwell
LOCATION OF MEETING *ENDROIT DE LA RÉUNION*	**25 Grosvenor Street - Toronto**	
DATE	February 6, 2013	
TIME/*HEURE*	10:00 am – 12:00 pm	

REMARKS *REMARQUES*

1. Meeting Purpose

Ross Richardson (CNSC): Provided background and context for the purpose of the meeting which was to:

1) Discuss recommendation #43 of the Darlington Joint Review Panel (JRP) Report on the development of a policy for land use around nuclear facilities.

2) Solicit feedback from Emergency Management Ontario (EMO) on its land use planning roles and responsibilities, views on applicable JRP recommendations on land use, and views on the development of a land use policy.

2. CNSC staff Presentation

Ross Richardson (CNSC): Presented "DNNP – JRP Recommendation #43 – Land Use Policy" (see E-doc 4070954 for CNSC Presentation).

3. Key Discussion Points

The key discussion points raised during the meeting are summarized as follows:

- CNSC staff explained that they are meeting with appropriate stakeholders including OPG, Emergency Management Ontario, Region of Durham, Municipality of Clarington, City of Oshawa, and the Government of Ontario (Ministry of Municipal Affairs and Housing, Energy, Environment, and Infrastructure) in order to facilitate the implementation of JRP recommendation #43. CNSC staff stated that these meetings will take place in the month of February 2013.

- EMO explained its roles and responsibilities with respect to nuclear emergency planning as well as its relationships with other provincial ministries, local governments and OPG.
- EMO stated that land use planning it outside of its mandate and that the responsibility for land use planning in Ontario resides with the Ontario Ministry of Municipal Affairs and Housing (MMAH).
- EMO indicated that they are in regular contact with MMAH at an operational level, however, there is little to no interaction between EMO and MMAH on land use policy matters.
- EMO indicated that they did not provide comments on the MMAH draft set of land use policies that were released for comment in September 2012.
- While not considered part of their mandate, EMO stated that they would be supportive of land use policy that would facilitate nuclear emergency planning.
- EMO explained that they are currently reviewing the Provincial Nuclear Emergency Response Plan (PNERP) in response to an action from the CNSC's Fukushima Task Force Report. This review is expected to be completed by December 2013.
- EMO noted it would be beneficial to have the provincial and municipal emergency planning co-ordinators attend future meetings with the CNSC on land use planning. EMO provided the provincial and municipal emergency planning co-ordinators contact information to the CNSC for information.
- **Views on the development of a land use policy**
    - Should MAH develop a policy specific to nuclear in the Provincial Policy Statement (PPS), MOE would be happy to provide review/comment on the draft policy from a consequence management perspective.
    - EMO feels it may be difficult to avoid specifics in a policy however, there may be other places outside of a higher level policy in which to provide further guidance.
    - EMO view of what success would like like with respect to a policy would be that no Citizen of Ontario would be subjected to an avoidable hazard. EMO role is not to say "don't put people there because it will result in complicated plans, but rather IF you allow people to settle there, then you must plan for and consider all of the following things in your plans…"

- **Potential impact of a Policy change on EMO Plans -** EMO is able to adjust their plans accordingly. MOE would be satisfied with existing emergency management plans with minor changes to the Darlington Plan but may need to put in an adjustment to their Master Plan with significant changes. They feel this is not likely. The accident scenarios outlined in the EA would need to go beyond these in order to effect a change to their plans. For example, consideration of multi-unit accidents would change their plans as this is considered more severe and less probable. The risk assessments for the selected technology could even represent reduced risks and be less than accident scenarios outlined in the EA. EMO plans are in the prudence range as opposed to the safety case range.

- **Current estimated population within 3 km zone** – There are an estimated 2,000 residents currently within 3km of the Darlington site.

- **General logistical details between EMO and Municipalities** – Emergency planning typically goes bottom up with individuals being responsible for the first 72 hrs. Following this, Municipalities identify any gaps in their ability to deal with certain scenarios to the province. With nuclear, EMO directs the off-site response, indicating to municipalities what their response should be. The Municipality and EMO work together on planning. EMO owns the provincial nuclear response plan but they don't carry it out. The EMO program delivery section looks at every plan in the province to ensure its suitability against a generic set of approx. 39 hazards which the municipalities use as a guide to identify which apply to them.

- **Emergency Management and Civil Protection Act** – communities with nuclear sites must have an emergency plan consistent with the Provincial Nuclear Emergency Response Plan (PNERP).

- **Clear roles & responsibilities between Municipality / Region** – EMO noted that the Municipalities and the Region have clearly defined what each does during an emergency.

- **CNSC Fukushima Task Force Report Recommendations** – the EMO is following through with the recommendation to re-assess all nuclear emergency plans by December 2013.

4. Summary of Key Messages

- MOE explained that Land Use Planning is under the authority of MAH and that consequence management is within the pervue of EMO.

- MOE indicated they would support policy that reduces the population in

	the vicinity of an NPP. • Should MMAH develop a policy specific to nuclear in the Provincial Policy Statement (PPS), MOE would be happy to provide review/comment on the draft policy from a consequence management perspective. • EMO would be able to adjust their plans accordingly to any impacts flowing down as a result of policy changes in the PPS through to municipal plans and therefore onto the subsequent emergency response plans.
NOTES WRITTEN BY	**Name(s)/Nom(s) :** Laura Andrews

STUK

OHJE GUIDE YVL 1.10

Safety criteria for siting a nuclear power plant

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RADIATION AND NUCLEAR SAFETY AUTHORITY

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STUK

GUIDE YVL 1.10
11 July 2000

Safety criteria for siting a nuclear power plant

This Guide is in force as of 1 January 2001 until further notice.

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RADIATION AND NUCLEAR SAFETY AUTHORITY

Authorisation

By virtue of the below acts and regulations, the Radiation and Nuclear Safety Authority (STUK) issues detailed regulations that apply to the safe use of nuclear energy and to physical protection, emergency preparedness and safeguards:

- Section 55, paragraph 2, point 3 of the Nuclear Energy Act (990/1987)
- Section 29 of the Council of State Decision (395/1991) on the Safety of Nuclear Power Plants
- Section 13 of the Council of State Decision (396/1991) on the Physical Protection of Nuclear Power Plants
- Section 11 of the Council of State Decision (397/1991) on the Emergency Preparedness of Nuclear Power Plants
- Section 8 of the Council of State Decision (398/1991) on the Safety of a Disposal Facility for Reactor Waste
- Section 30 of the Council of State Decision (478/1999) on the Safety of Disposal of Spent Nuclear Fuel.

Rules for application

The publication of a YVL guide does not, as such, alter any previous decisions made by STUK. After having heard those concerned, STUK makes a separate decision on how a new or revised YVL guide applies to operating nuclear power plants, or to those under construction, and to licensees' operational activities. The guides apply as such to new nuclear facilities.

When considering how new safety requirements presented in YVL guides apply to operating nuclear power plants, or to those under construction, STUK takes into account section 27 of the Council of State Decision (395/1991), which prescribes that *for further safety enhancement, action shall be taken which can be regarded as justified considering operating experience and the results of safety research as well as the advancement of science and technology.*

If deviations are made from the requirements of the YVL guides, STUK shall be presented with some other acceptable procedure or solution by which the safety level set forth in the YVL guides is achieved.

Translation. Original text in Finnish.

1 General

Section 6 of the Nuclear Energy Act (YEL 990/1987) stipulates that *the use of nuclear energy must be safe; it shall not cause injury to people, or damage to the environment or property.*

In the siting of a nuclear power plant, the aim is to protect the plant against external threats as well as to minimise any environmental detriments and threats that might arise from it. Other factors to be considered include: impact on land use, socio-economic impacts, traffic arrangements, reliable electric power transfer to the national grid and specific factors relating to the security of supply of electric power.

Prior to the licensing procedure proper, the environmental effects of the nuclear power plant project are studied and evaluated by environmental impact assessment (EIA). The EIA procedure falls under the Act on Environmental Impact Assessment Procedure (EIA) (468/1994) and the Decree on EIA (268/1999). In addition, Finland's neighbouring countries shall be heard where deemed necessary by virtue of the Convention on Environmental Impact Assessment in a Transboundary Context [1].

The Nuclear Energy Act prescribes that there must be a decision in principle of the Council of State, approved by Parliament, stating that the nuclear power plant project is in the overall good of society. An application for the decision in principle is submitted to the Council of State; the Ministry of Trade and Industry submits it to the Radiation and Nuclear Safety Authority (STUK) for a preliminary safety evaluation and requests statements from the Ministry of the Environment, the municipal council of the candidate municipality and its neighbouring municipalities. The Nuclear Energy Decree (YEA 161/1998) stipulates that an environmental impact assessment report drawn up as a result of the EIA procedure shall be appended to the application for the decision in principle. The Council of State can consider a positive decision in principle only in case the candidate municipality has issued a statement in favour of the facility's construction.

Detailed licensing requirements applicable to the construction and operation of nuclear power plants are stipulated in the Nuclear Energy Act and Decree. The granting of a licence in accordance with the Nuclear Energy Act requires that the project and its environmental impacts are reported to the Commission of the European Communities, not later than six months prior to the granting of the licence, as required in article 37 of EURATOM Treaty and in Commission Recommendation 99/829/Euratom [2], which supplements the Treaty.

The Land Use and Building Act (132/1999) and Decree (895/1999) prescribe planning pertaining to land use and construction. Regional plans and local master plans are, by nature, far-reaching, general land use plans. Detailed plans are drawn up for the detailed arrangement, construction and development of land use at local level. Construction is not allowed on shore zones belonging to the coastal area of a sea or of a water system unless the area is covered by a detailed plan (a detailed shore plan) or by a specific local master plan. When deciding about a land use plan and a construction permit the authorities consider the special requirements pertaining to construction work on the nuclear power plant site and in its surroundings. Section 58 of the Nuclear Energy Act decrees that before a town plan[1] or building plan[1] is drawn up for the area intended for the site of a nuclear facility, and prior to the approval of such a plan where a site is reserved for the construction of a nuclear facility, a statement must be obtained from the Radiation and Nuclear Safety Authority.

In addition to the above, the environmental permit procedure prescribed in the Environmental Permit Procedures Act (731/1991) applies to the construction and operation of nuclear power

1 The terms "town plan" and "building plan" have been replaced with a "detailed plan" by virtue of the Land Use and Building Act (132/1999) and Decree (195/1999).

plants. Rescue plans with provision for nuclear power plant accidents are dealt with in the Act on Rescue Services (561/1999) and the Decree on Rescue Services (857/1999) as well as in the Ministry of the Interior Order 1/97 [3] and the associated Guideline A:57 [4].

Requirements applicable to the limitation of radioactive releases from nuclear power plants are presented in chapter 3 of the Council of State Decision (VNP 395/1991) on the general regulations for the safety of nuclear power plants. Section 20 of the Decision, for its part, requires that *the most important nuclear power plant safety functions shall remain operable in spite of any natural phenomena estimated possible on site or other events external to the plant.* Supplementary guidelines pertaining to safety functions can be found in Guides YVL 2.6 and YVL 2.8.

Guide YVL 2.6 concerns the effects of seismic events and how they should be considered in the structural concepts of nuclear power plants. Guide YVL 2.8 deals with probabilistic safety analyses (PSA) for nuclear power plants.

STUK Guides YVL 7.1–7.11 and YVL 7.18 deal with onsite and offsite radiation safety and with licensees' emergency response plans.

This guide sets forth requirements for safety of the population and the environment in nuclear power plant siting. It also sets out the general basis for procedures employed by other competent authorities when they issue regulations or grant licences. On request STUK issues case-specific statements about matters relating to planning and about other matters relating to land use in the environment of nuclear power plants.

Alternative candidate plant sites may be simultaneously examined during the EIA process and in the application for a decision in principle. In accordance with the Nuclear Energy Act, applications for a construction licence and an operating licence may only concern one plant site.

2 Plant site and surroundings

The normal operation of the nuclear power plant or anticipated operational transients do not limit land use offsite. In the environment surrounding the nuclear power plant, however, precautions in the form of land use and public protection plans shall be taken with a view to the possibility of a severe accident [5, 6]. This means, among other things, that in the plant's vicinity there may not be facilities or population centres where the necessary protective measures, such as sheltering indoors or evacuation, would be difficult to implement. In the plant's vicinity, no activities may be carried out that could pose an external threat to the plant.

The general principle in the siting of nuclear power plants is to have the facilities in a sparsely populated area and far away from large population centres. What justifies placement in a sparsely populated area is that emergency planning will then be directed at a smaller population group and will thus be easier to implement.

A nuclear power **plant site** extends to about a kilometre's distance from the facility. It is defined as an area where only power plant related activities are allowed as a rule. Permanent settlement is prohibited and only very limited employee accommodation or recreational settlement is allowed. The licensee responsible for the operation of the nuclear power plant shall have authority of decision over all activities in the area and shall be able to remove unauthorised individuals from the site, if necessary, or prevent such individuals from entering it. The plant site may contain other non-facility related activities provided that they do not pose a threat to plant safety. A traffic lane may traverse the site if the volume of traffic is small and if traffic can be directed elsewhere, if necessary. Visits onsite are allowed provided that the licensee has the possibility to control the movement of visitors.

The plant site is surrounded by a **protective zone** extending to about a five kilometres' distance from the facility. Land use restrictions are in force within the zone. Dense settlement and hospitals or facilities inhabited or visited by a considerable number of people are not allowed within the zone. The zone may not contain such significant productive activities as could be affected by an accident at the nuclear power plant. The number of permanent inhabitants should not be in excess of 200. The number of persons taking part in recreational activities may be higher, provided that an appropriate rescue plan can be drawn up for the area.

In accordance with a Ministry of the Interior Order [3], the nuclear facility is to be surrounded by an **emergency planning zone** extending to about 20 kilometres from the facility; the zone shall be covered by detailed rescue plans for public protection drawn up by the authorities. The authorities also bear responsibility for the implementation of the plans. In implementation, special attention shall be paid to the characteristics of the site's surroundings, such as archipelagos that are difficult to cross and recreational settlements, for example. The emergency planning zone may not contain such populations or population centres as would render impossible the efficient implementation of rescue measures applicable to them.

3 Safety factors affecting site selection

3.1 External events affecting safety

The applicant for a licence shall list those external events that could pose a threat to safety at the site in question and shall also assess the risks arising from these events. Effects on the supply of cooling water and on electric power grid connections shall also be considered.

Hazardous industry, traffic and exceptional natural phenomena shall be considered. Examples of exceptional natural phenomena include

- freezing or other clogging of the cooling water intake
- storms
- snow loads
- flood
- low sea level
- seismic events.

The risks arising from external events are assessed by analyses conducted in accordance with Guide YVL 2.8.

3.2 Radioactive releases

Sections 9–12 of the Council of State Decision (395/1991) set forth regulations for the limitation of population radiation exposure around nuclear power plants and for the limitation of radioactive releases under normal operating conditions, anticipated operational transients as well as postulated accidents and severe accidents.

Limits on radioactive releases are defined such that radiation doses to the population around the plant, calculated for the site in question on the basis of the release limits, do not exceed the dose limits set by Council of State Decision.

Guide YVL 7.1 sets out in more detail the Council of State's regulations for radiation exposure and release limits. It sets forth the general requirements for analysis methods, for exposure pathways to be examined by dose calculation and for the evaluation of individual and collective doses to the population.

Guide YVL 7.3 presents detailed requirements applicable to the conducting of analyses on the dispersion of radioactive releases and Guide YVL 7.2 sets forth detailed requirements for the calculation of individual and collective doses to the population.

When radiation doses to the surrounding population are calculated, the region's special characteristics—hydrological, geological and meteorological—as well as the living conditions and habits of the population shall be considered.

4 Regulatory control by the Radiation and Nuclear Safety Authority

4.1 EIA procedure

STUK issues statements to the Ministry of Trade and Industry on the EIA programme and on the environmental impact assessment report drawn up on the basis of the programme.

4.2 Decision in principle

Sections 23 and 24 of the Nuclear Energy Decree prescribe that the following documents, among others, shall be appended to the application for a decision in principle referred to in the Nuclear Energy Act:

- a general description of ownership and occupation of the planned nuclear facility site
- a description of settlement and other activities on the planned nuclear facility site and in its vicinity, including land use planning arrangements
- an assessment of suitability of the planned site for its purpose and of land use restrictions in plant surroundings caused by the siting of the nuclear power facility
- an assessment report drawn up in accordance with the Act on Environmental Impact Assessment Procedure and an account for the design criteria the applicant intends to apply in order to avoid environmental damage and to limit environmental burdens.

STUK requires from the applicant an illustrative assessment of the possible environmental effects of various accident situations.

STUK makes a preliminary safety evaluation of the application for a decision in principle for submission to the Ministry of Trade and Industry. STUK assesses the site, taking into consideration the documentation provided by the applicant, legislation and the requirements of YVL guides. If there already is a nuclear power plant on the planned site, any relevant regulatory experience relating to its operation will be taken into account.

4.3 Construction licence and operating licence

The Council of State authorises the construction and operation of a nuclear power plant.

In accordance with the Nuclear Energy Act, the following site-related documents whose submission is decreed in section 32 of the Nuclear Energy Decree shall be appended to the construction licence application:

- proof of the applicant's right to use the planned facility site
- a description of settlement and other activities as well as planning arrangements on the planned facility site and in its vicinity
- a description of the nuclear facility's effects on the environment and a description of the design criteria the applicant aims to employ to limit environmental damage.

In accordance with section 35 of the Nuclear Energy Decree, the applicant is to submit to STUK a preliminary safety analysis report (PSAR) about the planned facility and its emergency response plans. The preliminary safety analysis report includes at least general design and safety criteria for the facility, a detailed description of the facility and site, a description of the facility's operation and behaviour under accident conditions as well as a detailed description of the effects of its operation on the environment.

Further, STUK requires that the applicant submits a preliminary probabilistic safety analysis in accordance with Guide YVL 2.8 for evaluation of the probability of possible accidents at the plant and of related events as well as the magnitude of consequent radioactive releases.

Correspondingly, an application for an operating licence for a nuclear power plant shall include the reports required in section 34 of the Nuclear

Energy Decree. Section 36 of the Nuclear Energy Decree prescribes that, when applying for an operating licence, the applicant shall send to STUK also the following documents, among others:

- a final safety analysis report (FSAR)
- a probabilistic safety analysis report (PSA)
- a description of emergency preparedness arrangements
- an environmental radiation monitoring programme for the nuclear power plant.

STUK draws up safety evaluations of the applications for the construction licence and subsequently the operating licence and submits statements to the Ministry of Trade and Industry. When reviewing relevant sections of the safety analysis report and making the safety evaluation concerning the facility site and its environment, STUK checks that the report includes sufficient and clear descriptions of

- geography in the region as well as prevailing and predicted population distributions
- use of land and water area as well as sources of livelihood in the region
- site climate and meteorological dispersion conditions
- hydrological factors onsite and in the environment
- geology and seismology onsite and in the environment.

The holder of an operating licence for a nuclear power plant shall update the final safety analysis report (FSAR) also during the plant's operation. Reviewed FSAR descriptions of the facility site and its environment shall be submitted to STUK for approval.

5 References

[1] Convention on Environmental Impact Assessment in a Transboundary Context, 25 February 1991.

[2] European Commission Recommendation (1999/829/Euratom) on the Application of Article 37 of EURATOM Treaty.

[3] Protective measures for radiation situations - planning and communicating, Ministry of the Interior, SM 1/97.

[4] Instructions for action in a radiation accident situation, Ministry of the Interior, A:57, 10/011/98, 16 April 1998.

[5] IAEA Safety Series 50-C-S, Code on the Safety of Nuclear Power Plants: Siting, 1988.

[6] International Nuclear Safety Convention (Decree 725/1996).

YVL Guides

General guides

YVL 1.0 Safety criteria for design of nuclear power plants, 12 Jan. 1996

YVL 1.1 Finnish Centre for Radiation and Nuclear Safety as the regulatory authority for the use of nuclear energy, 27 Jan. 1992

YVL 1.2 Documents pertaining to safety control of nuclear facilities, 11 Sept. 1995

YVL 1.3 Mechanical components and structures of nuclear power facilities. Inspection licenses, 22 Oct. 1996 (in Finnish)

YVL 1.4 Quality assurance of nuclear power plants, 20 Sep. 1991

YVL 1.5 Reporting nuclear power plant operation to the Finnish Centre for Radiation and Nuclear Safety, 1 Jan. 1995

YVL 1.6 Nuclear power plant operator licensing, 9 Oct. 1995

YVL 1.7 Functions important to nuclear power plant safety, and training and qualification of personnel, 28 Dec. 1992

YVL 1.8 Repairs, modifications and preventive maintenance at nuclear facilities, 2 Oct. 1986

YVL 1.9 Quality assurance during operation of nuclear power plants, 13 Nov. 1991

YVL 1.10 Requirements for siting a nuclear power plant, 11 July 2000

YVL 1.11 Nuclear power plant operating experience feedback, 22 Dec. 1994

YVL 1.13 Nuclear power plant outages, 9 Jan. 1995

YVL 1.14 Mechanical equipment and structures of nuclear facilities. Control of manufacturing, 4 Oct. 1999 (in Finnish)

YVL 1.15 Mechanical components and structures in nuclear installations, Construction inspection, 19 Dec. 1995 (in Finnish)

YVL 1.16 Control of nuclear liability insurance policies, 22 March 2000 (in Finnish)

Systems

YVL 2.1 Nuclear power plant systems, structures and components and their safety classification, 26 June 2000

YVL 2.2 Transient and accident analyses for justification of technical solutions at nuclear power plants, 18 Jan. 1996

YVL 2.3 Preinspection of nuclear power plant systems, 14 Aug. 1975

YVL 2.4 Primary and secondary circuit pressure control at a nuclear power plant, 18 Jan. 1996

YVL 2.5 Pre-operational and start-up testing of nuclear power plants, 8 Jan. 1991

YVL 2.6 Provision against earthquakes affecting nuclear facilities, 19 Dec. 1988

YVL 2.7 Ensuring a nuclear power plant's safety functions in provision for failures, 20 May 1996

YVL 2.8 Probabilistic safety analyses (PSA), 20 Dec. 1996

Pressure vessels

YVL 3.0 Regulatory control of pressure vessels in nuclear facilities. General guidelines, 11 Sep. 1996

YVL 3.1 Construction plan for nuclear facility pressure vessels, 27 May 1997 (in Finnish)

YVL 3.3 Nuclear power plant pressure vessels. Control of piping, 4 December 1996

YVL 3.4 Nuclear power plant pressure vessels. Manufacturer's competence, 16 December 1996 (in Finnish)

YVL 3.7 Pressure vessels of nuclear facilities. Commissioning inspection, 12 Dec. 1991

YVL 3.8 Nuclear power plant pressure vessels. Inservice inspections, 13 Dec. 1993

YVL 3.9 Nuclear power plant pressure vessels. Construction and welding filler materials, 6 April 1995 (in Finnish)

Buildings and structures

YVL 4.1 Concrete structures for nuclear facilities, 22 May 1992

YVL 4.2 Steel structures for nuclear facilities, 19 Jan. 1987

YVL 4.3 Fire protection at nuclear facilities, 1 Nov. 1999

Other structures and components

YVL 5.1 Nuclear power plant diesel generators and their auxiliary systems, 23 Jan. 1997 (in Finnish)

YVL 5.2 Nuclear power plant electrical systems and equipment, 23 Jan. 1997 (in Finnish)

YVL 5.3 Regulatory control of nuclear facility valves and their actuators, 7 Feb. 1991

YVL 5.4 Supervision of safety relief valves in nuclear facilities, 6 April 1995 (in Finnish)

YVL 5.5 Supervision of electric and instrumentation systems and components at nuclear facilities, 7 June 1985

YVL 5.6 Ventilation systems and components of nuclear power plants, 23 Nov. 1993

YVL 5.7 Pumps at nuclear facilities, 23 Nov. 1993

YVL 5.8 Hoisting appliances and fuel handling equipment at nuclear facilities, 5 Jan. 1987

Nuclear materials

YVL 6.1 Control of nuclear fuel and other nuclear materials required in the operation of nuclear power plants, 19 June 1991

YVL 6.2 Design bases and general design criteria for nuclear fuel, 1 Nov. 1999

YVL 6.3 Supervision of fuel design and manufacture, 15 Sept. 1993

YVL 6.4 Transport packages for nuclear material and waste, 9 October 1995

YVL 6.5 Supervision of nuclear fuel transport, 12 October 1995 (in Finnish)

YVL 6.6 Surveillance of nuclear fuel performance, 5 Nov. 1990

YVL 6.7 Quality assurance of nuclear fuel, 23 Nov. 1993

YVL 6.8 Handling and storage of nuclear fuel, 13 Nov. 1991

YVL 6.9 The national system of accounting for and control of nuclear material, 23 Sept. 1999 (in Finnish)

YVL 6.10 Reports to be submitted on nuclear materials, 23 Sept. 1999 (in Finnish)

YVL 6.11 Physical protection of nuclear power plants, 13 July 1992 (in Finnish)

YVL 6.21 Physical protection of nuclear fuel transports, 15 Feb. 1988 (in Finnish)

Radiation protection

YVL 7.1 Limitation of public exposure in the environment of and limitation of radioactive releases from nuclear power plants, 14. Dec. 1992

YVL 7.2 Evaluation of population doses in the vicinity of a nuclear power plant, 23 Jan. 1997 (in Finnish)

YVL 7.3 Evaluation of models for calculating the dispersion of radioactive substances from nuclear power plants, 23 Jan. 1997 (in Finnish)

YVL 7.4 Nuclear power plant emergency preparedness, 23 Jan. 1997

YVL 7.5 Meteorological measurements of nuclear power plants, 28 Dec. 1990

YVL 7.6 Monitoring of discharges of radioactive substances from nuclear power plants, 13 July, 1992

YVL 7.7 Radiation monitoring in the environment of nuclear power plants, 11 Dec. 1995

YVL 7.8 Environmental radiation safety reports of nuclear power plants, 11 Dec. 1995 (in Finnish)

YVL 7.9 Radiation protection of nuclear power plant workers, 14 Dec. 1992

YVL 7.10 Monitoring of occupational exposure at nuclear power plants, 29 Aug. 1994

YVL 7.11 Radiation monitoring systems and equipment in nuclear power plant, 20 Dec. 1996

YVL 7.18 Radiation protection aspects in the design of NPPs, 20 Dec 1996

Radioactive waste management

YVL 8.1 Disposal of reactor waste, 20 Sept. 1991

YVL 8.2 Exemption from regulatory control of nuclear wastes, 19 March 1992

YVL 8.3 Treatment and storage of radioactive waste at a nuclear power plant, 20 Aug. 1996

The YVL guides without any language marking are available both in English and Finnish. The guides are on the Internet at http://www.stuk.fi/english/yvl.html

Ontario

REPORT OF

PROVINCIAL WORKING GROUP # 8

THE UPPER LIMIT FOR DETAILED NUCLEAR EMERGENCY PLANNING

JUNE 30, 1988

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REPORT

OF

PROVINCIAL WORKING GROUP #8

EXECUTIVE SUMMARY

The Working Group was constituted to consider and make recommendations on the reference radiological situation which would define the upper limit for detailed nuclear emergency response planning in Ontario, and related matters.

Composition

Chairman:

Dr. K.G. McNeill	University of Toronto

Members:

Dr. J.H. Aitken	Ministry of Labour*
Mr. F.B. Ali	Ministry of the Solicitor General
Mr. G. Armitage	Ontario Hydro
Mr. L.N. Carling	Atomic Energy Control Board
Mr. J.Q. Howieson	Atomic Energy of Canada Limited
Mrs. L. Pearson	University of Toronto**

Secretary:

Ms. P.R. Gomes	Ministry of the Solicitor General

* Left the Working Group in April 1988 on leaving the public service

** Replaced Dr. Aitken in April 1988

Summary of Recommendations

1. The Working Group recommends that two tiers of emergency planning are needed:

    (i) the first tier (termed the Maximum Planning Accident or MPA) provides detailed planning for accidents which can be quantitatively determined to be as low as once in 10^5 station-years. For this tier the Working Group recommends that planning assure public exposure to radioactive doses be kept less than the Protective Action Levels

    (ii) the second tier (termed the Worst Credible Radiation Emission or WCRE) provides planning for accidents which are lower in frequency or whose frequency cannot be quantified (gross human error or hostile action). For this tier the Working Group recommends planning to protect against the onset of early morbidity (sickness) and the onset of early mortality (death) in a member of the public.

2. The Working Group recommends that for detailed planning of emergency measures to provide a safety net in case of engineering failures (the Maximum Planning Accident), the maximum doses given as a function of time and distance in Tables 6.2, 6.3, and 6.4 of the Report be used for the Pickering, Bruce, and Darlington

stations respectively.

3. The Working Group recommends that for planning of emergency measures to deal with the possible effects of a Worst Credible Radiation Emission the doses given as a function of time and distance in Tables 7.2 and 7.3 of the Report be used for the Pickering, Bruce and Darlington stations. In utilizing these data to determine the extent of emergency planning that is required, the Province should take into account the improbability of the occurrence of some of these events, the preventable nature of others, the conservative nature of the calculations, the public's perception of its need for protection, and the alternative use of economic resources.

4. The Working Group recommends that the only planning that should be done for this type of emission is to prevent early morbidity or mortality, for which we recommend threshold levels to be taken as 50 rem whole body or 3000 rem thyroid for early morbidity and 150 rem whole body for early mortality.

5. Based on all of the above recommendations the Working Group recommends that the size of the Primary Zones for Pickering, Bruce and Darlington nuclear stations should be 13 km.

6. Around Chalk River Nuclear Laboratories the Primary Zone should remain unchanged at 10 km from the NRU

reactor (see sections 8.6 and 8.7).

7. In Essex County the Primary Zone should remain unchanged at 21.5 km from the Fermi reactor with reconsideration when the Fermi-2 Probabilistic Risk Assessment is available in the fall of 1988 (see sections 9.2 and 9.3).

8. The Working Group recommends that the Province consider taking appropriate measures within the context of the above recommendations in the following areas:

(a) the availability and distribution of potassium iodide pills.

(b) the need for early warning systems for the public.

(c) the need for adequate medical facilities to deal with possible acute radiation exposure.

(d) the advisability of restricting new housing construction near nuclear facilities.

9. The Working Group recommends that the Province of Ontario review the present Protective Action Levels in the light of world norms.

R E P O R T

TO THE

MINISTRY OF ENERGY AND ENVIRONMENT

CONCERNING TWO TECHNICAL MATTERS

IN THE

PROVINCE OF ONTARIO'S NUCLEAR EMERGENCY PLAN

BY

ROYAL SOCIETY OF CANADA & CANADIAN ACADEMY OF ENGINEERING

W. R. BRUCE

L. W. SHEMILT

A. T. STEWART

NOVEMBER 1996

Ms. Debbie Farr P.Eng., Manager

Electricity Operations and Planning Section

Ministry of Environment and Energy

135 St.Clair Ave W

Toronto, ON Canada M4V 1P5

Dear Ms. Farr:

We are pleased to present to you our Report Concerning Two Technical Matters in the Province of Ontario's Nuclear Emergency Plan. You commissioned this Report in correspondence that started a year ago.

In the process of this study we have developed and clarified the background needed to address the questions which were posed. The narrative of the report presents this background, our recommendations, and develops the reasons for our conclusions.

We thank the many who provided facts, opinions and wisdom to assist us. We have benefited from the advice and help from the Ministry of the Solicitor General especially from Mr.W.D.Harrison who has helped several times. We have been supplied with documents, comments and answers to our many questions by Ontario Hydro, delivered patiently by Mr.L.D.Morrow. And to your

Ministry we are indebted for arranging to have the brief comments on a Draft of our Report by Officers of the Ministry of the Solicitor General and Officers of Ontario Hydro. Their suggestions have been useful in clarifying matters of both fact and opinion. Finally we are indebted to your office for courtesies, patience and understanding.

We hope the Report will be useful and shall be happy to answer any questions that may arise.

Yours cordially,

W.R.Bruce L.W.Shemilt A.T.Stewart

W.R.Bruce L.W.Shemilt A.T.Stewart

for the

Royal Society of Canada & Canadian Academy of Engineering

I N D E X

EXECUTIVE SUMMARY

The Royal Society of Canada / Canadian Academy of Engineering panel was asked for recommendations on two principal questions. One question concerned the basis for planning a mitigating response to an accident at one of Ontario's nuclear generating stations and the other concerned two technical details of the emergency plan itself.

Q.1. Basis for planning: In 1988 the Working Group No.8 of the Ministry of the Solicitor General and the Ontario Nuclear Safety Review recommended comprehensive planning for an accident called by the former, "Worst Credible Radiation Emission". Since 1988 risk analyses have been improved and updated and we think that now it is wiser to consider planning for a group of accident scenarios for which the summed probability of occurrence is greater than approximately 10^{-7} per reactor year. (It should be noted that some accident scenarios in this group are similar in severe consequences to Worst Credible Radiation Emission consequences except for the delayed emission of radioactive materials.)

Q.2a. Predistribution of KI: The risk to the thyroid gland from inhaling radioactive iodine from a CANDU accident seems to us to be less than had been previously thought and a small part ot the risk to the whole body from such an accident. We therefore do not recommend predistribution of KI to residences.

Q.2b. The choice of 10 or 13 km for the outer boundary of the Primary Zone: In comparison to the wide range of consequences from a severe accident, 10 and 13 km are essentially the same number. Since the designation of zones should be for the purpose of developing and practising emergency responses, we find that a nominal 10 km is satisfactory.

In the Report of the Royal Society of Canada / Canadian Academy of Engineering the panel also suggests that since neither KI prophylaxis nor sheltering offer very much protection in a nuclear emergency, that sheltering be considered only as an automatic and immediate first step while arranging evacuation. There would then be one only action level for which we suggest 10-50 mSv - or, if a single number is preferred, 20 mSv..

SECTION 6 PRIMARY ZONE, 10 or 13 km?

6.1 In our modern society there are many industries that can create a risk for the surrounding population if an accident were to occur. How close should one live to an oil refinery, to an explosives factory, to a chemical manufacturing plant, or in our case, how close to a nuclear powered electricity generating plant ? Of course it is safer to be far away. The risk diminishes with distance as was shown in the Figure in Section 2. It is also evident from the Figure that the range of severity of possible accidents is enormous. This wide variability of accident consequences makes planning a response very difficult. It seems wasteful to spend much public money on detailed planning for very improbable accidents. Thus an informed and pragmatic judgment must be used in making the rules and plans for any response to an emergency.

6.2 Risk of exposure in a nuclear accident decreases with distance from the site of the accident and thus plans for action in an emergency are also a function of distance. For practical planning, the distance is divided into zones. [43]

* The Exclusion Zone, with its 1 km radius, is property of the Utility and surrounded by a fence.
* The Contiguous Zone, with a boundary approximately 3 km radius around the plant, is an area for which detailed plans can be developed. Because of its limited size relatively fast action is possible. High population density and possible bad weather could make evacuation difficult and this zone should have a small population and preferably be restricted to parkland or industrial park use.
* The Primary Zone, which has a radius nominally 10 km, is more difficult to plan for because of its larger area, larger population, and more varied use. (It should be noted that 10 km corresponds to the distance at which the dose is about 10 mSv in accident scenario MPA in WG-8)
* The Secondary Zone is beyond the 10 km boundary. Here

also some thought must be given and plans made for notifying and evacuating the population which is in the direct line of a possible radioactive plume.

6.3 For the Primary Zone notification of need to evacuate is more difficult than for the Contiguous Zone, and depending on the distribution of population, the evacuation itself may be much more difficult to organize. The exact boundary of this Primary Zone should be based on practical considerations. These include the various natural divisions, rivers, forests other topographic features, even power line and railway rights of way. In view of the great variability of a disaster, there is little real difference between 10 or 13 km. **WE THEREFORE CONCLUDE THAT 10 KM AS A NOMINAL RADIUS, APPLIED WITH PRACTICAL FLEXIBILITY, IS CONSISTENT WITH THE NEEDS OF THE PROVINCIAL NUCLEAR EMERGENCY PLAN FOR ALL OF ONTARIO'S NUCLEAR GENERATING STATIONS.** The most important criterion is the ability to make zone boundaries that are practical in an emergency. In addition, the use of 10 km implies a reasoned generality while 13 km implies a precision which does not exist.

6.4 Similar advice arises from European experience: "... the 10 km planning zone is chosen as a suitable general planning basis from which to establish an emergency response structure and operating platform. Irrespective of zone size, countermeasures can still be implemented on an ad hoc basis for events with larger consequences and affecting areas beyond the formal plume exposure zone boundary." (Quoted from the Ontario Hydro Submission, Mar 1996) [35].

6.5 In summary, it is appropiate to plan for accidents by zones defined by radii from the station and to use a radius of 10 km for the outer limit of the Primary Zone for which detailed plans should be made.

SECTION 7 SUMMARY OF RECOMMENDATIONS

7.1 The first "specific question" put to the RSC/CAE committee is answered in Section 4: WE FIND IN THE CONTEXT OF PRESENT DAY EMERGENCY PLANNING THAT IT IS NOT REASONABLE TO DEFINE THE "MAXIMUM CREDIBLE RELEASE" FOR "COMPREHENSIVE PLANNING" AS THE WCRE OF WG-8. WE RECOMMEND THAT DETAILED EMERGENCY PLANNING SHOULD BE DONE FOR ACCIDENTS RESULTING FROM A CREDIBLE SERIES OF EVENTS WHICH COULD OCCUR WITH A PROBABILITY OF APPROXIMATELY 10^{-7}/REACTOR YEAR. (ONCE IN TEN MILLION YEARS PER REACTOR).

7.2 The second "specific question" is answered in Section 5: WE CONCLUDE THAT POTASSIUM IODIDE PROPHYLAXIS IS NOT THE APPROPRIATE PRIMARY MITIGATION FOR INDIVIDUALS IN THE CONTIGUOUS ZONE, AND THEREFORE DO NOT RECOMMEND COMPLETE PREDISTRIBUTION OF THE TABLETS. THE MAJOR EFFORT SHOULD BE EVACUATION FROM THE RADIATION AREA FOR WHICH WE PROPOSE A SINGLE ACTION LEVEL OF 10-50 mSv.

and in Section 6: WE THEREFORE CONCLUDE THAT 10 KM AS A NOMINAL RADIUS, APPLIED WITH PRACTICAL FLEXIBILITY, IS CONSISTENT WITH THE NEEDS OF THE PROVINCIAL NUCLEAR EMERGENCY PLAN FOR ALL OF ONTARIO'S NUCLEAR GENERATING STATIONS.

Canadian Nuclear Safety Commission	**Commission canadienne de sûreté nucléaire**
Public meeting	**Réunion publique**
August 18th, 2016	**Le 18 août 2016**
Public Hearing Room 14th floor 280 Slater Street Ottawa, Ontario	Salle des audiences publiques 14e étage 280, rue Slater Ottawa (Ontario)
Commission Members present	**Commissaires présents**
Dr. Michael Binder Mr. Dan Tolgyesi Dr. Sandy McEwan Ms Rumina Velshi Mr. André Harvey	M. Michael Binder M. Dan Tolgyesi Dr Sandy McEwan Mme Rumina Velshi M. André Harvey
Secretary:	**Secrétaire:**
Mr. Marc Leblanc	M. Marc Leblanc
General Counsel:	**Avocate générale :**
Ms Lisa Thiele	Me Lisa Thiele

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Power continued to maintain and implement an effective environmental risk assessment and management program for the protection of the environment and human health at Point Lepreau. NB Power submitted an environmental risk assessment in 2015 according to CSA Standard N288.6 that is entitled "Environmental risk assessment at Class 1 nuclear facilities and uranium mines and mills".

NB Power continues to work on addressing identified gaps in its environmental protection programs.

Fish mortality monitoring due to cooling water intake continued throughout 2015. CNSC staff will review the final NB Power reports expected later this year.

This concludes the Gentilly-2 and the Point Lepreau presentations. I will now turn the presentation back to Mr. Gerry Frappier.

MR. FRAPPIER: Thank you, Mr. Poulet.

This next section of the presentation will highlight some industry regulatory developments. Specifically, I'll provide some updates on the neutron overpower protection methodology, the counterfeit suspect fraudulent items program, probabilistic safety assessments, the industry response to Fukushima Daiichi accident and the new nuclear project at Darlington.

A key highlight that we would like to bring to the Commission's attention is associated with emergency preparedness as noted in supplementary CMD 16-M30C, and these highlights, however, will be presented in a separate presentation that will follow the conclusion of this presentation.

CNSC staff have been providing annual updates on the status of the review of the new enhanced neutron overpower methodology since 2009. The 2015 update is found at Section 2.2.2 of the NPP report.

You will recall that to address impacts of heat transport system aging on neutron overpower protection trip set points, Bruce Power and OPG proposed a new enhanced neutron overpower protection methodology. The new methodology uses a statistical approach to compute the neutron overpower set points.

CNSC has been reviewing industry submissions and subsequent updates and improvements to their approach over the past several years.

OPG and Bruce Power submitted their final response to the CNSC in March 2015. CNSC staff completed their review of this final response in January of 2016.

CNSC staff concluded that Bruce power and OPG stations are well protected by the neutron overpower trip set points calculated using the enhanced neutron overpower methodology.

This will be the final annual update to

the Commission regarding this methodology. However, CNSC staff will continue monitoring the implementation of the methodology and will perform additional inspections with the aim of verifying additional precautions taken by licensees to ensure the trip set points remain conservative at all times.

Regarding counterfeit, suspect and fraudulent items, in March 2015, a valve supplier notified licensees of Canadian nuclear power plants that materials contained in its valve assemblies and components may not conform to accepted standards, specifications or technical requirements.

Licensees immediately notified the CNSC about this event, which encompassed valves supplied to Canadian nuclear power plants between 2001 and 2013.

CNSC staff have maintained continuous regulatory oversight of this event and remain satisfied that licensees continue to ensure adequate provisions for the protection of workers, the public and the environment.

CNSC staff have provided the Commission with updates on this issue on two occasions in 2015 as well as in April of this year. CNSC staff concluded that the engineering assessments and reviews conducted by licensees, suppliers and authorized inspection agencies have been performed thoroughly and in a robust manner.

Based on the outcome of these assessments and reviews, there is no safety risk for the continued use of the affected valves.

CNSC staff are developing a new Reg Doc that describes the management system requirements applicable to counterfeit, suspect, fraudulent items and define CNSC’s expectations. A new CSA quality assurance standard is also being developed. This new standard will contain requirements for the prevention and detection of counterfeit, suspect and fraudulent items.

I would now like to highlight our PSA program, or probabilistic safety assessment program. This has been an area of keen interest for the Commission over the past few years. We talked a little bit about it yesterday as well.

Before elaborating on the whole site probabilistic safety assessment, I would like to start by highlighting that the role of the probabilistic safety assessment within the CNSC regulatory framework as well as the benefits gained through the probabilistic safety assessments.

All Canadian nuclear power plants were designed and their safety case developed based on deterministic approaches, not probabilistic approaches. Canada is one of the few countries that requires a PSA of all the nuclear power plants.

We believe that a good PSA helps to identify safety improvement opportunities.

The PSAs are performed on a per unit and per unique hazard basis. The unique hazards are internal events, seismic events, fire or high winds. This provides a wealth of risk informed information used in identifying the safety improvement opportunities for a unit to be protected against a very specific type of hazard.

As one of the many benefits of the PSA, CANDU PSAs have identified safety improvements well before the events and lessons learned from the Fukushima accident. Examples are the identification of inclusion of extra emergency power generators, filtered venting systems, enhancing the relief capacity of the shield tank and the enhancement of the power house venting systems.

It is important to mention that, as per the international practice, PSA results are not used as the sole basis for a regulatory decision, nor as a pass/fail line without due consideration of other important aspects of the overall plant safety. The results of a PSA are used in conjunction with analysis and evaluations.

While Canada is the leader in the application of PSA, the Commission has pushed for more to come -- to be done, pardon me.

During the Pickering hearing in may 2013, the Commission noted that the PSAs are developed on a reactor basis and the PSA results are expressed on a per reactor year. The Commission wanted us to consider how to undertake a PSA type assessment that would include multiple units, a so-called whole site PSA.

As a result, during the May 2014 Pickering hold point hearings, the Commission directed the CNSC staff to include in annual reports a clear timeline for the development and implementation of whole site-based safety goals and a PSA methodology to go along with it.

As requested by the Commission, this nuclear power plant report includes a clear timeline for the development and implementation of the whole site based safety goals and the associated PSA implementation. I would like to talk about both of those now.

The current PSA are conducted on unit reactor basis. However, we should note that effects and contribution from adjacent units at multiple-unit stations are fully accounted for in the calculated PSA results. These PSA are fully in place for each MPP in Canada. Furthermore, they are updated and submitted to the CNSC every five years or as needed.

The following is an overview of CNSC staff's actions during the last three years associated with developing a new approach to multiple units:

- First, and as a follow-up to the Fukushima accident lessons learned, CNSC staff updated the regulatory documentation on PSA and reissued it as REGDOC 2.4.2 in May of 2014. The new REGDOC 2.4.2 specifically requires the inclusion in the PSA of the multiple unit impacts.

- Second, CNSC staff established a working group on safety goals. In November of 2014, CNSC staff organized with the Nuclear Energy Agency an international worksite on -- workshop on whole-site PSA. This workshop brought together imminent international experts, regulators, academics, consulting organizations and industry to share experiences on the topic of whole-site PSA and site-based safety goals.

The picture in this slide shows the members of the workshop technical committee which included internationally recognized experts in the field of PSA, so that says Joe de Pasalakis who is a professor at MIT and a former NRC Commissioner; Karl Fleming of KNF Consulting Services, Mohammad Modarres of the University of Maryland and many others.

CNSC staff is also heavily engaged in bilateral cooperation with the U.S. NRC and we are active in the Nuclear Energy Agency's working group on risk assessment or on risk, pardon me, which is making assessments on whole-site PSA.

The major outcome from these international consultations and benchmarking include that there is no international consensus for conducting whole-site PSA and there is no internationally established site-based safety goals.

All these observations are showing that the topic of safety goals is complex. Achieving an international consensus on this topic will be challenging.

Canada is the first country to look into the area of site-based safety goals and whole-site PSA and currently leads the international effort to help develop a technical basis for the development of whole-site PSA. This is being done through the Nuclear Energy Agency in Paris.

CNSC staff target the development of site-based safety goals concurrently with the industry's efforts towards implementation of a whole-site based methodology which I'll update in the next slide.

As directed by the Commission, OPG is developing a whole-site PSA for the Pickering Nuclear Generating Station and will be the first site to develop such a whole-site PSA. Therefore, on this slide I will provide a status update regarding the development of this methodology.

In March 2014 OPG submitted a concept-level whole-site PSA methodology which was accepted by CNSC staff. This concept-level methodology is based on the results of an international workshop on whole-site PSA organized by Canadian industry in January of 2014.

OPG staff are considering all reactor units, spent fuel bays, internal and external hazards and all operating modes for this Pickering whole-site PSA. This is expected to be completed by August of 2017.

There is no change in the timeline from the last update that we provided the Commission at the August 2015 Commission hearings. CNSC staff is closely monitoring the progress of this undertaking through regular information exchange meetings and will report again to the Commission at the upcoming Pickering licensing hearing to be held in 2017.

With respect to Fukushima-Daiichi Accident Response, all Fukushima action items are closed based on deliverables as defined in the action plan and the defined closure criteria. With the exception of a very small number of modifications that require design changes by the licensees which are on schedule for completion, the implementation of all the regulatory requirements has been completed. Verification for each facility is tracked through the normal compliance verification processes.

In December of 2015 the IEA published its Director General report on the Fukushima-Daiichi accident. The CNSC action plan that was done earlier is well aligned with the 45 lessons learned identified in the IEA report.

In particular, actions related to strengthen defence in-depth, enhancing emergency response, improving the regulatory framework and enhancing international collaborations were quickly imposed on licensees at major nuclear facilities. Additional lessons learned related to public communications are well aligned.

Post-accident recovery guidelines addressing the elements of the IEA report that speak to off-site measures related to the transition from emergency early response to recovery are being drafted by the CNSC in conjunction with local federal and provincial authorities and the licensees so what remains is the post-accident recovery guidelines that needs to be done with other jurisdictions. So this is a project that's ongoing.

For the Fukushima action items, the licensee submitted their last round of progress update reports in 2015. All short, medium and long-term Fukushima action items are closed for all stations. Compliance verification of Fukushima-related modifications and upgrades, the CNSC staff completed inspections at all

Canadian nuclear power plants to verify implementation of the Fukushima plant modifications and emergency mitigating equipment.

CNSC staff participated in all large-scale exercises to verify in situ the demonstration of equipment performance.

Regarding the new nuclear project at Darlington, this slide provides the annual update on the Darlington new nuclear project. Two important areas of activity were around bird habitat and land planning around the site. OPG continued monitoring the artificial nest habitat during the 2015 season. In March 2016, CNSC staff received and are currently reviewing the OPG 2015 Bank Swallow program results.

Key activities in progress to date regarding land use planning are as follows:

- The revised Provincial Policy Statement in 2014 includes new policy on land use compatibility which is further supported by definitions for sensitive land users and major facilities that include energy generating facilities such as the nuclear power plant.

- The Region of Durham has committed to updating by 2018 its regional official plan and ensures it aligns with this PPS 2014.

- A draft official plan for the

Municipality of Clarington was released in March 2015 and it includes policies to address the PPS 2014 around land use planning.

In closing, I would like to summarize the overall concluding remarks on the safety performance of nuclear power plants in Canada and the safety improvements being introduced by licensees.

Based on all compliance activities, CNSC staff made a number of general conclusions with respect to safety performance of nuclear power plants in Canada in 2015; namely that nuclear power plants operated safely; the integrated plant ratings were determined to be fully satisfactory for Bruce A, Bruce B, Darlington and Pickering and satisfactory for Point Lepreau and Gentilly-2.

All licensees received either satisfactory or fully satisfactory ratings in the specific control areas.

Licensees have implemented safety enhancements by addressing actions and making continuous improvement to the safety operations of their facilities.

The licensees are continuing their work on the safety analysis improvements and the CANDU safety issues as discussed in yesterday's meeting under CMD 16-M34.

This report shows that the licensees

continue to improve safety at Canadian nuclear power plants.

Mr. President and Members of the Commission, this concludes the presentation of the regulatory oversight report for Canadian nuclear power plants and thank you for your attention. The CNSC staff are now available to answer any questions the Commission may have.

THE PRESIDENT: Thank you. I thought you will continue with the presentation of Exercise Unified Response. Is that not the plan?

MR. FRAPPIER: Yes, we can do that. It will take us a couple of minutes to just change some staff around and then we can continue with the question period after if you want.

THE PRESIDENT: Yeah, because the question period will put them together and we can open it up for general questions.

--- Pause

THE PRESIDENT: Okay. Just everybody hold on for a second. I am just being -- we always are fans of efficiency. Since all the industry people are sitting here, maybe we can ask them for comments on this particular part while -- and then we'll flip over to the next one which they will have to answer on that one too. So I am

2014 Provincial Policy Statement

Under the *Planning Act*

Ontario.ca/PPS

Ontario

For more copies of this document,
in either English or French,
please contact:

Ministry of Municipal Affairs and Housing
Provincial Planning Policy Branch
777 Bay Street, 13th Floor
Toronto, ON M5G 2E5

Tel: 416-585-6014 or 1-877-711-8208

Website: Ontario.ca/PPS

Approved by the Lieutenant Governor in Council, Order in Council No. 107/2014

This Provincial Policy Statement was issued under section 3 of the *Planning Act* and came into effect April 30, 2014. It replaces the Provincial Policy Statement issued March 1, 2005.

Materials may be available to assist planning authorities and decision-makers with implementing the policies of the Provincial Policy Statement. Please visit the Ministry website at Ontario.ca/PPS for more information.

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1.2.6 Land Use Compatibility

1.2.6.1 *Major facilities* and *sensitive land uses* should be planned to ensure they are appropriately designed, buffered and/or separated from each other to prevent or mitigate *adverse effects* from odour, noise and other contaminants, minimize risk to public health and safety, and to ensure the long-term viability of *major facilities*.

1.3 Employment

1.3.1 Planning authorities shall promote economic development and competitiveness by:

a) providing for an appropriate mix and range of employment and institutional uses to meet long-term needs;
b) providing opportunities for a diversified economic base, including maintaining a range and choice of suitable sites for employment uses which support a wide range of economic activities and ancillary uses, and take into account the needs of existing and future businesses;
c) encouraging compact, mixed-use development that incorporates compatible employment uses to support liveable and resilient communities; and
d) ensuring the necessary *infrastructure* is provided to support current and projected needs.

1.3.2 Employment Areas

1.3.2.1 Planning authorities shall plan for, protect and preserve *employment areas* for current and future uses and ensure that the necessary *infrastructure* is provided to support current and projected needs.

1.3.2.2 Planning authorities may permit conversion of lands within *employment areas* to non-employment uses through a *comprehensive review*, only where it has been demonstrated that the land is not required for employment purposes over the long term and that there is a need for the conversion.

1.3.2.3 Planning authorities shall protect *employment areas* in proximity to *major goods movement facilities and corridors* for employment uses that require those locations.

1.3.2.4 Planning authorities may plan beyond 20 years for the long-term protection of employment areas provided lands are not designated beyond the planning horizon identified in policy 1.1.2.

Low and moderate income households: means
a) in the case of ownership housing, households with incomes in the lowest 60 percent of the income distribution for the *regional market area*; or
b) in the case of rental housing, households with incomes in the lowest 60 percent of the income distribution for renter households for the *regional market area*.

Major facilities: means facilities which may require separation from *sensitive land uses*, including but not limited to airports, transportation infrastructure and corridors, *rail facilities*, *marine facilities*, sewage treatment facilities, *waste management systems*, oil and gas pipelines, industries, energy generation facilities and transmission systems, and resource extraction activities.

Major goods movement facilities and corridors: means transportation facilities and corridors associated with the inter- and intra-provincial movement of goods. Examples include: inter-modal facilities, ports, *airports, rail facilities*, truck terminals, freight corridors, freight facilities, and haul routes and primary transportation corridors used for the movement of goods. Approaches that are freight-supportive may be recommended in guidelines developed by the Province or based on municipal approaches that achieve the same objectives.

Marine facilities: means ferries, harbours, ports, ferry terminals, canals and associated uses, including designated lands for future *marine facilities*.

Mine hazard: means any feature of a mine as defined under the *Mining Act*, or any related disturbance of the ground that has not been rehabilitated.

Minerals: means metallic minerals and non-metallic minerals as herein defined, but does not include *mineral aggregate resources* or *petroleum resources*.

Metallic minerals means those minerals from which metals (e.g. copper, nickel, gold) are derived.

Non-metallic minerals means those minerals that are of value for intrinsic properties of the minerals themselves and not as a source of metal. They are generally synonymous with industrial minerals (e.g. asbestos, graphite, kyanite, mica, nepheline syenite, salt, talc, and wollastonite).

Mineral aggregate operation: means
a) lands under license or permit, other than for *wayside pits and quarries*, issued in accordance with the *Aggregate Resources Act*;
b) for lands not designated under the *Aggregate Resources Act*, established pits and quarries that are not in contravention of municipal zoning by-laws and including adjacent land under agreement with or owned by the operator, to permit continuation of the operation; and
c) associated facilities used in extraction, transport, beneficiation, processing or recycling of *mineral aggregate resources* and derived products such as asphalt and concrete, or the production of secondary related products.

Mineral aggregate resources: means gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, rock or other material prescribed under the *Aggregate Resources Act* suitable for construction, industrial, manufacturing and maintenance purposes but does not include metallic ores, asbestos, graphite, kyanite, mica, nepheline syenite, salt, talc, wollastonite, mine tailings or other material prescribed under the *Mining Act*.

Mineral aggregate resource conservation: means
a) the recovery and recycling of manufactured materials derived from mineral aggregates (e.g. glass, porcelain, brick, concrete, asphalt, slag, etc.), for re-use in construction, manufacturing, industrial or maintenance projects as a substitute for new mineral aggregates; and
b) the wise use of mineral aggregates including utilization or extraction of on-site *mineral aggregate resources* prior to development occurring.

Mineral deposits: means areas of identified *minerals* that have sufficient quantity and quality based on specific geological evidence to warrant present or future extraction.

Mineral mining operation: means mining operations and associated facilities, or, past producing mines with remaining mineral development potential that have not been permanently rehabilitated to another use.

private communal sewage services and *individual on-site sewage services* is considered sufficient if the hauled sewage from the development can be treated and land-applied on agricultural land under the *Nutrient Management Act*, or disposed of at sites approved under the *Environmental Protection Act* or the *Ontario Water Resources Act*, but not by land-applying untreated, hauled sewage.

Reserve water system capacity: means design or planned capacity in a centralized water treatment facility which is not yet committed to existing or approved development.

Residence surplus to a farming operation: means an existing habitable farm residence that is rendered surplus as a result of farm consolidation (the acquisition of additional farm parcels to be operated as one farm operation).

Residential intensification: means intensification of a property, site or area which results in a net increase in residential units or accommodation and includes:

a) redevelopment, including the redevelopment of *brownfield sites*;
b) the development of vacant or underutilized lots within previously developed areas;
c) infill development;
d) the conversion or expansion of existing industrial, commercial and institutional buildings for residential use; and
e) the conversion or expansion of existing residential buildings to create new residential units or accommodation, including accessory apartments, second units and rooming houses.

River, stream and small inland lake systems: means all watercourses, rivers, streams, and small inland lakes or waterbodies that have a measurable or predictable response to a single runoff event.

Rural areas: means a system of lands within municipalities that may include rural *settlement areas*, *rural lands*, *prime agricultural areas*, natural heritage features and areas, and resource areas.

Rural lands: means lands which are located outside *settlement areas* and which are outside *prime agricultural areas*.

Sensitive: in regard to *surface water features* and *ground water features*, means areas that are particularly susceptible to impacts from activities or events including, but not limited to, water withdrawals, and additions of pollutants.

Sensitive land uses: means buildings, amenity areas, or outdoor spaces where routine or normal activities occurring at reasonably expected times would experience one or more *adverse effects* from contaminant discharges generated by a nearby *major facility*. *Sensitive land uses* may be a part of the natural or built environment. Examples may include, but are not limited to: residences, day care centres, and educational and health facilities.

Settlement areas: means urban areas and rural settlement areas within municipalities (such as cities, towns, villages and hamlets) that are:

a) built up areas where development is concentrated and which have a mix of land uses; and
b) lands which have been designated in an official plan for development over the long-term planning horizon provided for in policy 1.1.2. In cases where land in *designated growth areas* is not available, the *settlement area* may be no larger than the area where development is concentrated.

Sewage and water services: includes *municipal sewage services* and *municipal water services*, *private communal sewage services* and *private communal water services*, *individual on-site sewage services* and *individual on-site water services*, and *partial services*.

Significant: means

a) in regard to *wetlands*, *coastal wetlands* and *areas of natural and scientific interest*, an area identified as provincially significant by the Ontario Ministry of Natural Resources using evaluation procedures established by the Province, as amended from time to time;
b) in regard to *woodlands*, an area which is ecologically important in terms of features such as species composition, age of trees and stand history; functionally important due to its contribution to the broader landscape because of its location, size or due to the amount of forest cover in the planning area; or economically important due to site quality, species composition, or past management history. These are to be identified using criteria established by the Ontario Ministry of Natural Resources;

Land Use Planning Workshop: Darlington New Nuclear Project

Discussion and Summary Agreement

HARDY STEVENSON AND ASSOCIATES

364 Davenport Road
Toronto, Ontario M5R 1K6

Submitted: June 19, 2013
Updated: September 27, 2013

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1.0 Introduction

In August, 2011, the Joint Review Panel (JRP) completed its review of the Environmental Impact Statement for the Darlington New Nuclear Project (DNNP). The panel concluded that the Project is not likely to cause significant adverse environmental effects, provided the mitigation measures proposed and commitments made by OPG during the review, and the Panel's recommendations are implemented. As a result, a license to proceed with the preparation of the DNNP site has been issued.

The JRP considered land use and development matters near the DNNP. They indicated that while there are appropriate measures in place to ensure that vulnerable populations, including hospitals, schools and retirement homes, can be safely evacuated in the event of an accident, it would be prudent to prevent locating sensitive land uses within a 3 km zone around the DNNP. The JRP also stated that it would be prudent to avoid any further residential development north of Highway 401 in the D1, D2, D3 and D5 emergency response sectors; areas located less than 3 km from the DNNP site boundary. Accordingly, the JRP indicated that appropriate steps ought to be taken to evaluate and define buffer zones, taking into consideration the lessons learned from the Fukushima Daiichi nuclear incident.

To this end, the JRP issued four land use recommendations:

> **JRP Recommendation #43**
> That the CNSC engage appropriate stakeholders, including OPG, Emergency Management Ontario, municipal governments and the Government of Ontario to develop a policy for land use around nuclear generating stations.
>
> **JRP Recommendation #44**
> That the Government of Ontario take appropriate measures to prevent sensitive and residential development within 3 km of the site boundary.
>
> **JRP Recommendation #45**
> That the Municipality of Clarington prevent, for the lifetime of the nuclear facility, the establishment of sensitive public facilities such as schools, hospitals and residences for vulnerable clienteles within the 3 km zone around the site boundary.
>
> **JRP Recommendation #59**
> That the Municipality of Clarington manage development in the vicinity of the Project site to ensure that there is no deterioration in the capacity to evacuate members of the public for the protection of human health and safety.

2.0 Workshop Overview and Objectives

On June 12, 2013, the Canadian Nuclear Safety Commission (CNSC) hosted a one-day land use planning workshop at the Hilton Garden Inn in Ajax, Ontario in response to the JRP recommendations. The objective of the workshop was two-fold: (i) to engage appropriate stakeholders about the JRP recommendations and (ii) to begin collectively addressing the JRP recommendations with the ultimate goal of identifying existing land use policies or developing new policies that prevent sensitive land uses from locating within 3 km of the site boundary of the DNNP.

Participants agreed that the discussion would be limited to the DNNP site in particular, rather than to all nuclear generating stations in Canada.

To inform the discussion, the following materials were provided to participants:

a. Guideline D-1: Land Use Compatibility
b. Guideline D6: Compatibility Between Industrial Facilities and Sensitive Land Uses
c. Guideline D 6-1: Appendix A Industrial Categorization Criteria
d. Darlington Nuclear Generating Station Concentric Ring Map
e. Pickering and Darlington Nuclear Generating Station Concentric Ring Map and Land Uses
f. Draft Provincial Policy Statement (Track Change version, 2012)
g. Regulatory Document RD-337 Design of New Nuclear Power Plants
h. Regulatory Document RD-346 Site Evaluation or New Nuclear Power Plants

In the interest of brevity and due to the length of the D6 and D1 Ministry of Environment (MOE) Guidelines, the Draft Provincial Policy Statement (PPS), and the RD-337 and RD-346 Regulatory Documents, these materials have not been appended to this report.

The workshop agenda (Appendix D) was developed by Hardy Stevenson and Associates Limited (HSAL) based on pre-consultation with Workshop participants.

3.0 Workshop Participants

Seventeen individuals representing nine organizations and four levels of government participated in the workshop:

Laura Andrews , Canadian Nuclear Safety Commission

David Newland, Canadian Nuclear Safety Commission

Barclay Howden, Canadian Nuclear Safety Commission

Francis Martel, Canadian Nuclear Safety Commission

Rita Foulds , Emergency Management Ontario

Viki Erik, Ministry of Municipal Affairs and Housing

Daryl Lyons, Ministry of Municipal Affairs and Housing

Lesley Wintle, Ministry of Municipal Affairs and Housing

Heather Watt, Ministry of Environment

Alida Mitton, Ministry of Environment

Cheryl O'Donnel , Ministry of Energy

Roger Saunders, Region of Durham

Dorothy Skinner, Region of Durham

Faye Langmaid, Municipality of Clarington

Janice Szwarz, Municipality of Clarington

Warren Munro, Municipality of Oshawa

Ray Davies, Ontario Power Generation

Dave Hardy, R.P.P., of HSAL facilitated the workshop. Andrzej Schreyer, R.P.P., supported Dave Hardy during the workshop by taking notes of the workshop proceedings and preparing this report.

4.0 Current Context

The levels of government responsible for land use planning vary across Canada. In addition, land uses in the vicinity of Canada's nuclear generating stations also vary. For example, the Pickering Nuclear Generating Station has a range of residential, industrial, commercial and institutional uses beyond the site boundary. The Bruce Nuclear Generating Station and Point Lepreau Nuclear Generating Station are in rural areas with minimal residential land use. The DNNP is in the vicinity of land uses that currently have and are slated for both residential and employment/industrial growth. This report focuses on land uses relevant to the DNNP.

In Ontario there are three levels of government that specifically address land use: The Province of Ontario; Regional or County governments and local municipalities. These levels of government do not have approval authority over land use matters involving the use of nuclear technology and substances. Specifically, they may comment on approvals related to nuclear generating stations but they cannot approve or deny matters that have implications for off-site land uses. The exception is, the Province of Ontario owns the DNGS and can ultimately provide a political decision pertaining to the site. In contrast, it is the Federal level of Government through the CNSC that grants a license for the DNNP. However, the CNSC does not have authority to regulate land use outside of the site boundary.

Evacuation authority pertaining to nuclear generating stations rests with the Province of Ontario's Emergency Measures Organization (EMO) with respect to geographic areas that are subject to evacuation. The EMO determines which uses in the vicinity of Ontario's nuclear generating stations plants are sensitive and subject to evacuation based on scientific data. Experience has shown that some facilities, such as schools, are easier to evacuate than others, such as hospitals and prisons. It is also known that some population groups, such as children, are particularly sensitive to ionizing radiation. However, the EMO's authority cannot be applied to prevent certain land uses from locating in the vicinity of nuclear generating stations plants as a prudent avoidance measure.

The focus of the workshop was prudent avoidance of potential effects on sensitive uses by preventing the location of those land uses rather than the evacuation of uses that are seeking approval to locate or have been permitted to locate within 3 km of the nuclear generating station boundary.

4.1 Land Uses in the Vicinity of Darlington Nuclear Generating Station

According to the Region of Durham Official Plan, lands in the vicinity of the DNNP are designated as Employment Areas; Major Open Space Area; Waterfront Areas; Living Area; and, Prime Agricultural Areas (Appendix B, Darlington NGS maps). The largest amount of land is designated for Major Open Space and Employment. According to the Municipality of Darlington Official Plan, lands in the vicinity of the DNNP are designate as (Appendix C): Green Space; Light Industrial; Business Park; Waterfront Greenway; Utility; General Industrial; Prestige Employment; Community Park; Residential (Bowmanville).

Current land uses in the vicinity of the DNNP are consistent with the Municipality of Clarington and Region of Durham Official Plan. Existing land uses are largely comprised of rural and industrial uses. Lands to the west of the DNNP contain a range of uses including rural residential, an automobile auction operation, and a water pollution control plant (Courtice Water Pollution Control Plant). The Darlington Nuclear Park is located further to the west along Lake Ontario. Lands to the north of South Service Road and Highway 401 comprise a mix of agricultural, industrial, rural residential uses. The St. Mary's cement plant, small-scale commercial uses, and low density residential uses are located to the east. The Clarington Energy Business Park is located immediately to the west of the DNNP. This secondary plan area consists of prestige employment uses.

5.0 Key Areas of Discussion and Summary Agreement

5.1 Current Land Use Planning Tools

This section of the report summarizes the key issues and comments raised in the workshop with respect to the application of the most relevant land use planning tools currently in place. Land use planning tools refer to: Federal or Provincial Acts, Regulations, Statements, Orders, Policies or Guidelines. The tools also refer to Regional or local municipal Official Plans, zoning bylaws, holding orders, permits and licenses. Each relevant land use planning tool was examined with respect to the role it might play in responding to the JRP land use recommendations. Local and regional municipal land use authority is predominantly given through the Ontario Planning Act, R.S.O. 1990, Chapter P.13.

The discussion focused on new uses, rather than changes in existing use. However, there was some acknowledgement that a future discussion of changes to existing uses would be useful because the Municipality of Clarington has approval authority over these changes through their Committee of Adjustment. In addition, it was acknowledged that a future discussion of the role of some Provincial agencies that may have land use authority may also be in order. The example raised was the role of the Ontario Human Rights Commission (OHRC) and land uses pertaining to sensitive groups who are protected by the Ontario Human Rights Code. People protected by the Code can locate anywhere, although a municipality can challenge the location at the Ontario Municipal Board (OMB).

5.1.1 Municipality of Clarington Official Plan and Zoning Bylaw

An Official Plan is a statutory document which sets out the land use policy directions for long-term growth and development in a municipality. All municipal planning authorities in Ontario are required to prepare and adopt an Official Plan, unless exempt from approval, and submit it for approval in accordance with Section 14.7(3*)* of the Planning Act, R.S.O., 1990, Chapter P. 13. The Official Plan for the Municipality of Clarington (January 2007, Office Consolidation) is currently being updated in accordance with Section 26(1) of the Planning Act, R.S.O., 1990, Chapter P.13.

A zoning bylaw controls the specific use of land in a community. Municipalities have authority to enact zoning bylaws in accordance with Section 34(1) of the Planning Act, R.S.O., 1990, Chapter P. 13. Zoning bylaws state precisely how land may be used; where buildings and other structures can be located; the types of buildings that are permitted and how they may be used; and, the lot sizes and dimensions, parking requirements, building heights and setbacks from the street.

While an Official Plan sets out a municipality's general policies for future land use, a zoning bylaw puts the plan into effect and provides for its day-to-day administration. Zoning bylaws contain specific requirements that are legally enforceable. If construction or new development does not comply with zoning bylaw requirements, the Municipality has the authority to refuse issuance of a building permit.

The Official Plan and zoning bylaw represent the strongest land use planning tools in the Municipality of Clarington's policy tool kit to regulate land uses in the vicinity of the DNNP. Municipalities are also able to use Site Plan Approval under the Planning Act, Licensing under the Municipal Act S.O. 2001, Chapter 25, and Building Permit Approval under the Ontario Building Code Act, 1992, S.O., Chapter 23. The Ontario Fire Code O.Reg.213/07 and Fire Protection and Prevent Act, 1997. S.O., 1997 can also be used to regulate the approval and construction of buildings pertaining to specific land uses.

Land use policies approved through Official Plans, as well as decisions by municipal staff to deny development proposals such as 'sensitive land uses' within 3 km from the DNNP can be challenged at the OMB.

The Municipality of Clarington acknowledged that it is able to strengthen its Official Plan to preclude vulnerable land uses and clienteles from locating within 3 km of the DNNP to respond to JRP recommendations #44 and #59. For example, if a municipality specifically consults the public on a specific change in land use during its Official Plan review and amends its Official Plan and zoning bylaw accordingly, the likelihood of the Official Plan policy being given weight by the OMB increases significantly. Typically the OMB acknowledges the policy because it is a documented indication of how the residents of the municipality want to see the specific land use develop.

Thus, the Municipality of Clarington is able to strengthen the policy in its Official Plan. However, the Official Plan and zoning bylaw are both subject to approval by Municipal Council. In addition, they are both open to challenge at the OMB.

During the workshop, the Municipality of Clarington and the Region of Durham stated that an OMB hearing can cost the municipality several hundreds of thousands of dollars. The cost implications can be better appreciated when considering the steps involved when assessing a new development application within the Municipality of Clarington (Figure 1).

Without support for the land use policies around the DNNP from senior levels of government and political support, the likelihood of the Municipality of Clarington successfully supporting its land use polices at the OMB is not assured.

Workshop participants noted that the following support would be helpful:

CNSC Regulatory Statement

A regulatory statement from the CNSC setting out expectations for land uses near the DNNP, and in particular, a statement that includes support for employment/industrial uses and other non-sensitive uses within the 3 km zone. This would provide federal level support and direction for land use planning decisions made by the Municipality of Clarington and the Region of Durham.

Bolster the Provincial Policy Statement Regarding Nuclear Generating Stations

Since the Provincial Policy Statement (PPS) is the declaration of Ontario's policies on land use planning in Ontario's Provincial policy-led system, the Municipality of Clarington's Official Plan and the Region of Durham's Official Plan are required to be consistent with the PPS.

In order to strengthen the chance of successfully implementing and defending land use policies near the DNNP, the Municipality of Clarington and the Region of Durham recommended that land use compatibility policies near nuclear generating stations in the PPS are strengthened. Workshop participants suggested strengthening Section 1.6.8 of the PPS and adding '*nuclear generating stations*' to the list of major facilities currently listed in the definitions section of the PPS. For a more detailed discussion please see Section 5.1.3 of this report.

Region of Durham Official Plan Policies

The Municipality of Clarington's Official Plan must conform to Region of Durham's Official Plan. Staff at the Municipality of Clarington would have an increased level of comfort preparing strong land use policies for lands near the DNNP and defending future land use recommendations before Municipal Council and the OMB if the Region of Durham's Official Plan contained a strong policy statement with respect to land uses near the DNNP.

Supporting Science from Emergency Management Ontario

The Municipality of Clarington and the Region of Durham indicated that in addition to support from senior levels of government in the form of clear and consistent policy positions with respect to land uses near the DNNP, a strong scientific rationale is equally as critical.

The EMO indicated that it is working with the Canadian Standards Association (CSA) on the science and policy supporting emergency response. Supporting science from Emergency Management Ontario (EMO) would allow the Municipality of Clarington and the Region of Durham to rationalize and defend their land use positions and recommendations before Municipal council and the OMB, in particular within the 3 km zone. Workshop participants stated that supporting science would help to present a defensible case.

Technical studies inform the direction provided in the Provincial Nuclear Emergency Response Plan (PNERP). However, while the science is strong with respect to nuclear/radiological emergencies, and in particular evacuation requirements and the protection of health, safety, welfare and property, it does not address land uses in the vicinity of the DNNP. Furthermore, the science informs response measures in the event of a nuclear emergency, not prudent, land use planning and prevention.

Political Support

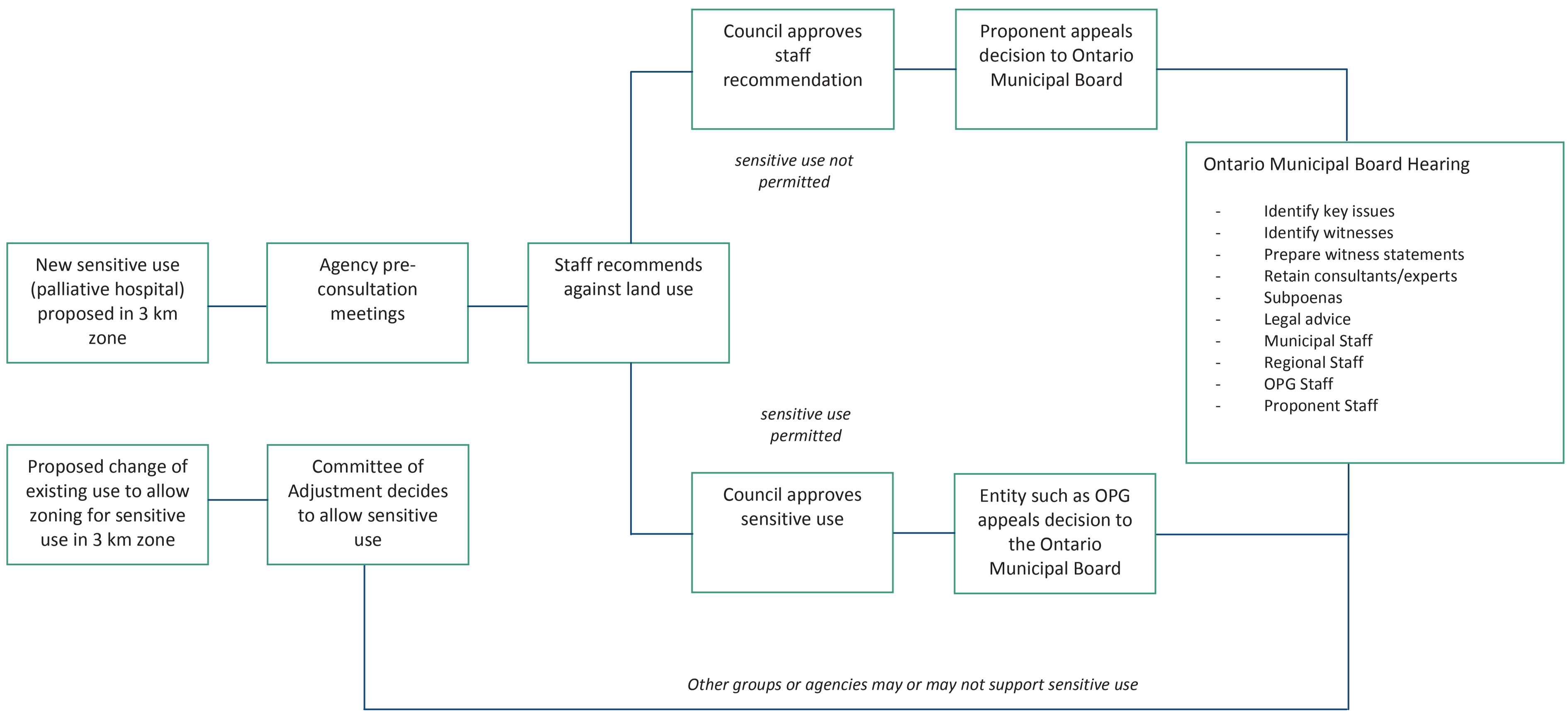
Participants indicated that a Municipal Council will occasionally override staff decisions and approve a land use. If this occurs for a sensitive land use within 3 km of the DNNP, the Municipality would no longer be supporting the intent of the JRP recommendations. The opposition to the land use would then have to occur through Ontario Power Generation, the Region of Durham, or other persons who would have standing at the OMB.

The area within the 3 km zone largely consists of lands designated for employment, industrial, and greenspace uses (Appendix A, Appendix B, Appendix C). The Municipality of Clarington would have heightened confidence to preclude land uses consistent with JRP recommendations #44 and #59 if the Province and the Region of Durham supported the development of employment and industrial uses on lands within the 3 km zone.

Workshop participants also indicated that senior level support is required for changes to sensitive uses from existing land uses through minor variance applications. Figure 1 includes a description of how the Municipality of Clarington would address a change in an approved land use to a sensitive use. An example of a change to a sensitive use might be an application for rezoning to allow a single family home use to convert to a multiple family residence with beds for disabled individuals. The change could be approved or denied by the Municipality's Committee of Adjustment. Objections to the change are also appealable to the OMB.

Lastly, the Municipality of Clarington indicated that senior levels of government can, on rare occasions, override local municipal decisions and approve certain land uses, such as prisons or hospitals, for instance. While this is highly unusual, and does not present a noteworthy concern because the Province's preference is to work directly with local municipalities, the Municipality of Clarington acknowledged that there are land use decisions that may not necessarily be entirely within their control.

Figure 1: Development Application Process in the Municipality of Clarington



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5.1.2 The Region of Durham Official Plan

The Region of Durham Official Plan is a statutory document which sets out Regional Council's land use policy directions for long-term growth and development in the Region of Durham. The Region of Durham Official Plan was adopted by Regional Council on July 14, 1976 and approved by the Minister of Housing on March 17, 1978. The original Official Plan has been replaced by the current Official Plan, which was adopted by Council on June 5, 1991 and consolidated with amendments in accordance with the five year review process as per the Planning Act. The current version of the Official Plan is the 2008, office consolidation.

All municipal planning authorities shall prepare and adopt an Official Plan, unless exempt from approval, and submit it for approval in accordance with Section 14.7(3*)* of the Planning Act, R.S.O., 1990, Chapter P. 13. The Ministry of Municipal Affairs and Housing (MMAH) has the authority to approve the Region of Durham's Official Plan.

The Region of Durham Official Plan represents the strongest land use planning tool in the Region's policy tool kit to regulate land uses in the vicinity of the DNNP for the same reasons as those cited for the Municipality of Clarington's Official Plan. The same limitations as those cited for Clarington's Official Plan also apply to the Region of Durham Official Plan.

In addition to the limitations cited above, the Region of Durham has two other key challenges: (i) conforming to the requirements of the Growth Plan for the Greater Golden Horseshoe (GGGH), and in particular employment and population targets in the face of a declining land supply and (ii) an expanding residential community (Bowmanville) which partially lies within the 3 km zone (Appendix B) and for which development has already been approved.

Regional workshop participants pointed out that the over the term of the Official Plan, the Region of Durham will be seeking employment lands to meet Provincial employment intensification targets in the area around DNNP and in the vicinity of Highway 401 and the future highway link to 407. Staff noted that the 3 km zone near the DNNP is an ideal location for the establishment of employment lands which would fulfill the requirements of the GGGH. This land use would also support the JRP recommendations.

The GGGH also requires regional and local governments to implement population intensification targets. A target area includes a section on the western boundary of Bowmanville that is within 3 km of the DNNP.

In order to address the expansion of the Bowmanville community, and proposed residential communities in general, workshop participants agreed that new urban areas (not currently designated) should be the focus of the 3 km zone land use policy near the DNNP in response to the JRP Recommendations. These should be the area of focus, rather than areas that are already developed or lands for which development has already been planned and/or approved. Furthermore, workshop participants also recommended that new development and plans within the 3 km zone not include 'sensitive land uses and/or vulnerable populations', with respect to the Region of Durham Official Plan

Workshop participants recommended that the 3 km zone boundary should be measured from the centre of the DNNP consistent with the Provincial Nuclear Emergency Response Plan (PNERP).

Accordingly, a map depicting a 3 km zone from centre of the site was prepared after the workshop (Appendix C).

The Region of Durham stated that if the Municipality of Clarington and Region of Durham both had consistent Official Plan policies, supported by policies in the PPS, zoning could address a large proportion of the land use issues/concerns near the DNNP.

The discussion concluded with workshop participants acknowledging the need to strengthen policies in the Region of Durham's Official Plan in order to facilitate the development of employment and industrial uses near the DNNP. They also acknowledged that the Official Plan should prohibit 'sensitive land uses and/or vulnerable populations' within the 3 km zone measured from the centre of the DNNP.

The Region of Durham stated that it would have a greater level of comfort and confidence to support such policies if the PPS included clear, consistent polices to the same effect (see Section 5.1.3 for more detailed discussion) and if there was science in place providing a defensible rational for such land use policies before Regional Council and the OMB. The Region of Durham also pointed out that it would need to consult the public and other stakeholders with respect to such land use policies.

5.1.3 Provincial Policy Statement

The PPS is the declaration of the government's policies on land use planning. The PPS provides direction on matters of provincial interest concerning land use planning and development. The PPS supports the provincial policy-led planning system in Ontario.

While Provincial Policy Statements have been part of planning for many years, the current PPS came into effect on March 1, 2005. Subsection 3(10) of the Planning Act, R.S.O., 1990, Chapter P.13 states that the PPS must be reviewed every five years from the date that the PPS came into effect, to determine whether revisions are needed. Ontario is currently revising the PPS in accordance with the legislated five-year review period for the PPS.

The PPS is issued under Section 3 of the Planning Act (R.S.O. 1990, Chapter P.13) and all decisions affecting land use planning matters "shall be consistent with" the PPS. Municipalities are required to prepare their Official Plans based on the policies contained in the PPS.

Section 1.2.6.1 addresses land use compatibility between "major facilities" and "sensitive land uses" and in particular, states that each:

> *"should be planned to ensure they are appropriately designed, buffered and/or separated from each other to prevent 'adverse effects' from odour, noise, and other contaminants, minimize risk to public health and safety, and to ensure the long-term viability of major facilities."*

Participants concluded that PPS policy 1.2.6.1 would require municipalities to draft policies that are consistent with the PPS. With PPS support, these policies would provide support for local municipalities at the OMB. Workshop participants recommended that 'nuclear generating stations' be added to existing major facilities listed in the definitions section of the PPS. By doing so it would provide a higher level of comfort defending land use decisions.

The definition of "major facilities" in the PPS now reads:

> *"Facilities which may require separation from sensitive land uses, including but not limited to airports, transportation infrastructure and corridors, rail facilities, marine facilities, sewage treatment facilities, waste management systems, oil and gas pipelines, industries, and resource extraction activities."*

Workshop participants also reviewed Section 1.6.8. of the PPS as it contains land use compatibility policies pertaining to airports, rail and marine facilities[1]. Participants stated this Section has a potentially helpful policy basis because it is able to bring specific Federal Guidelines pertaining to federally regulated facilities, into Provincial Policy. Section 1.6.8.1 states:

> *"Planning for land uses in the vicinity of airports, rail facilities and marine facilities shall be undertaken so that their long-term operation and economic role is protected."*

Section 1.6.8.2 states:

> *"Airports shall be protected from incompatible land uses and development by:*
>
> a) *prohibiting new residential development and other sensitive land uses in the areas near airports above 30 NEF/NEP, as set out on maps (as revised from time to time) that have been reviewed by Transport Canada;*
> b) *considering redevelopment of existing residential uses and other sensitive land uses or infilling of residential and other sensitive land uses in areas above 30 NEF/NEP only if it has been demonstrated that there will be no negative impacts on the long-term function of the airport; and*
> c) *discouraging land uses which may cause a potential aviation safety hazard."*

Participants agreed that Section 1.6.8 could benefit from the inclusion of land use compatibility policies near nuclear generating stations. This would bolster the province's policy direction with respect to land use compatibility matters in the vicinity of nuclear generating stations thereby providing more support for municipal land use decisions within the 3 km zone.

However, several workshop participants voiced caution about amending the PPS. While the PPS directs municipal land use planning policies contained in Official Plans, it is a high level policy document without sufficient granularity to deal with specific nuclear generating stations. Compared to other land uses across Ontario, there are very few properties that having a land use subject to a policy that is intended to have province-wide application. The change would also require scientific support. Thus, based on this limitation, it was decided that the PPS cannot adequately address land uses near nuclear generating stations alone. However, an amendment to the PPS would still have an important role pertaining to challenges at the OMB.

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[1] At the time of the workshop the draft PPS did not contain policies pertaining to rail and marine facilities.

5.1.4 D1 and D6 Guidelines

Workshop participants reviewed the Ministry of Environment (MOE) D1 and D6 Guidelines. The Guidelines are primarily concerned with minimizing land use impacts due to noise, dust and air emissions. They are most applicable for assessing Ontario Environmental Protection Act, R.S.O. 1990, Chapter E.19 considerations (e.g., approval of a chlorine tank adjacent to a school yard). The Guidelines are also designed to address the day-to-day operations of facilities and not public safety or health matters associated with nuclear generating stations. Further, as radionuclides are a federal matter provincial ministries such as the MOE specifically do not address this cause of impact. Based on this limitation, as well as the mandate of the MOE, participants concluded that the Guidelines are not applicable to nuclear generating stations and that the MOE does not have jurisdiction as it pertains to these land use planning matters.

5.1.5 Minister's Zoning Order

A Minister's Zoning Order (MZO) is provincial legislation that controls the use of land and determines explicit requirements for new development. A MZO can limit particular types of development and be used to control land use in any area of the province. Moreover, a MZO can protect land from particular types of development to enable for current uses to be compatible with future uses.

The Planning Act, R.S.O. 1990, Chapter P.13 gives the Minister of Municipal Affairs and Housing the authority to zone any property in the province. Zoning orders are found in areas without municipal organization and are rarely used where municipalities have existing zoning bylaws. The typical intent is to protect a provincial interest.

MZO's are most commonly used in northern Ontario where there is no local municipality or local zoning bylaw. Once a MZO is in effect, the Minister can either delegate the administration of the order to the local planning board or make it the local by-law.

Workshop participants agreed that a MZO is not applicable to the DNNP because it is too specific and is meant to hold land until provincial policy provides resolution to the land use. It is also highly unlikely that a MZO would be issued in the Municipality of Clarington where there are strong land use policy frameworks in place, including an Official Plan and corresponding zoning bylaw.

5.1.6 Ontario Municipal Board

The Ontario Municipal board (OMB) is an independent adjudicative tribunal responsible for settling disputes over land use planning and other municipal issues. The OMB hears appeals related to land use planning under the Planning Act and other legislation. In determining appeals, the OMB interprets and applies policies, such as the PPS, as well as other provincial laws and policies. As a result, OMB decisions have important consequences for land use planning in Ontario. The OMB gets it authority from the Ontario Municipal Board Act, R.S.O. 1990, Chapter O.28. It requires and tests evidence under the Canada Evidence Act, R.S.C., 1985, Chapter C-5.

Witnesses appear under oath and are subject to cross examination. Both factual and opinion evidence (based on qualified witnesses) can be brought before the Board. Factual and opinion evidence supported by science is given weight. The decisions of the OMB usually bring finality to land use decisions. Decisions by the Board can only be appealed to Ontario Superior Court or to the Provincial Cabinet.

Workshop participants agreed that an OMB decision pertaining to land uses in the vicinity of the DNNP would be final and determinative of the land use. However, without supportive policy, guidelines, statements and regulations, OMB land use decisions in the vicinity of DNNP would be subject to uncertainty.

5.1.7 Guideline TP1247 – Land Use in the Vicinity of Airports

Workshop participants examined whether other Federal regulations may be adjusted and applied in support of land uses around nuclear generating stations. The example of Transport Canada aviation regulations were raised as an example of a Federal regulation guiding land use planning at the municipal level in Ontario.

Aviation in Canada is regulated through the authority of the federal government. The Aeronautics Act, R.S.C., 1985, c. A-2 gives the Minister of Transport the power to enact regulations affecting noise from aircraft and airports.

Transport Canada provides a noise contouring system called the Noise Exposure Forecast (NEF) System, designed to predict annoyance from aircraft noise. The NEF is used for long-term land use planning and is based on the International Civil Aviation Organization (ICAO) recommended model. The NEF model is supported by a document that contains land use guidance (Document TP1247) which is designed to achieve compatible land use around airports. Ontario has incorporated the guidance into the PPS (Section 1.6.8.2)

Guideline TP1247 recommends that residential housing construction not be undertaken inside the NEF 30 contour. Participants considered whether a Federal guideline can also be applied for housing in the vicinity of a federally approved nuclear facility. They concluded that the Guideline is meant to address a large number of potential land uses and would not be appropriate for the DNNP, representing a specific use.

The Aeronautics Act contains the following provisions for zoning land adjacent to airports in Canada that has relevance for the discussion of land uses within the vicinity of nuclear generating stations:

> *" (2) The Governor in Council may make regulations for the purposes of*
>
> > (a) *preventing lands adjacent to or in the vicinity of a federal airport or an airport site from being used or developed in a manner that is, in the opinion of the Minister, incompatible with the operation of an airport;*
> >
> > (b) *preventing lands adjacent to or in the vicinity of an airport or airport site from being used or developed in a manner that is, in the opinion of the Minister, incompatible with the safe operation of an airport or aircraft; and*

(c) preventing lands adjacent to or in the vicinity of facilities used to provide services relating to aeronautics from being used or developed in a manner that would, in the opinion of the Minister, cause interference with signals or communications to and from aircraft or to and from those facilities.

Conditions precedent

(3) The Governor in Council shall not make a zoning regulation under paragraph (2)(a) unless

(a) the Minister, after making a reasonable attempt to do so, has been unable to reach an agreement with the government of the province in which the lands to which the zoning regulation applies are situated providing for the use or development of the lands in a manner that is compatible with the operation of an airport; or

(b) in the opinion of the Minister, it is necessary to immediately prevent the use or development of the lands to which the zoning regulation applies in a manner that is incompatible with the operation of an airport.

Non-conforming uses, etc.

(4) No zoning regulation shall apply to or in respect of a use of land, buildings, structures or objects or a building, structure or object that, on the day on which the zoning regulation comes into force, exists as a use, building, structure or object that does not conform to the zoning regulation.

Deeming existence of certain things

(5) For the purposes of subsection (4), where on the day on which a zoning regulation comes into force, all approvals for construction required by law have been obtained permitting a building, structure or object that, if constructed, would not conform to the zoning regulation, the building, structure or object shall be deemed to exist on the day on which the zoning regulation comes into force."

5.2 Other Plans, Regulations and Policies

This section summarizes the key observations and issues raised with respect to other plans, regulations and policies not directly relevant to land use planning matters, but that are able to inform and strengthen land use planning decisions within the 3 km zone.

5.2.1 Provincial Nuclear Response Plan

This Provincial Nuclear Emergency Response Plan (PNERP) provides the basis upon which off-site emergency management is undertaken in the event of a nuclear/radiological emergency. The PNERP provides a plan for the protection of the environment, health, safety, welfare and private property.
The PNERP is authorized by Section 8 of the Emergency Management and Civil Protection Act, R.S.O. 1990, Chapter E.9.

The PNERP's Master Plan sets out the overall principles, policies, basic concepts, organizational structures and responsibilities, policies, functions and interrelationships, which govern all nuclear and radiological emergency management in Ontario.

Implementation Plans are applied to each major nuclear site, trans-border emergencies, and other types of radiological emergencies. Each major organization involved (e.g. provincial ministries, agencies, boards and commissions, municipalities, and nuclear organizations) creates its own plan to carry out the relevant role, responsibilities and tasks agreed to (referred to as Major Organizational Plans). Procedures are developed for emergency centres to be created. Checklists are based on the requirements of the procedures.

The PNERP differentiates between a nuclear emergency and a radiological emergency. A nuclear emergency occurs when there is an actual or potential hazard from ionizing radiation from a major nuclear installation. A radiological emergency would occur when there is an actual or potential hazard from ionizing radiation resulting from sources other than a major nuclear installation.

The Province of Ontario has overall responsibility for managing the off-site response to nuclear emergencies. Emergency Management Ontario (EMO) is an agency of the provincial government. The EMO is responsible for the implementation PNER and public safety during nuclear emergencies. The Region of Durham, through the Durham Emergency Management Office and the local municipalities have emergency plans in place to implement the PNERP. Local emergency responders, police, fire and ambulance crews ensure that the emergency plans are implemented properly.

The Incident Management System (IMS) for Ontario is a standardized approach to emergency management encompassing personnel, facilities, equipment, procedures, and communications operating within a common organizational structure. The IMS is compatible with other jurisdictions' incident management initiatives as well as the practices contained in the Canadian Standards Association (CSA) Emergency Management and Business Continuity Program Standard (CSA Z1600), the National Fire Protection Association (NFPA) 1561, Standard on Emergency Services Incident Management System, and the National Fire Protection Association (NFPA) 1600, Standard on Emergency Management and Business Continuity Programs.

Workshop participants indicated that while the PNERP provides good high-level direction pertaining to evacuation in the event of a nuclear/radiological emergency, it is not appropriate for managing land uses near the DNNP because the scope does not include approval of land uses.

5.2.2 Regulatory Document RD-337 Design of New Nuclear Power Plants

This regulatory document sets out the expectations of the CNSC regarding the design of new water-cooled nuclear power plants (NPPs). It establishes a set of comprehensive design expectations that are risk-informed and align with accepted international codes and practices. Moreover, RD-337 represents the CNSC's adoption of the principles set forth by the International Atomic Energy Agency (IAEA) in NS-R-1, Safety of Nuclear Plants: Design. It also addresses the interfaces between NPP design and environmental protection, radiation protection, human factors, security, safeguards, transportation, and accident and emergency response planning. The provisions of the Nuclear Safety and Control Act, S.C., 1997, Chapter 9 and associated regulations are applicable to this regulatory document.

Workshop participants decided that RD-337 is not sufficient for managing land uses near the DNNP because the scope does not include land uses.

5.2.3 Regulatory Document RD-346 Site Evaluation or New Nuclear Power Plants

This regulatory document sets out the expectations of the CNSC regarding the evaluation of sites for new nuclear power plants (NPPs) before application is made for a Licence to Prepare Site and before an environmental assessment (EA) determination is initiated. This document provides high level guidance pertaining to site evaluation activities.

RD-346 represents the CNSC's adaptation of the principles set forth by the International Atomic Energy Agency (IAEA) in NS-R-3, Site Evaluation for Nuclear Installations and includes the protection of the environment (e.g. identification of VECs and project interactions), security of the site, and protection of prescribed information and equipment. RD-346 serves the licensing needs under the Nuclear Safety and Control Act, S.C., 1997, Chapter 9 and the Canadian Environmental Assessment Act, S.C. 2012, Chapter. 19, Section 52.

RD-346 addresses public consultation protocols and Aboriginal 'Duty to Consult' requirements. It also addresses general criteria for site evaluation; emergency planning considerations (e.g. exclusion and protection zones), as well as the gathering of baseline environmental data.

Section 5.5.3 of RD-346 requires that the following population and emergency planning considerations are taken into account when planning new NPPs in order to achieve safety goals:

1. *"Population density and distribution within the protective zone, with particular focus on existing and projected population densities and distributions in the region including resident populations and transient populations—this data is kept up to date over the lifetime of the NPP;*

2. *Present and future use of land and resources;*

3. *Physical site characteristics that could impede the development and implementation of emergency plans;*

4. *Populations in the vicinity of the NPP that are difficult to evacuate or shelter (for example, schools, prisons, hospitals); and*

5. *Ability to maintain population and land-use activities in the protective zone at levels that will not impede implementation of the emergency plans."*

Workshop participants decided that RD-346 is not sufficient for managing land uses near the DNNP.

5.3 Scientific Support

Workshop participants indicated that scientific research and findings to support land use policy near the DNNP is critical to the success and implementation of the policy. Scientific research and findings would assist the Municipality of Clarington and the Region of Durham to provide a sound, robust defense of their land use positions and recommendations within the 3 km zone before Municipal Councils and at the OMB, should they be disputed.

Participants suggested that the scientific basis for evacuation zones used by Emergency Management Office (EMO) and the CSA can potentially be repurposed to support land use policy decisions, and in particular land use restrictions within the DNNP 3 km zone.

Participants also agreed that international 'best practices' should be reviewed to better understand how (if) other jurisdictions have land use exclusion zones near nuclear generating stations and if there are any lessons learned that can be brought to bear in the DNNP context.

5.4 Definitions

During the workshop, participants discussed a number of definitions, including:

> **Contiguous Zone**
> **"***The zone immediately surrounding the nuclear installation. Priority evacuations, if necessary, shall be undertaken within this area because of its proximity to the source of the potential hazard".* (PNERP; the contiguous zone for the Darlington site is 3 km).

During the workshop it was recommended that the Contiguous Zone also include water (Lake Ontario) south of the DNNP as part of the 3 km radius.

> **Exclusion Zone**
> **"***A parcel of land within or surrounding a nuclear facility on which there is no permanent dwelling and over which a licensee has the legal authority to exercise control."* (RD-346, Pg. 12, 2008)

> **Protective Zone**
> ***"****Is the area beyond the exclusion zone that needs to be considered with respect to implementing emergency measures. This includes considerations of such matters as population distribution and density, land and water usage, roadways, evacuation planning, and consequence analysis."* (RD-346, Pg. 12, 2008)

5.4.1 Sensitive Land Use

Workshop participants indicated that it is critical for all levels of policy and agency documents to have consistent definitions. For instance, it was noted that the definition of 'sensitive land use' contained in the PPS does not fully apply to what a 'sensitive land use' ought to be in the context of a land use policy near the DNNP. The PPS definition of a 'sensitive land use' is:

> *"...buildings, amenity areas, or outdoor spaces where routine or normal activities occurring at reasonably expected times would experience one or more adverse effects from contaminant discharges generated by a nearby major facility. Sensitive land uses may be a part of the natural or built environment. Examples may include, but are not limited to: residences, day care centres, and educational health facilities."*

Workshop participants agreed that a 'sensitive land use' in the context of the 3 km zone near DNNP should be based on ease of evacuation. It was agreed that the most sensitive land uses (e.g., those that are most difficult to evacuate) include hospitals, prisons, and senior's homes. There was also agreement among workshop participants that most residences (as long as they are inhabited by able bodied individuals), day care centres, and educational health facilities are not 'sensitive' because they are in fact easy to evacuate.

However, after the workshop the CNSC acknowledged that while 'ease of evacuation' may be one deciding factor with respect to identifying 'sensitive land uses', there is a need to further consider and discuss what additional criteria should be used to determine 'sensitive land uses' .

5.4.2 Boundary

During the workshop, participants referenced two maps (Appendix A, Appendix B). The concentric boundaries near the DNNP were discussed in particular. The following provides a description of the boundaries depicted on the maps:

Appendix A: Darlington Nuclear Generating Station Boundary Map

- Red boundary lines are measured from centre of the DNNP.
- Blue boundary lines are measured from the DNNP property boundary.

Appendix B: Pickering and Darlington Nuclear Generating Station Boundary Map

- Darlington NGS (Pg. 3)
  - The red 3 km boundary is intended to represent the potential 3 km area (based on the assumption that the new reactors will be located east of the existing reactors). The boundary is based on OPG mapping contained in the EA for the Darlington new build.
  - The black 3 km boundary represents a 3 km distance from the existing reactor.
  - The black 10 km boundary represents a 10 km distance from the existing reactor.

- Darlington NGS (Pg. 3)
  - The black 3 km boundary represents a 3 km distance from the DNNP property line.

During the workshop, participants decided that the 3 km zone should be measured from the centre of the DNNP (Appendix C). Land uses within the 3 km zone have the following designations:

- Green Space (north of Highway 401);
- Prestige Employment (north-east of the DNNP, south of Bowmanville);
- Environmental Protection (north-east of the DNNP, south of Bowmanville);
- Urban Residential (the south-western corner of Bowmanville);
- Community Park (north-east of the DNNP, south of Bowmanville);
- Aggregate Extraction (east of the DNNP);
- Waterfront Greenway (west and east of the DNNP along the Lake Ontario shoreline);
- Business Park (west of the DNNP); and
- Light Industrial (north-west of the DNNP, north of Highway 401 and north-west of the DNNP south of Highway 401).

6.0 Conclusions

General Principles

While the discussion during the day centred on the DNNP in particular, the following principles can be applied more broadly to other nuclear generating stations across Canada:

1. All levels of government must play a role in developing and supporting land use policies near nuclear generating stations;

2. Science must support land use policy near nuclear generating stations in order for land use decisions and policies to be sound and defensible;

3. Land use policy and land use decisions should be based on technical information regarding accidents and malfunctions, and the potential and real impacts on persons and the environment (i.e., the science);

4. Land use policies near nuclear generating stations are grounded in the strength of the local municipal planning regime. However, those Municipalities and Regions who are nuclear generating station hosts require support in the form of consistent and strong policy at the Provincial and Federal level.

General Conclusions

The general conclusions gleaned during the workshop can be summarized as follows:

1. Land use policy near nuclear generating stations requires a suite of tools from all levels of government with consistent direction;

2. The Municipality of Clarington Official Plan and the Region of Durham Official Plan need to be strengthened during the next five year review cycle;

3. Strong Official Plans and zoning bylaws can address a large portion of land use issues near the DNNP consistent with JRP recommendations. The Municipality of Clarington Official Plan needs support from the Region of Durham Official Plan, as well as the PPS. The Region of Durham Official Plan needs support from the PPS. There will be a higher level of comfort to defend land use policies and recommendations within the 3 km zone if there is support from each level of government;

4. The PPS needs to be bolstered to provide a higher level of comfort and support for the Region of Durham and the Municipality of Clarington to strengthen their Official Plans with respect to land use policies within the 3 km zone;

5. There is an opportunity to strengthen regulatory recommendations of the JRP and the CNSC through future licence reviews; and

6. There is a need to consider the role of emergency response in addressing the JRP recommendations.

Conclusions Pertaining to the JRP Recommendations

JRP Recommendation #43
The June 12, 2013 Land Use Planning workshop represents a first effort to engage collectively appropriate stakeholders to develop a policy for land use around nuclear generating stations. Seventeen individuals representing nine organizations and four levels of government participated in the workshop, including representatives from the CNSC, EMO, MMAH, MOE, MOE, Region of Durham, Municipality of Clarington, Municipality of Oshawa, and OPG.

During the workshop there was a great deal of cooperating and information sharing, a broad range of discussion and an agreement on next steps.

JRP Recommendation #44
The Province needs to strengthen the PPS to provide a higher level of comfort for the Municipality of Clarington and the Region of Durham to prohibit ‘sensitive land uses and/or vulnerable populations’ to locate within the 3 km zone. The EMO also needs to provide scientific support for land use policy decisions near nuclear generating stations. Lastly, the Province needs to demonstrate support for the Region of Durham’s employment/industrial intensification near the DNNP, as well as Official Plan policies with respect to population intensification, particularly the western portion of Bowmanville.

JRP Recommendation #45
The Municipality of Clarington should strengthen its Official Plan and Zoning Bylaw to prohibit ‘sensitive land uses and/or vulnerable populations’ to locate within the 3 km zone. However, the extent to which the Municipality of Clarington Official Plan can succeed in implementing land use exclusions within the 3 km zone is largely dependent on the presence of consistent and supportive policies in the Region of Durham Official Plan, the PPS, as well as science supporting land use exclusions in the 3 km zone.

JRP Recommendation #59
Same as JRP recommendation #45, above.

7.0 Recommendations

The following twelve key recommendations were generated at the conclusion of the workshop based on discussion over the course of the workshop:

1. Strengthen the Region of Durham Official Plan with respect to permitting employment/industrial land uses within 3 km of the centre of the DNNP as a method of excluding sensitive uses;

2. Strengthen the Municipality of Clarington Official Plan with respect to permitting employment/industrial land uses within 3 km of the DNNP as a method of excluding sensitive uses;

3. CNSC to draft letter to the Ministry of Municipal Affairs and Housing (MMAH) to request including 'nuclear generating stations' to the list of facilities included in the "Major Facilities" definition contained in the Provincial Policy Statement (PPS).

4. MMAH to consider including 'nuclear generating stations' to the list of existing facilities as part of the "Major Facilities" definition;

5. MMAH to support Regional and local municipal employment/industrial land uses around the DNNP if requested as part of implementation and support for the Growth Plan for the Greater Golden Horseshoe (GGGH) employment lands policies. MMAH to support the Region of Durham's efforts to resist population intensification on the west side of Bowmanville within 3 km of the centre of the DNNP;

6. Emergency Management Ontario (EMO) to consider repurposing the evacuation zone science to support land use restrictions near the DNNP. Science supporting the Provincial Nuclear Emergency Preparedness Plan (PNEPP) should also be repurposed in support of land use restrictions near the DNNP;

7. Federal and Provincial government representatives to commit to supporting the Region of Durham and the Municipality of Clarington if other senior levels of government are supporting sensitive uses (such as a provincial prison or a palliative care hospital) within 3 km of the DNNP that would have the effect of overriding municipal jurisdiction;

8. CNSC staff to consider whether some type of Regulatory Position on land use planning is needed.

9. CNSC to research and disseminate international practices pertaining to land use exclusion zones near nuclear generating stations;

10. Engage other stakeholder such as the Ontario Human Rights Commissions (OHRC) that regulates sensitive and other uses; and

11. The Municipality of Clarington and the Region of Durham to ensure Emergency Management Ontario (EMO) and Ontario Power Generation (OPG) remain informed about new sensitive land uses being proposed to locate within the 3 km zone.

Appendix A:

Darlington Nuclear Generating Station Boundary Map

DARLINGTON NUCLEAR SITE

From Centre of Site

From Property Boundary

Schools

Appendix B:

Pickering and Darlington Nuclear Generating Station Boundary Map

LEGEND

- 3 KM / 10 KM CONTIGUOUS ZONE OF NGS
- ESTIMATED 3 KM / 10 KM CONTIGUOUS ZONE OF NGS
- P12 — DEMO RESPONSE SECTORS

URBAN SYSTEM

- URBAN AREA BOUNDARY
- URBAN AREA BOUNDARY DEFERRED
- REGIONAL CENTRE
- URBAN AREA BOUNDARY APPEALED TO OMB
- URBAN GROWTH CENTRE
- REGIONAL CORRIDOR
- LIVING AREAS
- EMPLOYMENT AREAS
- AREAS DEVELOPABLE ON FULL/PARTIAL MUNICIPAL SERVICES
- AREAS DEVELOPABLE ON MUNICIPAL WATER SYSTEMS & PRIVATE WASTE DISPOSAL SYSTEMS
- AREAS DEVELOPABLE ON PRIVATE WELLS & MUNICIPAL SEWER SYSTEMS
- AREAS DEVELOPABLE ON PRIVATE WELLS & PRIVATE WASTE DISPOSAL SYSTEMS
- S — MUNICIPAL SERVICE

RURAL SYSTEM

- PRIME AGRICULTURAL AREAS

RURAL SETTLEMENTS :

- HAMLET
- (12) COUNTRY RESIDENTIAL SUBDIVISION (SEE TABLE E2 FOR DESCRIPTION)
- (3) RURAL EMPLOYMENT AREA (SEE TABLE E3 FOR DESCRIPTION)
- SHORELINE RESIDENTIAL
- (a) REGIONAL NODE (SEE SECTION 9C FOR DESCRIPTION)
- (12) AGGREGATE RESOURCE EXTRACTION AREA (SEE TABLE E1 FOR DESCRIPTION)

GREENLANDS SYSTEM

- MAJOR OPEN SPACE AREAS
- OAK RIDGES MORAINE AREAS
- WATERFRONT AREAS
- OAK RIDGES MORAINE BOUNDARY
- GREENBELT BOUNDARY
- RECREATIONAL /TOURIST ACTIVITY NODE
- WATERFRONT PLACE
- OPEN SPACE LINKAGE
- WATERFRONT LINKS

TRANSPORTATION SYSTEM

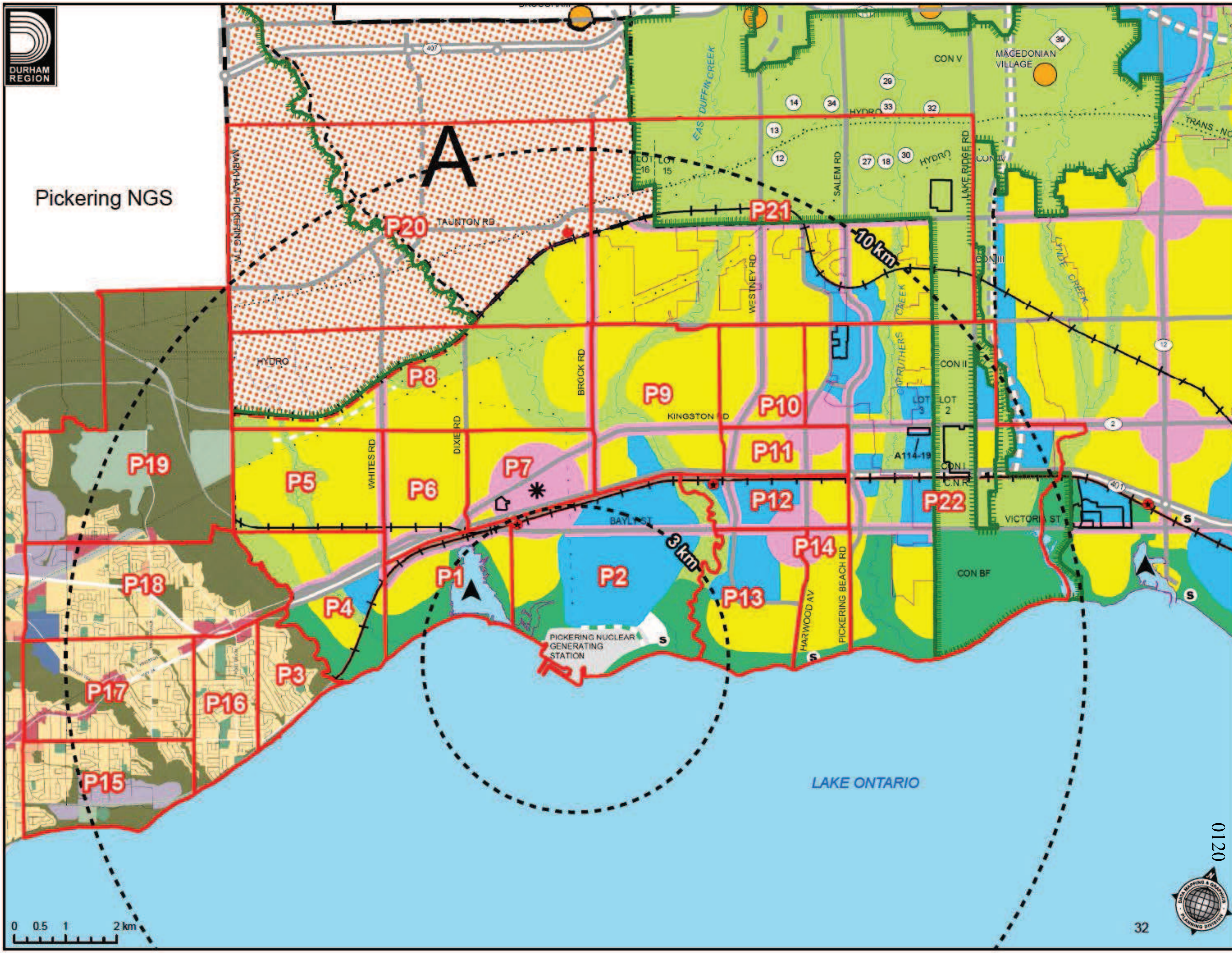
SEE SCHEDULE C FOR DESIGNATIONS

THE FOLLOWING IS SHOWN SELECTIVELY, FOR EASE OF INTERPRETATION OF OTHER DESIGNATIONS ONLY.

EXISTING		FUTURE
	ARTERIAL ROAD	
	FREEWAY	
	INTERCHANGE	
	GO RAIL	
	GO STATION	

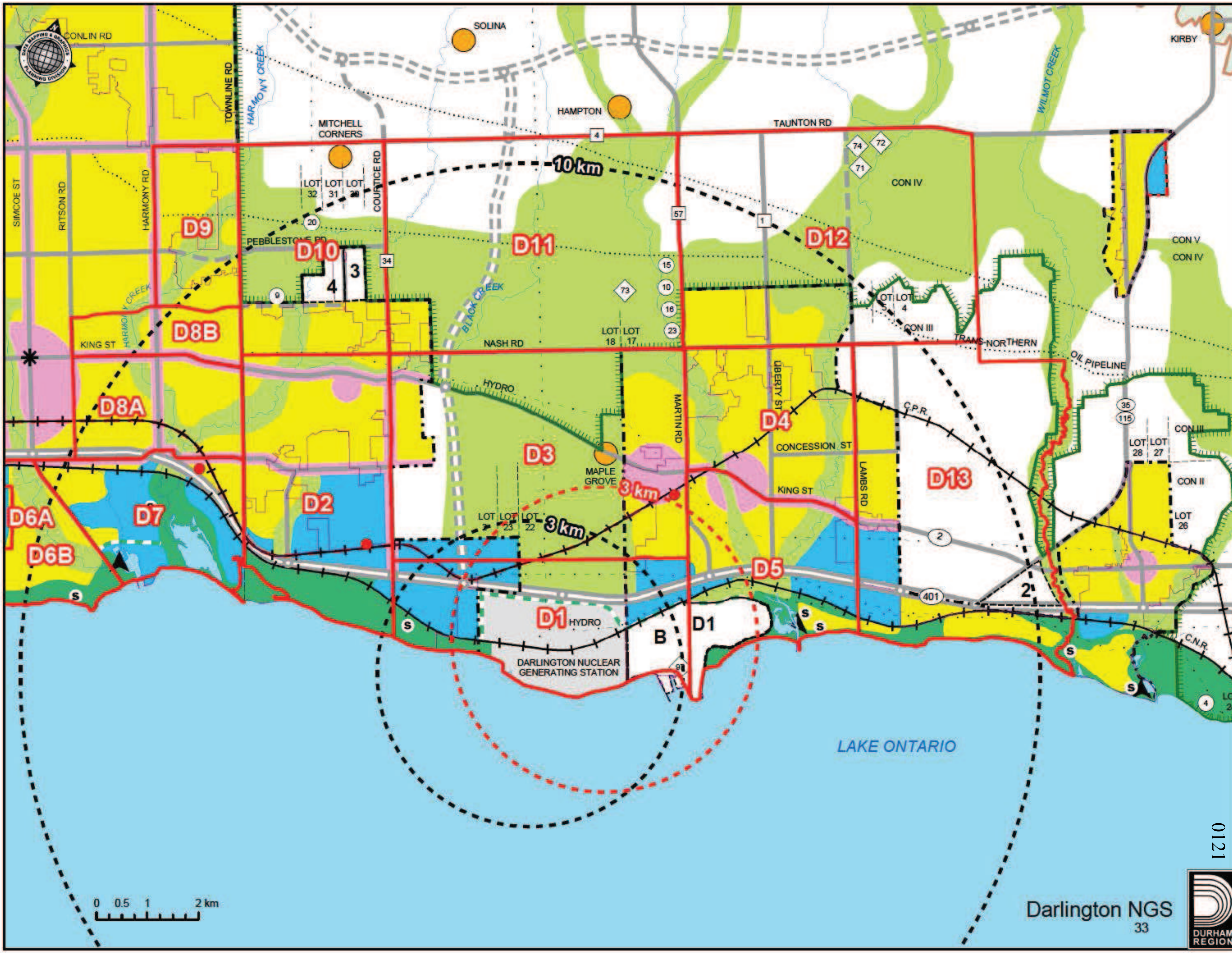
SPECIAL AREAS

- 2 — SPECIAL STUDY AREA
- A — SPECIFIC POLICY AREA
- D2 — DEFERRED BY MINISTER OF MUNICIPAL AFFAIRS
- APPEALED TO O.M.B.
- LANDS APPEALED TO OMB, REFER TO POLICY 14.13.7



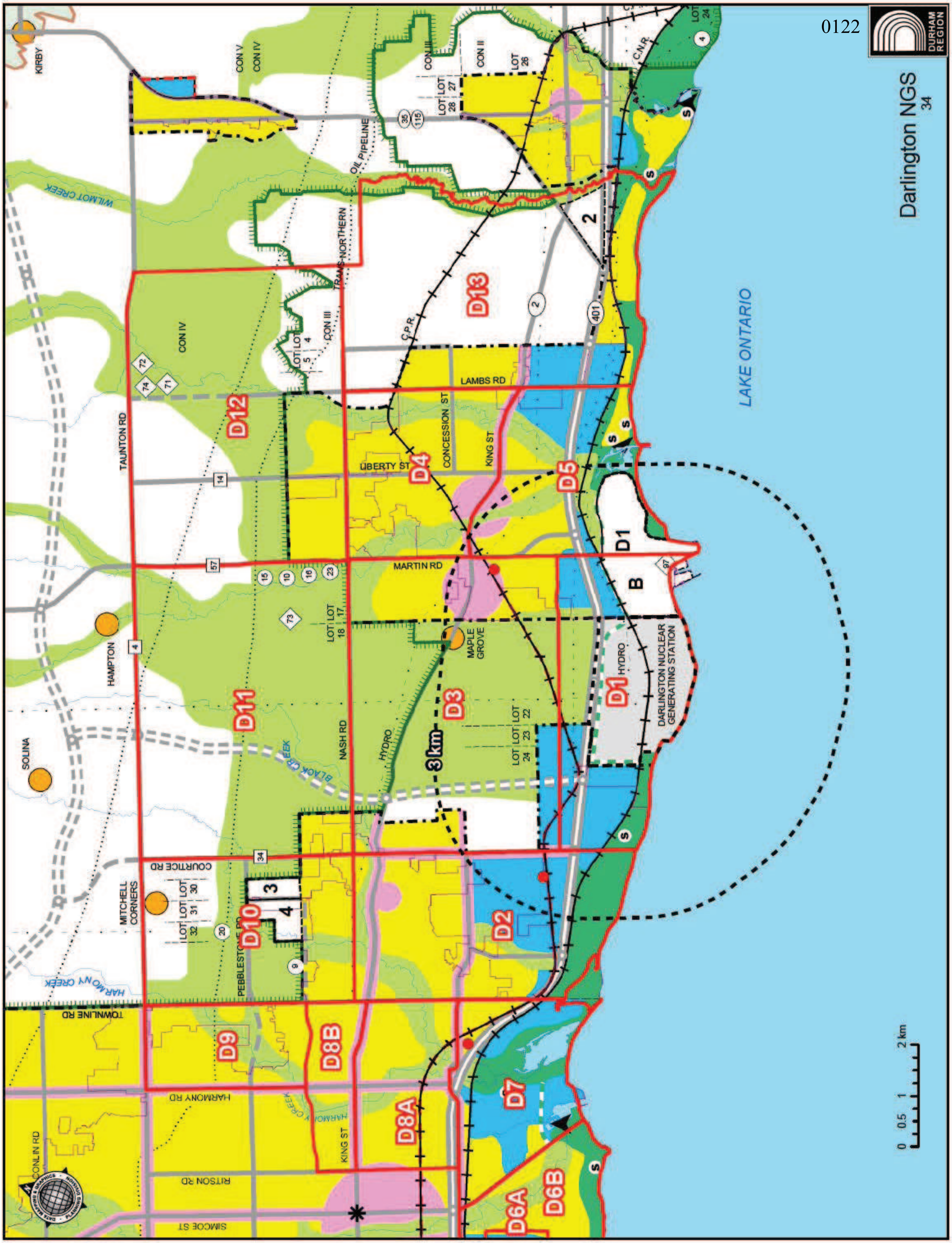
Pickering NGS
DURHAM REGION
A
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
P13
P14
P15
P16
P17
P18
P19
P20
P21
P22
10 km
3 km
TAUNTON RD
MARKHAM PICKERING TW
HYDRO
WHITES RD
DIXIE RD
BROCK RD
KINGSTON RD
WESTNEY RD
SALEM RD
LAKE RIDGE RD
BAYLY ST
VICTORIA ST
HARWOOD AV
PICKERING BEACH RD
PICKERING NUCLEAR GENERATING STATION
EAST DUFFIN CREEK
CARRUTHERS CREEK
LYNDE CREEK
MACEDONIAN VILLAGE
CON V
CON IV
CON III
CON II
CON I
CON BF
LOT 16
LOT 15
LOT 3
LOT 2
A114-19
C.N.R.
TRANS - NOR
LAKE ONTARIO
0 0.5 1 2 km
32

0120



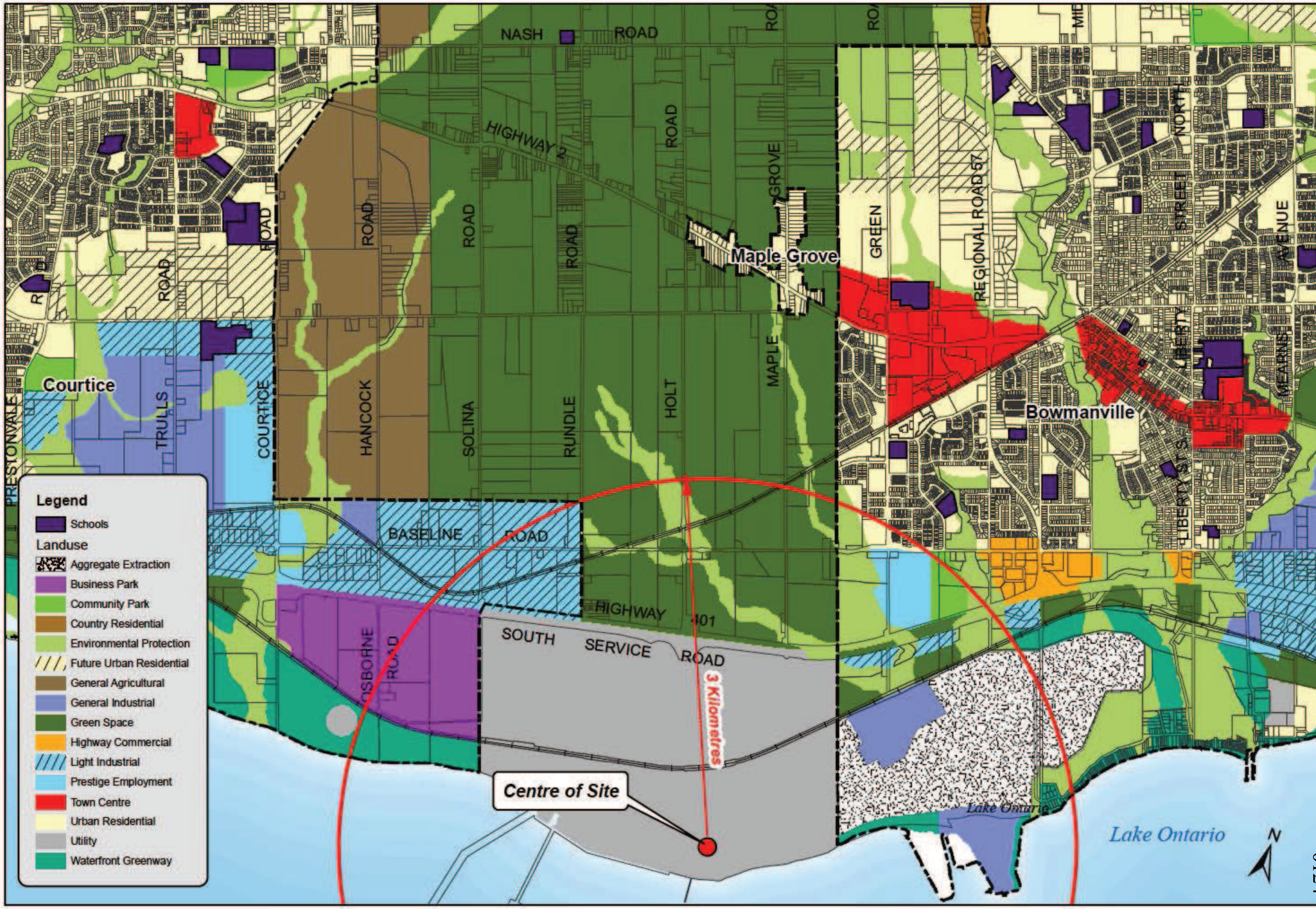
Darlington NGS
33
DURHAM REGION
LAKE ONTARIO
DARLINGTON NUCLEAR GENERATING STATION
HYDRO
10 km
3 km
3 km
D1
D1
B
D2
D3
D4
D5
D6A
D6B
D7
D8A
D8B
D9
D10
D11
D12
D13
1
2
3
4
SOLINA
HAMPTON
MITCHELL CORNERS
MAPLE GROVE
KIRBY
TAUNTON RD
CONLIN RD
TOWNLINE RD
SIMCOE ST
RITSON RD
HARMONY RD
COURTICE RD
PEBBLESTONE RD
KING ST
NASH RD
MARTIN RD
LIBERTY ST
CONCESSION ST
LAMBS RD
HARMONY CREEK
BLACK CREEK
WILMOT CREEK
HYDRO
C.P.R.
C.N.R.
TRANS-NORTHERN OIL PIPELINE
CON V
CON IV
CON III
CON II
LOT 32
LOT 31
LOT 18
LOT 17
LOT 23
LOT 22
LOT 5
LOT 4
LOT 28
LOT 27
LOT 26
LOT 24
401
0 0.5 1 2 km

0121


DURHAM REGION
Darlington NGS
34
LAKE ONTARIO
DARLINGTON NUCLEAR GENERATING STATION
HYDRO
3 km
D1
D2
D3
D4
D5
D6A
D6B
D7
D8A
D8B
D9
D10
D11
D12
D13
B
2
3
4
TAUNTON RD
NASH RD
KING ST
CONCESSION ST
LIBERTY ST
LAMBS RD
MARTIN RD
COURTICE RD
TOWNLINE RD
HARMONY RD
RITSON RD
SIMCOE ST
CONLIN RD
PEBBLESTONE RD
WILMOT CREEK
BLACK CREEK
HARMONY CREEK
TRANS-NORTHERN OIL PIPELINE
C.P.R.
C.N.R.
KIRBY
HAMPTON
SOLINA
MITCHELL CORNERS
MAPLE GROVE
CON V
CON IV
CON III
CON II
401
0 0.5 1 2 km

Appendix C:

3 km Zone from Centre of Darlington Nuclear Site



3 km Zone From Centre Of Darlington Nuclear Site

0124

Appendix D:
Workshop Agenda

HARDY STEVENSON AND ASSOCIATES

Land Use Planning
Re: Darlington Nuclear Generating Station
Stakeholder Workshop
Proposed Agenda

Dave Hardy, facilitator

June 12, 2013

9:00 am to 4:30 pm

Hilton Garden Inn, Canadian Hall B, 500 Beck Crescent, Ajax

9:00	**Welcome and introductions**
9:10	**Workshop objectives and agenda review – Dave Hardy**
9:20	**Overview of potential policy**
10:00	**Confirmation of key land use policy issues/concerns**
10:15	**Break**
10:30	**What should be the content of a policy (or similar instrument)?**
12:00	**LUNCH**
12:45	**Afternoon agenda check**
1:30	**Toward the structure and content of a draft policy or other instrument**
3:15	**Break**
3:30	**Process mapping and the process of implementing the policy**
4:15	**What actions need to happen post-workshop?**
4:30	**Close**

OFFICIAL PLAN REVIEW
Compass to our Future

Draft
Official Plan 2016
Municipality of Clarington

Planning Services Department
"Local Planning for Global Stewardship"

Clarington

May 30, 2016

Dear Sir/Madame

Re: Clarington's Draft Official Plan 2016: Draft Official Plan Amendment No. 107

The Clarington Planning Services Department has released the Draft Official Plan 2016, which includes the Draft Official Plan Amendment No. 107 and the Clarington Official Plan documenting the proposed changes, for public review and comment. The amendment will bring the existing Clarington Official Plan into conformity with the Province's Growth Plan and Greenbelt Plan, as well as implement the Region of Durham's Official Plan. The Official Plan is the policy document that guides decisions about managing growth, creating sustainable transportation choices, fostering job creation and investment, protecting the natural environment, and mitigating the impacts of climate change.

In March 2015, a working document proposing changes to the Official Plan was released for public review and comment. Staff held 4 public information sessions to inform the public and obtain feedback on the proposed changes. Through that process, staff received over 200 written submissions from various committees and members of the community, as well as interested property owners. All comments were considered in the preparation of the Draft Official Plan 2016.

The Municipality will hold a Public Open House on **Tuesday June 28th**, and a Public Meeting in the fall. Following these meetings, Planning Staff will then prepare a recommendation report and Final Draft for Council to make a decision, which is expected in November of 2016. It will then be forwarded to the Region of Durham for approval.

All information and background documents are available at www.clarington.net/ourplan/. In addition, printed copies are available for review at any Clarington Public Library Branch or at the Planning Services Department.

If you have any questions please do not hesitate to contact any member of the Official Plan review team: Carlos Salazar, Lisa Backus or Nicole Zambri at 905-623-3379.

Best regards,

Carlos Salazar
Manager of Community Planning & Design

How to Read the Plan

For ease of reference, the proposed changes in the Draft Official Plan Amendment are shown within the full Clarington Official Plan document as strikeouts and underlines. Text additions are shown with an underline (example) and text deletions are shown as a strike-out ~~(example)~~. Words in italics (*example*) are defined terms and can be found in the definition section of Chapter 24.

Public Open House

The Municipality will hold a Public Open House on **Tuesday, June 28th, 2016.** This is a drop in session that provides you with an opportunity to ask questions and learn more about the policy and mapping changes.

Location:
Clarington Public Library,
Bowmanville Branch, 2nd floor
163 Church Street, Bowmanville

Drop-in times:
2 pm to 4 pm
6 pm to 8 pm

More Information and Other Ways to Participate:

All the background information is available at: www.clarington.net/ourplan

Documents may be viewed at any Clarington Public Library Branch and at the Planning Services Department.

Get Involved – provide your comments:

Online: www.clarington.net/ourplan

E-mail: ourplan@clarington.net

In writing to: Planning Services: Official Pan Review
40 Temperance Street
Bowmanville, ON L1C 3A6

Your Official Plan Review Team

If you have any question or need additional information, please contact any member of the Official Plan Review team:

Carlos Salazar, Lisa Backus, or Nicole Zambri

Phone: 905-623-3379 Toll Free: 1-855-779-1923

Clarington

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Clarington

Clarington

i) The Municipality has adopted a *site*-specific amendment to the Zoning By-law.

Regulatory Shoreline Area

~~4.6.6~~3.7.7 The Regulatory Shoreline Area as identified on Map F, is that area along the Lake Ontario Waterfront which is subject to dynamic beaches, flooding and/or erosion. The extent and exact location of the Regulatory Shoreline Area shall be identified in the implementing Zoning By-law in accordance with the detailed Lake Ontario Flood and Erosion Risk Mapping of the relevant Conservation Authority.

~~4.6.7~~3.7.8 The construction of new buildings or structures of any type within the Regulatory Shoreline Area shall not be permitted.

3.7.9 Notwithstanding Section 3.7.8, existing residences within the Regulatory Shoreline Area shall be permitted to have ~~one garage and~~ a one-time expansion as of January 29, 1996, up to a maximum of 20% of the ground floor living area or 30 square metres, provided that:

a) the structure is not located in the floodplain of a watercourse ~~stream~~ or Lake Ontario;

b) the structure is not located on a dynamic beach or within a damage centre as identified by the Conservation Authority;

c) new or existing hazards or adverse environmental impacts are not created or aggravated;

d) the Municipality and Conservation Authority have approved a Floodproofing and/or erosion control plan; and

e) vehicles and people have a way of safely entering and exiting the area.

~~4.6.8~~3.7.10 Once a dwelling located in the Regulatory Shoreline Area is destroyed or demolished by whatever reason, and reconstruction is not commenced within 24 months, the existing residential use is deemed to cease.

Human Made Hazard Lands

3.7.11 In the vicinity of the nuclear generating station, proposed *sensitive land uses* will be reviewed in the context of emergency measures planning.

Waste Disposal Assessment Areas

~~4.6.9~~3.7.12 *Waste* Disposal Assessment Areas shall include all lands that may be influenced by a *site* on which *waste* has been deposited, or by a *site* on which *waste* will be deposited under ~~a Provisional Certificate of Approval issued under~~ an approval issued pursuant to the *Environmental Protection Act*. The area of influence shall be defined as 500 metres from the lands containing *wastes* unless otherwise determined by the Province. *Development* within

0137

PLACES TO GROW

BETTER CHOICES. BRIGHTER FUTURE.

Growth Plan

for the Greater Golden Horseshoe, 2006

OFFICE CONSOLIDATION, JUNE 2013

Ontario

Ministry of Infrastructure

Cover photography by Iain Myrans

Growth Plan

for the Greater Golden Horseshoe, 2006

Office Consolidation
June 2013

Pursuant to the *Places to Grow Act, 2005:* the Growth Plan for the Greater Golden Horseshoe, 2006 was approved by the Lieutenant Governor in Council, Order-in-Council No 1221/2006 to take effect on June 16, 2006; Amendment 1 (2012) to the Growth Plan for the Greater Golden Horseshoe, 2006, was approved by the Lieutenant Governor in Council, Order-in-Council No 1702/2011 to take effect on January 19, 2012; and Amendment 2 (2013) to the Growth Plan for the Greater Golden Horseshoe, 2006, was approved by the Lieutenant Governor in Council, Order-in-Council No 767/2013 to take effect on June 17, 2013.

This consolidation is prepared for purposes of convenience only. It contains the above noted documents and updates references to the responsible Minister and Ministry and other minor corrections including spelling errors and showing terms in italics. For a list of all corrections please visit www.placestogrow.ca. For accurate references please consult the approved versions of the Growth Plan and the two amendments which are available at www.placestogrow.ca.

Ministry of Infrastructure

Ontario

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1

Introduction

1.1 Context

The *Greater Golden Horseshoe (GGH)* is one of the fastest growing regions in North America. It is also the destination of choice for many people and businesses relocating from other parts of Canada and around the world. They settle here because of the high quality of life and the economic opportunities. This is a place of prosperity where, through their skills and talents, people are building a great future for themselves.

Over the next quarter century, communities within the *GGH* will continue to experience the benefits that come with growth, including: vibrant, diversified communities and economies; new and expanded community services; and arts, culture and recreation facilities. However, without properly managing growth, communities will continue to experience the negative aspects associated with rapid growth, such as increased traffic congestion, deteriorating air and water quality, and the disappearance of agricultural lands and natural resources.

The Growth Plan for the Greater Golden Horseshoe (this Plan) has been prepared under the Places to Grow Act, 2005. It is a framework for implementing the Government of Ontario's vision for building stronger, prosperous communities by better managing growth in this region. This is a plan that recognizes the realities facing our cities and smaller communities, and that acknowledges what governments can and cannot influence. It demonstrates leadership for improving the ways in which our cities, suburbs, towns, and villages will grow over the long-term.

This Plan will guide decisions on a wide range of issues – transportation, infrastructure planning, land-use planning, urban form, housing, natural heritage and resource protection – in the interest of promoting economic prosperity. It will create a clearer environment for investment decisions and will help secure the future prosperity of the *GGH*.

This Plan builds on other key government initiatives including: the Greenbelt Plan, Planning Act reform and the Provincial Policy Statement, 2005 (PPS, 2005). This Plan does not replace municipal official plans, but works within the existing planning framework to provide growth management policy direction for the *GGH*.

This Plan reflects a shared vision amongst the Government of Ontario, the municipalities of the *GGH* and its residents. Successful implementation of this Plan's vision will be dependent upon collaborative decision-making.

In preparing for the future, it is essential that planning for the *GGH* take into account the importance, and the unique characteristics and strengths of its economy. These include:

- A diverse economy supported by a wide array of manufacturing industries of which the largest is the automotive sector, and other key industry clusters such as financial and business services, hospitality and tourism, education and research, life sciences, information services, and agriculture;
- An economy in transition, with economic activity and wealth increasingly generated by service and knowledge industries;
- Trade that accounts for over half of Ontario's GDP, over 90 per cent of which is with the United States;[1]
- A highly educated workforce, whose social and economic diversity are critical factors for success in the growing knowledge economy;
- Abundant natural heritage features and areas, and *prime agricultural areas*, and the government's commitment to protecting them, as demonstrated through initiatives such as the Greenbelt Plan, which make our communities more attractive and healthier places to live and work;
- Cultural amenities that offer the kinds of creative and recreational activities that attract knowledge workers.

The *GGH* must remain competitive with other city-regions. However, urban sprawl can affect its competitiveness. Despite its many assets, Ontario and the *GGH* face a number of challenges in sustaining and growing its economy:

- Increasing numbers of automobiles are travelling over longer distances resulting in clogged transportation corridors, including those that provide access to our critical border crossings. Traffic congestion and the delay in movement of goods costs Ontario upwards of $5 billion in lost GDP each year;[2]

[1] TD Economics. *Ontario: The Land of Opportunity*. September 2004, pg. 2

[2] Ontario Chamber of Commerce. *Cost of Border Delays to Ontario*. May 2004, pg. 8

- Attractive and efficient public transit is difficult to introduce into sprawling communities, and this limits our ability to respond effectively to growing traffic congestion issues;
- Employment lands are being converted from their intended uses, thereby limiting future economic opportunities;
- New infrastructure is being built to service lower-density areas, while existing infrastructure in the older parts of our communities remains underutilized;
- Urban sprawl contributes to the degradation of our natural environment, air quality and water resources, as well as the consumption of agricultural lands and other natural resources so critical to the future economy.

Decades of neglect and lack of sufficient investment have resulted in the current infrastructure deficit. Tens of billions of dollars beyond current levels of investment will be required before the situation is back in balance. All levels of government are under pressure to meet public infrastructure needs. Additional support from federal partners; innovative, alternative partnership arrangements that protect the public interest; and the strategic staging of infrastructure investments are all required to respond to these challenges. Ultimately, better investment in our cities will help to mitigate sprawl. Enhancing infrastructure, integrating and improving transit systems, protecting valuable natural resources and strengthening local government will all go far towards the implementation of this Plan.

This Plan addresses these challenges through policy directions that –

- direct growth to *built-up areas* where the capacity exists to best accommodate the expected population and employment growth, while providing strict criteria for *settlement area* boundary expansions
- promote *transit-supportive* densities and a healthy mix of residential and employment land uses
- preserve *employment areas* for future economic opportunities
- identify and support a transportation network that links *urban growth centres* through an extensive multi-modal system anchored by efficient public transit, together with highway systems for moving people and goods
- plan for *community infrastructure* to support growth
- ensure sustainable water and wastewater services are available to support future growth
- identify natural systems and *prime agricultural areas*, and enhance the conservation of these valuable resources
- support the protection and conservation of water, energy, air and cultural heritage, as well as integrated approaches to waste management.

1.2 Vision for 2041

1.2.1 A Vision for the Greater Golden Horseshoe

More than anything, the *Greater Golden Horseshoe (GGH)* will be a great place to live in 2041. Its communities will be supported by the pillars of a strong economy, a clean and healthy environment and social equity.

The *GGH* will offer a wide variety of choices for living. Thriving, livable, vibrant and productive urban and rural areas will foster community and individual well-being. The region will be supported by modern, well-maintained infrastructure built in accordance with a broad plan for growth. Residents will have easy access to shelter, food, education and health-care facilities, arts and recreation and information technology.

Getting around will be easy. An integrated transportation network will allow people choices for easy travel both within and between urban centres throughout the region. Public transit will be fast, convenient and affordable. Automobiles, while still a significant means of transport, will be only one of a variety of effective and well-used choices for transportation. Walking and cycling will be practical elements of our urban transportation systems.

A healthy natural environment with clean air, land and water will characterize the *GGH*. The Greenbelt, including significant natural features, such as the Oak Ridges Moraine and the Niagara Escarpment, has been enhanced and protected in perpetuity. These will form the key building blocks of the *GGH*'s natural systems. The *GGH*'s rivers and streams, forests and natural areas will be protected and accessible for residents to enjoy their beauty. Open spaces in our cities, towns and countryside will provide people with a sense of place.

Unique and high-quality agricultural lands will be protected for future generations. Farming will be productive, diverse and sustainable.

Urban centres will be characterized by vibrant and more compact settlement and development patterns and will provide a diversity of opportunities for living, working and enjoying culture. The evolving regional economy of the *GGH* will have matured into an economic powerhouse of global significance. It will function as Canada's principal international gateway.

The Greater Toronto and Hamilton area will be a thriving metropolis with an extraordinary waterfront. At the heart of this metropolis will be Toronto, a celebrated centre of influence for commerce, culture and innovation.

All of this will translate into a place where residents enjoy a high standard of living and an exceptional quality of life.

1.2.2 Guiding Principles

The vision for the *GGH* is grounded in the following principles that provide the basis for guiding decisions on how land is developed, resources are managed and public dollars invested:

- Build compact, vibrant and *complete communities*.
- Plan and manage growth to support a strong and competitive economy.
- Protect, conserve, enhance and wisely use the valuable natural resources of land, air and water for current and future generations.
- Optimize the use of existing and new infrastructure to support growth in a compact, efficient form.
- Provide for different approaches to managing growth that recognize the diversity of communities in the *GGH*.
- Promote collaboration among all sectors – government, private and non-profit – and residents to achieve the vision.

1.3 General Authority

This Plan for the *GGH* derives its authority from the Places to Grow Act, 2005. This Plan is approved through an Order-in-Council made by the Lieutenant Governor in Council under that Act.

This Plan applies to the *GGH* lands designated by Ontario Regulation 416/05.

1.4 How to Read this Plan

This Plan consists of policies, schedules, definitions and appendices. It also includes non-policy contextual commentary to provide background and describe the intent of the policies. Terms in italics are defined in the Definitions section of this Plan.

This Plan informs decision-making regarding growth management in the *GGH*. It contains a set of policies for managing growth and development to the year 2041. While certain policies have specific target dates, the goals and policies of this Plan are intended to be achieved within the life of this Plan.

The land-use planning process within the *GGH* is governed primarily by the Planning Act and the Government of Ontario's existing planning system.

The Provincial Policy Statement and Provincial Plans

The Provincial Policy Statement (PPS) provides overall policy directions on matters of provincial interest related to land use and development in Ontario, and applies to the *GGH*. This Plan should be read in conjunction with the applicable PPS.

This Plan should also be read in conjunction with relevant provincial plans, including the Greenbelt, Niagara Escarpment, and Oak Ridges Moraine Conservation Plans. These plans apply to parts of the *GGH* and provide specific policy on certain matters. This Plan, in conjunction with these other plans and the PPS, 2005, expresses the Government of Ontario's interests and directions with regard to growth management in the *GGH*.

As provided for in the Places to Grow Act, 2005, this Plan prevails where there is a conflict between this Plan and the PPS. The only exception is where the conflict is between policies relating to the natural environment or human health. In that case, the direction that provides more protection to the natural environment or human health prevails. Similarly where there is a conflict between the Greenbelt, Niagara Escarpment or Oak Ridges Moraine Conservation Plans and this Plan regarding the natural environment or human health, then the direction that provides more protection to the natural environment or human health prevails. Detailed conflict provisions are set out in the Places to Grow Act, 2005.

2 Where and How to Grow

2.1 Context

The *GGH* is one of the fastest growing regions in North America. By 2031, the population of this area is forecast to grow by an additional 3.7 million (from 2001) to 11.5 million people, accounting for over 80 per cent of Ontario's population growth. The magnitude and pace of this growth necessitates a plan for building healthy and balanced communities and maintaining and improving our quality of life.

To ensure the development of healthy, safe and balanced communities, choices about where and how growth occurs in the *GGH* need to be carefully made. Better use of land and infrastructure can be made by directing growth to existing urban areas. This Plan envisages increasing *intensification* of the existing *built-up area*, with a focus on *urban growth centres*, *intensification corridors*, *major transit station areas*, *brownfield sites* and *greyfields*. Concentrating new development in these areas also provides a focus for transit and infrastructure investments to support future growth.

The revitalization of *urban growth centres* is particularly important, not only because they can accommodate additional people and jobs, but because they will increasingly be regional focal points. They are meeting places, locations for cultural facilities, public institutions, major services, and transit hubs. These centres are not all at the same stage of development: some are the downtowns of older cities, while others are newly planned suburban centres. They all have potential to become more vibrant, mixed-use, transit-supportive communities.

Better use of land and infrastructure can also be achieved by building more compact greenfield communities that reduce the rate at which land is consumed. Communities will need to grow at *transit-supportive* densities, with transit-oriented street configurations. *Compact urban form* and *intensification* efforts go hand-in-hand with more transit: not only do they support each other, they are all necessary. This correlation is fundamental to where and how we grow. Communities will also need to provide a mix of jobs and housing to create opportunities for people to work close to where they live.

Providing opportunities for businesses to locate in the *GGH* is fundamental to using land wisely and ensuring a prosperous economic future. Therefore, it is important to ensure an adequate supply of land for *employment areas* and other employment uses.

There is a large supply of land already designated for future urban development in the *GGH*. In most communities there is enough land to accommodate projected growth based on the growth forecasts and *intensification target* and *density targets* of this Plan. It is important to optimize the use of the existing land supply to avoid over-designating new land for future urban development. This Plan's emphasis on *intensification* and optimizing the use of the existing land supply represents a new approach to city-building in the *GGH*, one which concentrates more on making better use of our existing infrastructure, and less on continuously expanding the urban area.

Strong, healthy and prosperous rural communities are also vital to the economic success of the *GGH* and contribute to our quality of life. This Plan recognizes and promotes the traditional role of rural towns and villages as a focus of economic, cultural and social activities that support surrounding rural and agricultural areas across the *GGH*. Healthy rural communities are key to the vitality and well-being of the whole area.

This Plan is about building *complete communities*, whether urban or rural. These are communities that are well-designed, offer transportation choices, accommodate people at all stages of life and have the right mix of housing, a good range of jobs, and easy access to stores and services to meet daily needs.

2.2 Policies for Where and How to Grow

2.2.1 Growth Forecasts

1. Population and employment forecasts contained in Schedule 3 for all upper- and single-tier municipalities will be used for planning and managing growth in the *GGH*.

2. The Minister of Infrastructure will review the forecasts contained in Schedule 3 at least every five years in consultation with municipalities, and may revise the forecasts.

2.2.2 Managing Growth

1. Population and employment growth will be accommodated by –

   a) directing a significant portion of new growth to the *built-up areas* of the community through *intensification*

   b) focusing *intensification* in *intensification areas*

   c) building compact, *transit-supportive* communities in *designated greenfield areas*

   d) reducing dependence on the automobile through the development of mixed-use, *transit-supportive*, pedestrian-friendly urban environments

   e) providing convenient access to intra- and inter-city transit

   f) ensuring the availability of sufficient land for employment to accommodate forecasted growth to support the *GGH*'s economic competitiveness

   g) planning and investing for a balance of jobs and housing in communities across the *GGH* to reduce the need for long distance commuting and to increase the *modal share* for transit, walking and cycling

   h) encouraging cities and towns to develop as *complete communities* with a diverse mix of land uses, a range and mix of employment and housing types, high quality public open space and easy access to local stores and services

   i) directing development to *settlement areas*, except where necessary for development related to the management or use of resources, resource-based recreational activities, and rural land uses that cannot be located in *settlement areas*

   j) directing major growth to *settlement areas* that offer *municipal water and wastewater systems* and limiting growth in *settlement areas* that are serviced by other forms of water and wastewater services

   k) prohibiting the establishment of new *settlement areas*.

2.2.3 General Intensification

1. By the year 2015 and for each year thereafter, a minimum of 40 per cent of all residential development occurring annually within each upper- and single-tier municipality will be within the *built-up area*.

2. If at the time this Plan comes into effect, an upper- or single-tier municipality is achieving a percentage higher than the minimum *intensification target* identified in policy 2.2.3.1, this higher percentage will be considered the minimum *intensification target* for that municipality.

3. If at the time this Plan comes into effect, an upper- or single-tier municipality has established in its official plan an intensification target that is higher than the minimum *intensification target* identified in policy 2.2.3.1, this higher target will be considered the minimum *intensification target* for that municipality.

4. The Minister of Infrastructure may review and permit an alternative minimum *intensification target* for an upper- or single-tier municipality located within the *outer ring* to ensure the *intensification target* is appropriate given the size, location and capacity of *built-up areas*.

5. The Minister of Infrastructure, in consultation with affected municipalities will verify and delineate the *built boundary*.

6. All municipalities will develop and implement through their official plans and other supporting documents, a strategy and policies to phase in and achieve *intensification* and the *intensification target*. This strategy and policies will –

   a) be based on the growth forecasts contained in Schedule 3, as allocated to lower-tier municipalities in accordance with policy 5.4.2.2

   b) encourage *intensification* generally throughout the *built-up area*

   c) identify *intensification areas* to support achievement of the *intensification target*

   d) incorporate the *built boundary* delineated in accordance with Policy 2.2.3.5

   e) recognize *urban growth centres*, *intensification corridors* and *major transit station areas* as a key focus for development to accommodate *intensification*

   f) facilitate and promote *intensification*

   g) identify the appropriate type and scale of development in *intensification areas*

   h) include *density targets* for *urban growth centres* where applicable, and minimum density targets for other *intensification areas* consistent with the planned transit service levels, and any *transit-supportive* land-use guidelines established by the Government of Ontario

   i) plan for a range and mix of housing, taking into account *affordable* housing needs

   j) encourage the creation of secondary suites throughout the *built-up area*.

7. All *intensification areas* will be planned and designed to –

   a) cumulatively attract a significant portion of population and employment growth

   b) provide a diverse and compatible mix of land uses, including residential and employment uses, to support vibrant neighbourhoods

c) provide high quality public open spaces with site design and urban design standards that create attractive and vibrant places

d) support transit, walking and cycling for everyday activities

e) generally achieve higher densities than the surrounding areas

f) achieve an appropriate transition of built form to adjacent areas.

8. Ministers of the Crown and municipalities will use infrastructure investment and other implementation tools and mechanisms to facilitate *intensification*.

2.2.4 Urban Growth Centres

1. *Urban growth centres* for the *GGH* are identified in Schedule 4.
2. The Minister of Infrastructure, in consultation with municipalities that have *urban growth centres*, will determine the approximate size and location of the *urban growth centres*.
3. Municipalities will delineate the boundaries of *urban growth centres* in their official plans.
4. *Urban growth centres* will be planned –

a) as focal areas for investment in institutional and region-wide public services, as well as commercial, recreational, cultural and entertainment uses

b) to accommodate and support major transit infrastructure

c) to serve as high density major employment centres that will attract provincially, nationally or internationally significant employment uses

d) to accommodate a significant share of population and employment growth.

5. *Urban growth centres* will be planned to achieve, by 2031 or earlier, a minimum gross *density target* of –

a) 400 residents and jobs combined per hectare for each of the *urban growth centres* in the City of Toronto

b) 200 residents and jobs combined per hectare for each of the Downtown Brampton, Downtown Burlington, Downtown Hamilton, Downtown Milton, Markham Centre, Mississauga City Centre, Newmarket Centre, Midtown Oakville, Downtown Oshawa, Downtown Pickering, Richmond Hill/Langstaff Gateway, Vaughan Corporate Centre, Downtown Kitchener and Uptown Waterloo *urban growth centres*

c) 150 residents and jobs combined per hectare for each of the Downtown Barrie, Downtown Brantford, Downtown Cambridge, Downtown Guelph, Downtown Peterborough and Downtown St. Catharines *urban growth centres*.

6. If at the time this Plan comes into effect, an *urban growth centre* is already planned to achieve, or has already achieved, a gross density that exceeds the minimum *density target* established in Policy 2.2.4.5, this higher density will be considered the minimum *density target* for that *urban growth centre*.

2.2.5 Major Transit Station Areas and Intensification Corridors

1. *Major transit station areas* and *intensification corridors* will be designated in official plans and planned to achieve –

   a) increased residential and employment densities that support and ensure the viability of existing and planned transit service levels

   b) a mix of residential, office, institutional, and commercial development wherever appropriate.

2. *Major transit station areas* will be planned and designed to provide access from various transportation modes to the transit facility, including consideration of pedestrians, bicycle parking and commuter pick-up/drop-off areas.

3. *Intensification corridors* will generally be planned to accommodate local services, including recreational, cultural and entertainment uses.

2.2.6 Employment Lands

1. An adequate supply of lands providing locations for a variety of appropriate employment uses will be maintained to accommodate the growth forecasts in Schedule 3.

2. Municipalities will promote economic development and competitiveness by –

   a) providing for an appropriate mix of employment uses including industrial, commercial and institutional uses to meet long-term needs

   b) providing opportunities for a diversified economic base, including maintaining a range and choice of suitable sites for employment uses which support a wide range of economic activities and ancillary uses, and take into account the needs of existing and future businesses

   c) planning for, protecting and preserving *employment areas* for current and future uses

   d) ensuring the necessary infrastructure is provided to support current and forecasted employment needs.

3. The downtown Toronto office core will continue to be the primary centre for international finance and commerce of the *GGH*.

4. *Major office* and appropriate major institutional development should be located in *urban growth centres*, *major transit station areas*, or areas with existing frequent transit service, or existing or planned *higher order transit* service.

5. Municipalities may permit conversion of lands within *employment areas*, to non-employment uses, only through a *municipal comprehensive review* where it has been demonstrated that –

   a) there is a need for the conversion

   b) the municipality will meet the employment forecasts allocated to the municipality pursuant to this Plan

   c) the conversion will not adversely affect the overall viability of the *employment area*, and achievement of the *intensification target*, *density targets*, and other policies of this Plan

   d) there is existing or planned infrastructure to accommodate the proposed conversion

   e) the lands are not required over the long term for the employment purposes for which they are designated

   f) cross-jurisdictional issues have been considered.

   For the purposes of this policy, major retail uses are considered non-employment uses.

6. Policy 2.2.6.5 only applies to *employment areas* that are not downtown areas or regeneration areas. For those *employment areas* that are downtown areas or regeneration areas, Policy 1.3.2 of the PPS, 2005 continues to apply.

7. In recognition of the importance of cross-border trade with the United States, this Plan recognizes a *Gateway Economic Zone* and *Gateway Economic Centre* near the Niagara-US border. Planning and economic development in these areas will support economic diversity and promote increased opportunities for cross-border trade, movement of goods and tourism.

8. Through *sub-area* assessment, the Minister of Infrastructure, in consultation with other Ministers of the Crown, municipalities and other stakeholders will identify provincially significant *employment areas* including prime industrial lands.

9. Municipalities are encouraged to designate and preserve lands within *settlement areas* in the vicinity of existing major highway interchanges, ports, rail yards and airports as areas for manufacturing, warehousing, and associated retail, office and ancillary facilities, where appropriate.

10. In planning lands for employment, municipalities will facilitate the development of *transit-supportive*, compact built form and minimize surface parking.

2.2.7 Designated Greenfield Areas

1. New development taking place in *designated greenfield areas* will be planned, designated, zoned and designed in a manner that –

   a) contributes to creating *complete communities*

   b) creates street configurations, densities, and an urban form that support walking, cycling, and the early integration and sustained viability of transit services

   c) provides a diverse mix of land uses, including residential and employment uses, to support vibrant neighbourhoods

   d) creates high quality public open spaces with site design and urban design standards that support opportunities for transit, walking and cycling.

2. The *designated greenfield area* of each upper- or single-tier municipality will be planned to achieve a minimum *density target* that is not less than 50 residents and jobs combined per hectare.

3. This *density target* will be measured over the entire *designated greenfield area* of each upper- or single-tier municipality, excluding the following features where the features are both identified in any applicable official plan or provincial plan, and where the applicable provincial plan or policy statement prohibits development in the features: wetlands, coastal wetlands, woodlands, valley lands, areas of natural and scientific interest, habitat of endangered species and threatened species, wildlife habitat, and fish habitat. The area of the features will be defined in accordance with the applicable provincial plan or policy statement that prohibits development in the features.

4. Policy 2.2.7.3 is provided for the purpose of measuring the minimum *density target* for *designated greenfield areas*, and is not intended to provide policy direction for the protection of natural heritage features, areas and systems.

5. The Minister of Infrastructure may review and permit an alternative *density target* for an upper- or single-tier municipality that is located in the *outer ring*, and that does not have an *urban growth centre*, to ensure the *density target* is appropriate given the characteristics of the municipality and adjacent communities.

6. Municipalities will develop and implement official plan policies, including phasing policies, and other strategies, for *designated greenfield areas* to achieve the *intensification target* and *density targets* of this Plan.

2.2.8 Settlement Area Boundary Expansions

1. The policies in this section apply only to the expansion of a *settlement area* within a municipality.
2. A *settlement area* boundary expansion may only occur as part of a *municipal comprehensive review* where it has been demonstrated that –
   a) sufficient opportunities to accommodate forecasted growth contained in Schedule 3, through *intensification* and in *designated greenfield areas*, using the *intensification target* and *density targets*, are not available:
      i. within the *regional market area*, as determined by the upper- or single-tier municipality, and
      ii. within the applicable lower-tier municipality to accommodate the growth allocated to the municipality pursuant to this Plan
   b) the expansion makes available sufficient lands for a time horizon not exceeding 20 years, based on the analysis provided for in Policy 2.2.8.2(a)
   c) the timing of the expansion and the phasing of development within the *designated greenfield area* will not adversely affect the achievement of the *intensification target* and *density targets*, and the other policies of this Plan
   d) where applicable, the proposed expansion will meet the requirements of the Greenbelt, Niagara Escarpment and Oak Ridges Moraine Conservation Plans
   e) the existing or planned infrastructure required to accommodate the proposed expansion can be provided in a financially and environmentally sustainable manner
   f) in *prime agricultural areas*:
      i. the lands do not comprise *specialty crop areas*
      ii. there are no reasonable alternatives that avoid *prime agricultural areas*
      iii. there are no reasonable alternatives on lower priority agricultural lands in *prime agricultural areas*
   g) impacts from expanding *settlement areas* on agricultural operations which are adjacent or close to the *settlement areas* are mitigated to the extent feasible

h) in determining the most appropriate location for expansions to the boundaries of *settlement areas*, the policies of Sections 2 (Wise Use and Management of Resources) and 3 (Protecting Public Health and Safety) of the PPS, 2005 are applied

i) for expansions of *small cities and towns* within the *outer ring*, municipalities will plan to maintain or move significantly towards a minimum of one full-time job per three residents within or in the immediate vicinity of the small city or town.

2.2.9 Rural Areas

1. Rural *settlement areas* are key to the vitality and economic well-being of rural communities. Municipalities are encouraged to plan for a variety of cultural and economic opportunities within rural *settlement areas* to serve the needs of rural residents and area businesses.
2. Development outside of *settlement areas*, may be permitted in *rural areas* in accordance with Policy 2.2.2.1(i).
3. *New multiple lots and units for residential development* will be directed to *settlement areas*, and may be allowed in *rural areas* in site-specific locations with approved zoning or designation that permits this type of development in a municipal official plan, as of the effective date of this Plan.
4. For lands within the *Greenbelt Area*, the applicable policies in the Greenbelt, Niagara Escarpment and Oak Ridges Moraine Conservation Plans apply.

3

Infrastructure To Support Growth

3.1 Context

Ready and accessible public infrastructure is essential to the viability of Ontario's communities and critical to economic competitiveness, quality of life and the delivery of public services. But increasing demand, low-density land-use patterns and historic underinvestment have resulted in a substantial infrastructure deficit to meet the needs of current residents as well as those of future Ontarians.

This Plan provides the framework for infrastructure investments in the *GGH*, so that existing infrastructure and future investments are optimized to serve growth to 2031 and beyond. The policy directions for *intensification* and *compact urban form* in this Plan guide many of the infrastructure priorities in this section. It is estimated that over 20 per cent of infrastructure capital costs could be saved by moving from lower density development to more efficient and *compact urban form*. The savings could then be reinvested more efficiently.[3]

This Plan guides infrastructure planning and strategic investment decisions to support and accommodate forecasted population and economic growth – particularly in the three key areas of transportation, water and wastewater systems, and *community infrastructure*. This Plan will be supported by ReNew Ontario, Ontario's multi-year provincial infrastructure investment strategy, additional investments in transportation such as Move Ontario, and by sustainable financing models and sound infrastructure asset management practices.

[3] GTA Task Force. *Greater Toronto: Report of the GTA Task Force*. January 1996, p. 12; Slack, Enid. *Municipal Finance and the Pattern of Urban Growth*, C.D. Howe Institute. No. 160, February 2002, p. 6; TD Economics. *Greater Toronto Area: Canada's Primary Economic Locomotive in Need of Repairs*. May 2002, p. 15.

The transportation policies in this section and schedules in this Plan guide the planning and development of an integrated and efficient transportation system needed to support a vibrant economy and quality of life in the *GGH*. The policy directions ensure that transit infrastructure is optimized by high density land uses, and that highway corridors are planned to promote efficient goods movement and support more efficient *compact urban form* through appropriate design and control of access points.

This Plan promotes co-ordination and consistency among land-use and transportation planning and investment by all levels of government and other transportation stakeholders in the *GGH*. To improve co-ordination, improve commuting choices and to implement transportation initiatives in this Plan, the Minister of Transportation has introduced legislation, which if passed would provide for the establishment of a Greater Toronto Transportation Authority.

Investments in water and wastewater systems by all levels of government have also lagged behind *GGH* growth and many municipalities are now faced with significant renewal and capacity expansion issues. There is a need to co-ordinate investment in water and wastewater infrastructure to support future growth in ways that are linked to the determination of how these systems are paid for and administered. Improved maintenance and upgrading of existing systems is necessary to ensure the reliable and safe provision of water.

Investment in *community infrastructure* – such as hospitals, long-term care facilities, schools, and *affordable* housing – should be planned to keep pace with changing needs and to promote more *complete communities*. In the case of housing, there is an underlying societal need for *affordable* housing in many municipalities that is heightened by growth pressures. Multi-year infrastructure strategies such as ReNew Ontario are addressing this infrastructure gap and directing investments to help achieve *complete communities*.

3.2 Policies for Infrastructure To Support Growth

3.2.1 Infrastructure Planning

1. Infrastructure planning, land use planning, and infrastructure investment will be co-ordinated to implement this Plan. Infrastructure includes but is not limited to transit, *transportation corridors*, water and wastewater systems, waste management systems, and *community infrastructure*.
2. Priority will be given to infrastructure investments made by the Province of Ontario that support the policies and schedules in this Plan.
3. The Minister of Infrastructure will work with other Ministers of the Crown and other public sector partners to identify strategic infrastructure needs to support

the implementation of this Plan through multi-year infrastructure planning, and through the *sub-area* assessment of transit and transportation, and water and wastewater systems.

3.2.2 Transportation – General

1. The *transportation system* within the *GGH* will be planned and managed to –

   a) provide connectivity among transportation modes for moving people and for moving goods

   b) offer a balance of transportation choices that reduces reliance upon any single mode and promotes transit, cycling and walking

   c) be sustainable, by encouraging the most financially and environmentally appropriate mode for trip-making

   d) offer *multi-modal* access to jobs, housing, schools, cultural and recreational opportunities, and goods and services

   e) provide for the safety of system users.

2. *Transportation system* planning, land use planning, and transportation investment, will be co-ordinated to implement this Plan.

3. In planning for the development, optimization, and/or expansion of new or existing *transportation corridors*, the Ministers of Infrastructure and Transportation, other Ministers of the Crown, other public agencies and municipalities will –

   a) ensure that corridors are identified and protected to meet current and projected needs for various travel modes

   b) support opportunities for *multi-modal* use where feasible, in particular prioritizing transit and goods movement needs over those of single occupant automobiles

   c) consider increased opportunities for moving people and moving goods by rail, where appropriate

   d) consider separation of modes within corridors, where appropriate

   e) for goods movement corridors, provide for linkages to planned or existing inter-modal opportunities where feasible.

4. Through *sub-area* assessment, the Ministers of Transportation and Infrastructure, in consultation with municipalities and other stakeholders, will undertake further work to implement the transportation network and policies of this Plan.
5. Municipalities will develop and implement *transportation demand management* policies in official plans or other planning documents, to reduce trip distance and time, and increase the *modal share* of alternatives to the automobile.

3.2.3 Moving People

1. Public transit will be the first priority for transportation infrastructure planning and major transportation investments.
2. All decisions on transit planning and investment will be made according to the following criteria:
   a) Using transit infrastructure to shape growth, and planning for high residential and employment densities that ensure the efficiency and viability of existing and planned transit service levels;
   b) Placing priority on increasing the capacity of existing transit systems to support *intensification areas;*
   c) Expanding transit service to areas that have achieved, or will be planned so as to achieve, *transit-supportive* residential and employment densities, together with a mix of residential, office, institutional and commercial development wherever possible;
   d) Facilitating improved linkages from nearby neighbourhoods to *urban growth centres*, *major transit station areas*, and other *intensification areas;*
   e) Consistency with the strategic framework for future transit investments outlined on Schedule 5;
   f) Increasing the *modal share* of transit.
3. Municipalities will ensure that pedestrian and bicycle networks are integrated into transportation planning to –
   a) provide safe, comfortable travel for pedestrians and bicyclists within existing communities and new development
   b) provide linkages between *intensification areas*, adjacent neighbourhoods, and transit stations, including dedicated lane space for bicyclists on the major street network where feasible.

4. Schedule 5 provides the strategic framework for future transit investment decisions, including capacity improvements to existing transit systems to support *intensification*, and proposed *higher order transit* and inter-regional transit links between *urban growth centres*, in the *GGH*. Schedule 5 should be read in conjunction with the policies in this Plan. The transit linkages shown on Schedule 5 provide a strategic framework and are not drawn to scale. Actual timing, phasing and alignments are subject to further study and, where applicable, the environmental assessment process.

3.2.4 Moving Goods

1. The first priority of highway investment is to facilitate efficient goods movement by linking *inter-modal facilities*, international gateways, and communities within the *GGH*.

2. The Ministers of Transportation and Infrastructure, other appropriate Ministers of the Crown, and municipalities will work with agencies and transportation service providers to –

   a) co-ordinate and optimize goods movement systems

   b) improve corridors for moving goods across the *GGH* consistent with Schedule 6 of this Plan

   c) promote and better integrate *multi-modal* goods movement and land-use and transportation system planning, including the development of freight-supportive land-use guidelines.

3. The planning and design of highway corridors, and the land use designations along these corridors, will support the policies of this Plan, in particular that development is directed to *settlement areas*, in accordance with policy 2.2.2.1(i).

4. Municipalities will provide for the establishment of priority routes for goods movement, where feasible, to facilitate the movement of goods into and out of areas of significant employment, industrial and commercial activity and to provide alternate routes connecting to the provincial network.

5. Municipalities will plan for land uses in *settlement areas* adjacent to, or in the vicinity of, transportation facilities such as *inter-modal facilities*, rail yards, airports, dockyards, and major highway interchanges that are compatible with, and supportive of, the primary goods movement function of these facilities.

6. Schedule 6 provides the strategic framework for future goods movement investment decisions in the *GGH*. Schedule 6 should be read in conjunction with the policies in this Plan. The proposed corridors shown on Schedule 6 provide a

strategic framework and are not drawn to scale. Actual timing, phasing, and alignments are subject to further study and, where applicable, the environmental assessment process.

3.2.5 Water and Wastewater Systems

1. Municipalities should generate sufficient revenue to recover the *full cost* of providing *municipal water and wastewater systems*.
2. For lands within the *Greenbelt Area*, all policies regarding water and wastewater systems or stormwater set out in provincial plans, applicable to lands within the *Greenbelt Area*, continue to apply.
3. Municipalities are encouraged to plan and design *municipal water and wastewater systems* that return water to the Great Lake *watershed* from which the withdrawal originates.
4. Construction of new, or expansion of existing, *municipal* or *private communal water and wastewater systems* should only be considered where the following conditions are met:

    a) Strategies for water conservation and other water demand management initiatives are being implemented in the existing service area;

    b) Plans for expansion or for new services are to serve growth in a manner that supports achievement of the *intensification target* and *density targets*;

    c) Plans have been considered in the context of applicable inter-provincial, national, bi-national, or state-provincial Great Lakes Basin agreements.

5. Through *sub-area* assessment, the Minister of Infrastructure, in consultation with municipalities and other stakeholders, will undertake an analysis of the implications of forecasted growth for water and wastewater servicing.
6. Municipalities that share an inland water source and/or receiving water body, should co-ordinate their planning for potable water, stormwater, and wastewater systems to ensure that water quality and quantity is maintained or improved.
7. Municipalities, in conjunction with conservation authorities, are encouraged to prepare *watershed plans* and use such plans to guide development decisions and water and wastewater servicing decisions.
8. Municipalities are encouraged to implement and support innovative stormwater management actions as part of *redevelopment* and *intensification*.

3.2.6 Community Infrastructure

1. *Community infrastructure* planning, land-use planning, and *community infrastructure* investment will be co-ordinated to implement this Plan.

2. Planning for growth will take into account the availability and location of existing and planned *community infrastructure* so that *community infrastructure* can be provided efficiently and effectively.

3. An appropriate range of *community infrastructure* should be planned to meet the needs resulting from population changes and to foster *complete communities*.

4. Services planning, funding and delivery sectors are encouraged to develop a *community infrastructure* strategy to facilitate the co-ordination and planning of *community infrastructure* with land use, infrastructure and investment through a collaborative and consultative process.

5. Municipalities will establish and implement minimum *affordable* housing targets in accordance with Policy 1.4.3 of the PPS, 2005.

6. Upper- and single-tier municipalities will develop a housing strategy in consultation with lower-tier municipalities, the Minister of Municipal Affairs and Housing and other appropriate stakeholders. The housing strategy will set out a plan, including policies for official plans, to meet the needs of all residents, including the need for *affordable* housing – both home ownership and rental housing. The housing strategy will include the planning and development of a range of housing types and densities to support the achievement of the *intensification target* and *density targets*.

4

Protecting What is Valuable

4.1 Context

The *GGH* is blessed with a broad array of unique natural heritage features and areas, irreplaceable cultural heritage sites, and valuable renewable and non-renewable resources that are essential for the long-term economic prosperity, quality of life, and environmental health of the region. These valuable assets must be wisely protected and managed as part of planning for future growth.

Some of these features, areas and sites are already protected through legislation such as the Ontario Heritage Act, statements of provincial policy such as the PPS, 2005, and provincial plans such as the Greenbelt, Niagara Escarpment and Oak Ridges Moraine Conservation Plans. This Plan supports and builds on these initiatives. A balanced approach to the wise use and management of all resources, including natural heritage, agriculture, and mineral aggregates, will be implemented.

As the *GGH* grows, so will the overall demand for water, energy, air, and land. The ongoing availability of these natural resources is essential for the sustainability of all communities. This Plan recognizes and supports the role of municipal policy in providing leadership and innovation in developing a culture of conservation.

As noted in Section 1.4 of this Plan, the PPS, 2005 applies in the *GGH* and the provisions of this Plan are to be read in conjunction with all applicable provisions of the PPS, 2005 and other applicable documents.

4.2 Policies for Protecting What is Valuable

4.2.1 Natural Systems

1. Through *sub-area* assessment, the Minister of Infrastructure and other Ministers of the Crown, in consultation with municipalities and other stakeholders will identify natural systems for the *GGH*, and where appropriate develop additional policies for their protection.

2. For lands within the *Greenbelt Area*, all policies regarding natural systems set out in provincial plans, applicable to lands within the *Greenbelt Area*, continue to apply.

3. Planning authorities are encouraged to identify natural heritage features and areas that complement, link, or enhance natural systems.

4. Municipalities, conservation authorities, non-governmental organizations, and other interested parties are encouraged to develop a system of publicly accessible parkland, open space and trails, including shoreline areas, within the *GGH* that –

   a) clearly demarcates where public access is and is not permitted

   b) is based on a co-ordinated approach to trail planning and development

   c) is based on good land stewardship practices for public and private lands.

5. Municipalities are encouraged to establish an urban open space system within *built-up areas*, which may include rooftop gardens, communal courtyards, and public parks.

4.2.2 Prime Agricultural Areas

1. Through *sub-area* assessment, the Minister of Infrastructure and other Ministers of the Crown, in consultation with municipalities and other stakeholders, will identify *prime agricultural areas*, including *specialty crop areas*, in the *GGH*, and where appropriate, develop additional policies for their protection.

2. For lands within the *Greenbelt Area*, all policies regarding agricultural areas set out in provincial plans, applicable to lands within the *Greenbelt Area*, continue to apply.

3. Municipalities are encouraged to maintain, improve and provide opportunities for farm-related infrastructure such as drainage and irrigation.

4. Municipalities are encouraged to establish and work with agricultural advisory committees and consult with them on decision-making related to agriculture and growth management.

4.2.3 Mineral Aggregate Resources

1. Through *sub-area* assessment, the Ministers of Infrastructure and Natural Resources will work with municipalities, producers of *mineral aggregate resources*, and other stakeholders to identify significant *mineral aggregate resources* for the *GGH*, and to develop a long-term strategy for ensuring the wise use, conservation, availability and management of *mineral aggregate resources* in the *GGH*, as well as identifying opportunities for resource recovery and for co-ordinated approaches to rehabilitation where feasible.

4.2.4 A Culture of Conservation

1. Municipalities will develop and implement official plan policies and other strategies in support of the following conservation objectives:

   a) Water conservation, including –

      i. water demand management, for the efficient use of water

      ii. water recycling to maximize the reuse and recycling of water.

   b) Energy conservation, including –

      i. energy conservation for municipally owned facilities

      ii. identification of opportunities for alternative energy generation and distribution

      iii. energy demand management to reduce energy consumption

      iv. land-use patterns and urban design standards that encourage and support energy-efficient buildings and opportunities for cogeneration.

   c) Air quality protection, including reduction in emissions from municipal and residential sources.

   d) Integrated waste management, including –

      i. enhanced waste reduction, composting, and recycling initiatives and the identification of new opportunities for source reduction, reuse, and diversion where appropriate

      ii. a comprehensive plan with integrated approaches to waste management, including reduction, reuse, recycling, composting, diversion, and the disposal of residual waste

      iii. promotion of reuse and recycling of construction materials

      iv. consideration of waste management initiatives within the context of long term regional planning, and in collaboration with neighbouring municipalities.

   e) Cultural heritage conservation, including conservation of cultural heritage and archaeological resources where feasible, as *built-up areas* are intensified.

5 Implementation and Interpretation

5.1 Context

Key to the success of this Plan is its effective implementation. Successful implementation will require that all levels of government, non-governmental organizations, the private sector, and citizens work together in a co-ordinated and collaborative way to implement the policies of this Plan and to realize its goals. The success of this Plan is dependent on a range of mechanisms being in place to implement the Plan's policies. This includes the legislative framework provided by the Places to Grow Act, 2005, and a wide range of complementary planning and fiscal tools, including instruments found in the Planning Act and the Municipal Act, 2001.

Measuring the success of this Plan will also require rigorous and consistent evaluation of its progress. One method to measure this Plan's progress currently under development is an index that will monitor changes in the amount of land developed and the increased percentage of new development taking place within the *built-up areas* of the *GGH*.

5.2 Places to Grow Act, 2005

The Places to Grow Act, 2005 provides the legislative framework for this Plan. It gives the Lieutenant Governor in Council the authority to establish any area of land in the Province as a growth plan area and requires that the Minister of Infrastructure prepare a growth plan for all or part of that area. The growth plan area for this Plan is defined by Ontario Regulation 416/05, and is shown on Schedule 1 of this Plan.

A growth plan works in conjunction with other provincial legislation, policies, plans and regulations. Land use within the growth plan area is governed by the Planning Act and Ontario's planning system and is also subject to the conformity requirements and conflict provisions of the Places to Grow Act, 2005. Within a growth plan area, a growth plan applies to all decisions on matters, proceedings or applications, made under the Planning Act and the Condominium Act, 1998, subject to any applicable regulations.

The Places to Grow Act, 2005 also includes processes for making and amending growth plans. This includes the requirement that the Minister of Infrastructure review each growth plan at least every 10 years after the plan comes into force. Under the Act, the Minister of Infrastructure may propose an amendment to a growth plan. When an amendment is proposed, the Minister of Infrastructure will give notice and invite written submissions on the amendment. Any significant modification to the plan requires approval of the Lieutenant Governor in Council.

5.3 Implementation Analysis

The Minister of Infrastructure will work with other Ministers of the Crown, municipalities and other stakeholders on the following key pieces of further analysis, in order to implement this Plan:

1. Verification and finalization of the *built boundary;*
2. Assessment of the need for new *designated greenfield areas;*
3. Determination of the approximate size and location of the *urban growth centres;*
4. *Sub-area* assessments at a regional scale, focussing on –
   a) regional economic analysis and provincially significant employment areas
   b) further work on the proposed transportation network
   c) implications of projected growth for water and wastewater servicing
   d) identification of natural systems
   e) identification of *prime agricultural areas*, including *specialty crop areas*
   f) identification of significant *mineral aggregate resources.*
5. Development of a new methodology for measuring and forecasting employment.

Implementation analysis will be undertaken by the Minister of Infrastructure, in consultation with other Ministers of the Crown, municipalities, and other stakeholders. While this further analysis and assessment is being completed, all relevant policies of this Plan continue to apply.

5.4 Policies for Implementation and Interpretation

5.4.1 General Implementation and Interpretation

1. This Plan, including context sections, policies, definitions and schedules, should be read in its entirety and all relevant policies are to be applied to each situation.
2. The appendices to this Plan are provided for information purposes only.
3. Terms in italics are defined in the Definitions section of this Plan. The definitions apply to these italicized terms regardless of whether the terms are singular or plural.
4. In the Definitions section, sources have been cited where the definitions are the same or have the same content as the definitions provided in the policy or statute cited.
5. The policies and targets of this Plan represent minimum standards. Planning authorities and decision-makers are encouraged to go beyond minimum standards established in specific policies and targets, unless doing so would conflict with any policy of this Plan, the applicable PPS, or any other provincial plan.
6. Unless otherwise stated, the boundaries and lines displayed on the schedules provide general direction only and should not be read to scale.
7. The *built-up area*, shown on Schedules 2, 4, 5, and 6, is conceptual only.
8. The *designated greenfield area*, shown on Schedules 2, 4, 5, and 6, is conceptual. For the actual *settlement area* boundary, the appropriate municipal official plans should be consulted.
9. Where this Plan indicates that further analysis and assessment will be carried out but the analysis has not been completed, all relevant policies of this Plan continue to apply and any policy that relies on information that will be available from further analysis should be implemented to the fullest extent possible.
10. Where policies contain a list of sub-policies, the list of sub-policies is to be applied in its entirety unless otherwise specified.
11. References to the responsibilities of the Minister of Infrastructure set out in this Plan should be read as the Minister, his or her assignee, his or her delegate pursuant to the Places to Grow Act, 2005, or any other member of Executive Council given responsibility for growth plans under the Places to Grow Act, 2005.

5.4.2 Co-ordination

1. A co-ordinated approach will be taken both within the Government of Ontario, and in its dealings with municipalities and other related planning agencies, to implement this Plan, in particular for issues that cross municipal boundaries.
2. Where planning is conducted by an upper-tier municipality, the upper-tier municipality, in consultation with the lower-tier municipalities, will –
   a) allocate the growth forecasts provided in Schedule 3 to the lower-tier municipalities
   b) identify intensification targets for lower-tier municipalities, to achieve the *intensification target* and *density targets* for *urban growth centres* where applicable
   c) identify density targets for the *designated greenfield areas* of the lower-tier municipalities, to achieve the *density target* for *designated greenfield areas*
   d) provide policy direction on matters that cross municipal boundaries.
3. Where planning is not conducted by an upper-tier municipality, the affected lower-tier municipalities and the upper-tier municipality will work together to implement the matters listed in policy 5.4.2.2. The Minister of Infrastructure will work with the affected municipalities as appropriate to implement these policies.
4. Notwithstanding policy 5.4.2.2, if at the time this Plan comes into effect a lower-tier municipality's population is greater than 50 percent of the population of the upper-tier municipality, the upper-tier municipality may assign some or all of its responsibilities pursuant to the policies of this Plan to the applicable lower-tier municipality, provided that applicable allocations and targets are met at the regional or county level.
5. Single-tier municipalities in the *outer ring* and adjacent municipalities should ensure a co-ordinated approach to implement the policies of this Plan.

5.4.3 Monitoring and Performance Measures

1. The Minister of Infrastructure will develop a set of indicators to measure the implementation of the policies in this Plan.
2. The Minister of Infrastructure will monitor the implementation of this Plan, including reviewing performance indicators concurrent with any review of this Plan.
3. Municipalities will monitor and report on the implementation of this Plan's policies within their municipality, in accordance with guidelines developed by the Minister of Infrastructure.

5.4.4 Public Engagement

1. The Minister of Infrastructure will ensure ongoing consultation with the public and stakeholders on the implementation of this Plan.
2. The Minister of Infrastructure will provide information to the public and stakeholders in order to build understanding of growth management and facilitate informed involvement in the implementation of this Plan.
3. Municipalities are encouraged to engage the public and stakeholders in local efforts to implement this Plan and to provide the necessary information to ensure the informed involvement of local citizens.

5.4.5 Transition

1. Schedule 3 forecasts shall be implemented by applying:

   a) Only the 2031A forecasts to:

      i. all upper- and single-tier municipal official plans, including amendments or requests for an amendment, *commenced* on or after June 16, 2006 but before June 17, 2013; and,

      ii. all official plans, including amendments or requests for an amendment, *commenced* before June 16, 2006 and required to be continued and disposed of in accordance with this Plan;

   b) Only the 2031A forecasts, as allocated by the upper-tier municipality pursuant to policy 5.4.2.2(a) or by the Minister of Infrastructure pursuant to policy 5.4.2.3, to all lower-tier municipal official plans, including amendments or requests for an amendment, *commenced* before the applicable upper-tier municipal official plan is *amended to conform* with the Updated Forecasts;

   c) Only the 2031A forecasts to all zoning by-laws, including amendments, applications for an amendment to a zoning by-law, applications for approval of a plan of subdivision, and applications for the approval of, or an exemption from an approval of, a condominium, *commenced* before all official plans applicable to the lands affected by these matters are *amended to conform* with the Updated Forecasts;

   d) Only the forecasts contained in Schedule 7 for the *Simcoe Sub-area* to:

      i. all upper- and single-tier municipal official plans, including amendments or requests for an amendment, *commenced* on or after June 16, 2006 but before June 17, 2013;

ii. all official plans, including amendments or requests for an amendment, *commenced* before June 16, 2006 and required to be continued and disposed of in accordance with this Plan;

iii. all lower-tier municipal official plans, including amendments or requests for an amendment, *commenced* before the Simcoe County official plan is *amended to conform* with the Updated Forecasts; and

iv. all zoning by-laws, including amendments, applications for an amendment to a zoning by-law, applications for approval of a plan of subdivision, and applications for the approval of, or an exemption from an approval of, a condominium, *commenced* before all official plans applicable to the lands affected by these matters are *amended to conform* with the Updated Forecasts; and

e) The Updated Forecasts to any *planning matter* other than those listed in 5.4.5.1(a), 5.4.5.1(b), 5.4.5.1(c) and 5.4.5.1(d).

2. Notwithstanding policy 1.4, for the *planning matters* referred to in policy 5.4.5.1(a), 5.4.5.1 (b), 5.4.5.1(c) and 5.4.5.1(d), the policies of this Plan are intended to be achieved by 2031.

6

Simcoe Sub-area

6.1 Context

The *Simcoe Sub-area* is comprised of the County of Simcoe and the cities of Barrie and Orillia. Section 6 provides more detailed direction on how this Plan's vision will be achieved in the *Simcoe Sub-area*.

The policies in Section 6 direct a significant portion of growth within the *Simcoe Sub-area* to communities where development can be most effectively serviced, and where growth improves the range of opportunities for people to live, work, and play in their communities, with a particular emphasis on *primary settlement areas*. The City of Barrie is the principal *primary settlement area*. Downtown Barrie is the only *urban growth centre* in the *Simcoe Sub-area*. The policies in Section 6 recognize and support the vitality of urban and rural communities in the *Simcoe Sub-area*. All municipalities will play an important role in ensuring that future growth is planned for and managed in an effective and sustainable manner that conforms with this Plan. The intent of this policy is that by 2031 development for all the municipalities within Simcoe County will not exceed the overall population and employment forecasts contained in Schedule 7.

Ensuring an appropriate supply of land for employment and residential growth, and making the best use of existing infrastructure is also important to the prosperity of the *Simcoe Sub-area*. Section 6 identifies specific employment areas that will enable municipalities in the *Simcoe Sub-area* to benefit from existing and future economic opportunities. By providing further direction on where growth is to occur in the *Simcoe Sub-area*, it also establishes a foundation for municipalities to align infrastructure investments with growth management, optimize the use of existing, planned and new infrastructure, co-ordinate water and wastewater services, and promote green infrastructure and innovative technologies.

A more livable, compact, complete urban structure with good design and built form will support the achievement of economic and environmental benefits. Through effective growth management, municipalities will ensure that the natural environment is protected from the impacts of growth in the *Simcoe Sub-area*, while providing amenities for the residents and visitors to this area from across the *Greater Golden Horseshoe* and beyond.

6.2 Growth Forecasts

1. Notwithstanding policy 5.4.2.2(a), lower-tier municipalities in the County shall use the population and employment forecasts contained in Schedule 7 for planning and managing growth in the *Simcoe Sub-area*.
2. The employment forecasts include employment located in the *strategic settlement employment areas* and *economic employment districts*.
3. The Minister of Infrastructure will review the forecasts contained in Schedule 7 in conjunction with the review of Schedule 3, and in consultation with municipalities in the *Simcoe Sub-area*, and may revise the forecasts.

6.3 Managing Growth

6.3.1 Primary Settlement Areas

1. *Primary settlement areas* for the *Simcoe Sub-area* are identified in Schedule 8.
2. *Municipalities with primary settlement areas* will, in their official plans and other supporting documents –
   a) identify *primary settlement areas*
   b) identify and plan for *intensification areas* within *primary settlement areas*
   c) plan to create *complete communities* within *primary settlement areas*
   d) ensure the development of high quality urban form and public open spaces within *primary settlement areas* through site design and urban design standards that create attractive and vibrant places that support walking and cycling for everyday activities and are *transit-supportive*.
3. *Primary settlement areas* in the County will be identified in the official plan of the County of Simcoe.
4. The Town of Innisfil, Town of Bradford West Gwillimbury and the Town of New

Tecumseth will direct a significant portion of population and employment growth forecasted to the applicable *primary settlement areas.* The Town of Bradford West Gwillimbury and the Town of Innisfil, in planning to meet their employment forecasts, may direct appropriate employment to the *Bradford West Gwillimbury strategic settlement employment area* and the *Innisfil Heights strategic settlement employment area* respectively.

6.3.2 Settlement Areas

1. Development may be approved in *settlement areas* in excess of what is needed to accommodate the forecasts in Schedule 7, provided the development –

   a) contributes to the achievement of the intensification targets and density targets identified by the Minister in accordance with policy 6.5.3

   b) is on *lands for urban uses* as of January 19, 2012

   c) can be serviced in accordance with applicable provincial plans and provincial policies

   d) is in accordance with the requirements of the Lake Simcoe Protection Plan, 2009, if applicable.

2. The County may approve adopted official plans or adopted official plan amendments regarding lands within a *settlement area* that redesignate *lands not for urban uses* to *lands for urban uses* that are in excess of what is needed for a time horizon of up to 20 years or to accommodate the forecasts in Schedule 7, whichever is sooner, provided it is demonstrated that this growth –

   a) can be serviced in accordance with applicable provincial plans and provincial policies

   b) contributes to the achievement of the intensification target and density target set in accordance with policy 6.5.3

   c) contributes to the development of a *complete community*

   d) is subject to phasing policies

   e) contributes to the achievement of the jobs to residents ratio in Schedule 7 for the lower-tier municipality

f) is in accordance with the requirements of the Lake Simcoe Protection Plan, 2009, if applicable

g) is supported by appropriate transportation infrastructure and is in accordance with any transportation guidelines and policies developed by the County of Simcoe

h) is in accordance with any additional growth management policies specified by the County of Simcoe that do not conflict with the policies in this Plan.

3. The sum of all population growth accommodated on *lands for urban uses* approved pursuant to policy 6.3.2.2 shall not exceed a total population of 20,000 for the County of Simcoe.

4. Municipalities in the County of Simcoe may approve development on *lands for urban uses* approved pursuant to policies 6.3.2.2 and 6.3.2.3.

5. Policies 6.3.2.2 and 6.3.2.3 will apply to the County of Simcoe and its lower-tier municipalities until January 19, 2017.

6. The County of Simcoe Council will monitor and report annually on approvals made pursuant to policies 6.3.2.2 and 6.3.2.3.

7. *Settlement area* boundary expansions are subject to policy 2.2.8 of this Plan, except policies 2.2.8.2(a)(i) and 2.2.8.2(i).

8. In addition to policy 4.2.4 of this Plan, municipalities in the *Simcoe Sub-area* are encouraged to achieve greater efficiency and conservation in energy, water and wastewater management through building and community design.

9. The County of Simcoe and the lower-tier municipalities in the County shall establish and implement phasing policies to ensure the orderly and timely progression of development on *lands for urban uses*.

10. The County of Simcoe will develop and implement through its official plan, policies to implement policy 6.3.2.

6.4 Employment Lands

1. The *Bradford West Gwillimbury strategic settlement employment area*, the *Innisfil Heights strategic settlement employment area*, the *Lake Simcoe Regional Airport economic employment district* and the *Rama Road economic employment district* are identified in Schedule 8.

2. The Minister of Infrastructure, in consultation with other Ministers of the Crown, and affected municipalities and stakeholders, will determine the location and boundaries of *strategic settlement employment areas,* and may establish as appropriate the following:

   a) Permitted uses, and the mix and percentage of certain uses;

   b) Permitted uses for specific areas within the *strategic settlement employment areas*;

   c) Lot sizes; and

   d) Any additional policies and definitions that apply to these areas.

3. The Minister of Infrastructure, in consultation with other Ministers of the Crown, and affected municipalities and stakeholders, will determine the location and boundaries, and establish as appropriate the uses permitted in the *economic employment districts*.

4. The Minister of Infrastructure may review and amend decisions made pursuant to policies 6.4.2 and 6.4.3. Municipalities in the *Simcoe Sub-area* may request the Minister to consider a review.

5. The County of Simcoe and lower-tier municipalities in the County in which the *strategic settlement employment areas* and *economic employment districts* are located, will delineate the areas and districts, as determined by the Minister of Infrastructure, in their official plans.

6. The lower-tier municipalities in the County in which the *strategic settlement employment areas* and *economic employment districts* are located will develop official plan policies to implement the matters determined by the Minister of Infrastructure in accordance with policies 6.4.2, 6.4.3, and 6.4.4, as applicable.

7. Although not *settlement areas*, the *strategic settlement employment areas* and *economic employment districts* are considered *designated greenfield area* for the purposes of policies 2.2.7.2, 2.2.7.3, and 2.2.7.5 of this Plan.

8. For lands within *strategic settlement employment areas* and the *economic employment districts* the municipality can identify the natural heritage systems, features, and areas for protection.

6.5 Implementation

1. The policies in Section 6 apply only to the *Simcoe Sub-area*.
2. For the *Simcoe Sub-area*, where there is a conflict between policies in Section 6, Schedule 7, and Schedule 8 and the remainder of this Plan, the policies in Section 6, Schedule 7, and Schedule 8 prevail.
3. Notwithstanding policies 5.4.2.2(b) and 5.4.2.2(c) where this Plan allocates growth forecasts to the lower-tier municipalities in the County of Simcoe, the Minister of Infrastructure will identify for the County and the lower-tier municipalities in the County intensification targets to achieve the *intensification target*, and identify density targets to achieve the *density target* for *designated greenfield areas*.

7

Definitions

Affordable

a) in the case of ownership housing, the least expensive of:

1. housing for which the purchase price results in annual accommodation costs which do not exceed 30 per cent of gross annual household income for low and moderate income households; or

2. housing for which the purchase price is at least 10 per cent below the average purchase price of a resale unit in the *regional market area*;

b) in the case of rental housing, the least expensive of:

1. a unit for which the rent does not exceed 30 per cent of gross annual household income for low and moderate income households; or

2. a unit for which the rent is at or below the average market rent of a unit in the *regional market area*.

For the purposes of this definition:

Low and moderate income households means, in the case of ownership housing, households with incomes in the lowest 60 per cent of the income distribution for the *regional market area*; or in the case of rental housing, households with incomes in the lowest 60 per cent of the income distribution for renter households for the *regional market area*.

(Provincial Policy Statement, 2005)

Amended to Conform

An official plan is amended to conform to this Plan when a new official plan or an official plan amendment being made to bring the municipal official plan into conformity with this Plan, as required pursuant to section 12 of the Places to Grow Act, 2005, is final and the new official plan or the official plan amendment is in effect.

Bradford West Gwillimbury Strategic Settlement Employment Area

Location set out in Schedule 8. The Bradford West Gwillimbury strategic settlement employment area boundary is determined by the Minister of Infrastructure and planned for in accordance with policy 6.4.

Brownfield Sites

Undeveloped or previously developed properties that may be contaminated. They are usually, but not exclusively, former industrial or commercial properties that may be underutilized, derelict or vacant. (Provincial Policy Statement, 2005)

Built-up Area

All land within the *built boundary*.

Built Boundary

The limits of the developed urban area as defined by the Minister of Infrastructure in accordance with Policy 2.2.3.5.

Commenced

For the following matters, the matter was started:

a) in the case of a request for an official plan amendment under section 22 of the Planning Act, on the day the request is received;

b) in the case of an official plan, an amendment to it or a repeal of it, under section 17 or section 26 of the Planning Act, on the day the by-law adopting the plan, amendment or repeal is passed;

c) in the case of a zoning by-law or an amendment to it, under section 34 of the Planning Act, on the day the by-law is passed;

d) in the case of an application for an amendment to a zoning by-law under section 34 of the Planning Act, on the day the application is made; and

e) in the case of an application for the approval of a plan of subdivision under section 51 of the Planning Act, or an application for the approval of, or an exemption from an approval of, a condominium under section 9 of the Condominium Act, 1998, on the day the application is made.

Community Infrastructure

Community infrastructure refers to lands, buildings, and structures that support the quality of life for people and communities by providing public services for health, education, recreation, socio-cultural activities, security and safety, and *affordable* housing.

Compact Urban Form

A land-use pattern that encourages efficient use of land, walkable neighbourhoods, mixed land uses (residential, retail, workplace and institutional all within one neighbourhood), proximity to transit and reduced need for infrastructure. Compact urban form can include detached and semi-detached houses on small lots as well as townhouses and walk-up apartments, multi-storey commercial developments, and apartments or offices above retail.

Complete Communities

Complete communities meet people's needs for daily living throughout an entire lifetime by providing convenient access to an appropriate mix of jobs, local services, a full range of housing, and *community infrastructure* including *affordable* housing, schools, recreation and open space for their residents. Convenient access to public transportation and options for safe, non-motorized travel is also provided.

Density Targets

The density target for *urban growth centres* is defined in Policies 2.2.4.5 and 2.2.4.6. The density target for *designated greenfield areas* is defined in Policies 2.2.7.2, 2.2.7.3 and 2.2.7.5.

Designated Greenfield Area

The area within a *settlement area* that is not *built-up area*. Where a *settlement area* does not have a *built boundary*, the entire *settlement area* is considered designated greenfield area.

Drinking-water System

A system of works, excluding plumbing, that is established for the purpose of providing users of the system with drinking water and that includes any thing used for the collection, production, treatment, storage, supply or distribution of water; any thing related to the management of residue from the treatment process or the management of the discharge of a substance into the natural environment from the treatment system; and a well or intake that serves as the source or entry point of raw water supply for the system. (Safe Drinking Water Act, 2002)

Economic Employment Districts

To be planned and protected for locally significant employment uses. These are not *settlement areas*.

Employment Area

Areas designated in an official plan for clusters of business and economic activities including, but not limited to, manufacturing, warehousing, offices, and associated retail and ancillary facilities. (Provincial Policy Statement, 2005)

Full Cost

The full cost of providing water and wastewater services includes the source protection costs, operating costs, financing costs, renewal and replacement costs and improvement costs associated with extracting, treating or distributing water to the public, and collecting, treating or discharging wastewater.

Gateway Economic Centre

Settlement areas identified in this Plan, as conceptually depicted on Schedules 2, 5, and 6 that, due to their proximity to major international border crossings, have unique economic importance to the region and Ontario.

Gateway Economic Zone

Settlement areas identified in this Plan within the zone that is conceptually depicted on Schedules 2, 5, and 6, that, due to their proximity to major international border crossings, have unique economic importance to the region and Ontario.

Greater Golden Horseshoe (GGH)

The geographic area designated as the Greater Golden Horseshoe growth plan area in Ontario Regulation 416/05.

Greenbelt Area

The geographic area of the Greenbelt as defined by the Ontario Regulation 59/05 as provided by the Greenbelt Act, 2005.

Greyfields

Previously developed properties that are not contaminated. They are usually, but not exclusively, former commercial properties that may be underutilized, derelict or vacant.

Higher Order Transit

Transit that generally operates in its own dedicated right-of-way, outside of mixed traffic, and therefore can achieve a frequency of service greater than mixed-traffic transit. Higher order transit can include heavy rail (such as subways), light rail (such as streetcars), and buses in dedicated rights-of-way.

Inner Ring

The geographic area consisting of the municipalities of Hamilton and Toronto and the upper-tier municipalities of Durham, Halton, Peel and York.

Innisfil Heights Strategic Settlement Employment Area

Location set out in Schedule 8. The Innisfil Heights strategic settlement employment area boundary is determined by the Minister of Infrastructure and planned for in accordance with policy 6.4.

Intensification

The development of a property, site or area at a higher density than currently exists through:

a) *redevelopment*, including the reuse of *brownfield sites*;

b) the development of vacant and/or underutilized lots within previously developed areas;

c) infill development; or

d) the expansion or conversion of existing buildings.

(Provincial Policy Statement, 2005)

Intensification Areas

Lands identified by municipalities or the Minister of Infrastructure within a *settlement area* that are to be the focus for accommodating *intensification*. Intensification areas include *urban growth centres*, *intensification corridors*, *major transit station areas*, and other major opportunities that may include infill, *redevelopment*, *brownfield sites*, the expansion or conversion of existing buildings and *greyfields*.

Intensification Corridors

Intensification areas along major roads, arterials or *higher order transit* corridors that have the potential to provide a focus for higher density mixed-use development consistent with planned transit service levels.

Intensification Target

The intensification target is as established in Policies 2.2.3.1, 2.2.3.2, 2.2.3.3, and 2.2.3.4.

Inter-modal Facility

A location where transfers between modes can be made as part of a single journey. For example, a typical freight inter-modal facility is a rail yard where containers are transferred between trucks and trains.

Lake Simcoe Regional Airport Economic Employment District
Location set out in Schedule 8. The Lake Simcoe Regional Airport economic employment district boundary is determined by the Minister of Infrastructure and planned for in accordance with policy 6.4. Major retail and residential uses are not permitted.

Lands for Urban Uses
Lands that are not designated for agricultural or rural uses within a *settlement area* identified in the approved official plan for the municipality.

Lands Not for Urban Uses
Lands that are designated for agricultural or rural uses within a *settlement area* identified in the approved official plan for the municipality.

Major Office
Major office is generally defined as freestanding office buildings of 10,000 m^2 or greater, or with 500 jobs or more.

Major Transit Station Area
The area including and around any existing or planned *higher order transit* station within a *settlement area*; or the area including and around a major bus depot in an urban core. Station areas generally are defined as the area within an approximate 500m radius of a transit station, representing about a 10-minute walk.

Mineral Aggregate Resources
Gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, rock or other material prescribed under the Aggregate Resources Act suitable for construction, industrial, manufacturing and maintenance purposes but not including metallic ores, asbestos, graphite, kyanite, mica, nepheline syenite, salt, talc, wollastonite, mine tailings or other material prescribed under the Mining Act. (Provincial Policy Statement, 2005)

Modal Share
The percentage of person-trips or of freight movements made by one travel mode, relative to the total number of such trips made by all modes.

Multi-modal
The availability or use of more than one form of transportation, such as automobiles, walking, cycling, buses, rapid transit, rail (such as commuter and freight), trucks, air and marine.

Municipal Comprehensive Review

An official plan review, or an official plan amendment, initiated by a municipality that comprehensively applies the policies and schedules of this Plan.

Municipal Water and Wastewater Systems

Municipal water systems, are all or part of a *drinking-water system* –

a) that is owned by a municipality or by a municipal service board established under section 195 of the Municipal Act, 2001

b) that is owned by a corporation established under section 203 of the Municipal Act, 2001

c) from which a municipality obtains or will obtain water under the terms of a contract between the municipality and the owner of the system, or

d) that is in a prescribed class of municipal drinking-water systems as defined in regulation under the Safe Drinking Water Act, 2002.

And, municipal wastewater systems are any *sewage works* owned or operated by a municipality.

Municipalities with Primary Settlement Areas

City of Barrie, City of Orillia, Town of Bradford West Gwillimbury, Town of Collingwood, Town of Innisfil, Town of Midland, Town of New Tecumseth, and Town of Penetanguishene.

New Multiple Lots and Units for Residential Development

The creation of more than three units or lots through either plan of subdivision, consent or plan of condominium.

Outer Ring

The geographic area consisting of the cities of Barrie, Brantford, Guelph, Kawartha Lakes, Orillia and Peterborough; the Counties of Brant, Dufferin, Haldimand, Northumberland, Peterborough, Simcoe, and Wellington; and the Regions of Niagara and Waterloo.

Planning Matter

Any matter listed under *commenced* or:

a) an application for an approval of development in a site plan control area under subsection 41(4) of the Planning Act;

b) an application for a minor variance under section 45 of the Planning Act;

c) an application to amend or revoke an order made under section 47 of the Planning Act; or

d) an application for a consent under section 53 of the Planning Act.

Primary Settlement Areas

Locations set out in Schedule 8. Primary settlement areas are the *settlement areas* of the City of Barrie, the City of Orillia, the Town of Collingwood, the Town of Midland together with the Town of Penetanguishene, and the *settlement areas* of the communities of Alcona in the Town of Innisfil, Alliston in the Town of New Tecumseth and Bradford in the Town of Bradford West Gwillimbury.

Prime Agricultural Area

Areas where prime agricultural lands predominate. This includes areas of prime agricultural lands and associated Canada Land Inventory Class 4-7 soils, and additional areas where there is a local concentration of farms which exhibit characteristics of ongoing agriculture. Prime agricultural areas may be identified by the Ontario Ministry of Agriculture, Food, and Rural Affairs using evaluation procedures established by the Province as amended from time to time, or may also be identified through an alternative agricultural land evaluation system approved by the Province.

For the purposes of this definition:

Prime agricultural land includes *specialty crop areas* and/or Canada Land Inventory Classes 1, 2, and 3 soils, in this order of priority for protection. (Provincial Policy Statement, 2005)

Private Communal Water and Wastewater Systems

Private communal water systems are *drinking-water systems* that are not *municipal water systems* as defined in *municipal water and wastewater systems*, and that serve six or more lots or private residences, and

Private communal wastewater systems are *sewage works* that serve six or more lots or private residences and are not owned or operated by a municipality.

Rama Road Economic Employment District

Location set out in Schedule 8. The Rama Road economic employment district boundary is determined by the Minister of Infrastructure and planned for in accordance with policy 6.4. Major retail uses are not permitted.

Redevelopment

The creation of new units, uses or lots on previously developed land in existing communities, including *brownfield sites*. (Provincial Policy Statement, 2005)

Regional Market Area

An area, generally broader than a lower-tier municipality that has a high degree of social and economic interaction. In southern Ontario, the upper- or single-tier municipality will normally serve as the regional market area. Where a regional market area extends significantly beyond upper- or single-tier boundaries, it may include a combination of upper-, single- and/or lower-tier municipalities. (Provincial Policy Statement, 2005)

Rural Areas

Lands which are located outside *settlement areas* and that are not *prime agricultural areas*. (Provincial Policy Statement, 2005)

Settlement Areas

Urban areas and rural settlement areas within municipalities (such as cities, towns, villages and hamlets) where:

a) development is concentrated and which have a mix of land uses; and

b) lands have been designated in an official plan for development over the long term planning horizon provided for in the Provincial Policy Statement, 2005. Where there are no lands that have been designated over the long-term, the settlement area may be no larger than the area where development is concentrated.

Sewage Works

Any works for the collection, transmission, treatment and disposal of sewage or any part of such works, but does not include plumbing to which the Building Code Act, 1992 applies. (Ontario Water Resources Act)

For the purposes of this definition:

Sewage includes, but is not limited to drainage, storm water, residential wastes, commercial wastes and industrial wastes.

Simcoe Sub-area

The geographic area consisting of the County of Simcoe, the City of Barrie and the City of Orillia.

Small Cities and Towns

Settlement areas that do not include an *urban growth centre*.

Specialty Crop Area

Areas designated using evaluation procedures established by the Province, as amended from time to time, where specialty crops such as tender fruits (peaches, cherries, plums), grapes, other fruit crops, vegetable crops, greenhouse crops, and crops from agriculturally developed organic soil lands are predominantly grown, usually resulting from:

a) soils that have suitability to produce specialty crops, or lands that are subject to special climatic conditions, or a combination of both; and/or

b) a combination of farmers skilled in the production of specialty crops, and of capital investment in related facilities and services to produce, store, or process specialty crops.

(Provincial Policy Statement, 2005)

Strategic Settlement Employment Areas

To be planned and protected for employment uses that require large lots of land and depend upon efficient movement of goods and access to Highway 400. These are not *settlement areas*. Major retail and residential uses are not permitted.

Sub-area

An area identified by the Minister of Infrastructure within the *Greater Golden Horseshoe* at a scale generally larger than any one upper- or single-tier municipality.

Transit-supportive

Makes transit viable and improves the quality of the experience of using transit. When used in reference to development, it often refers to compact, mixed-use development that has a high level of employment and residential densities to support frequent transit service. When used in reference to urban design, it often refers to design principles that make development more accessible for transit users, such as roads laid out in a grid network rather than a discontinuous network; pedestrian-friendly built environment along roads to encourage walking to transit; reduced setbacks and placing parking at the sides/rear of buildings; and improved access between arterial roads and interior blocks in residential areas.

Transportation Corridor

A thoroughfare and its associated buffer zone for passage or conveyance of vehicles or people. A transportation corridor includes any or all of the following:

a) Major roads, arterial roads, and highways for moving people and goods;

b) Rail lines/railways for moving people and goods;

c) Transit rights-of-way/transitways including buses and light rail for moving people.

Transportation Demand Management

A set of strategies that results in more efficient use of the transportation system by influencing travel behaviour by mode, time of day, frequency, trip length, regulation, route, or cost. Examples include: carpooling, vanpooling, and shuttle buses; parking management; site design and on-site facilities that support transit and walking; bicycle facilities and programs; pricing (road tolls or transit discounts); flexible working hours; telecommuting; high occupancy vehicle lanes; park-and-ride; incentives for ride-sharing, using transit, walking and cycling; initiatives to discourage drive-alone trips by residents, employees, visitors, and students.

Transportation System

A system consisting of corridors and rights-of-way for the movement of people and goods, and associated transportation facilities including transit stops and stations, cycle lanes, bus lanes, high occupancy vehicle lanes, rail facilities, park-and-ride lots, service centres, rest stops, vehicle inspection stations, inter-modal terminals, harbours, and associated facilities such as storage and maintenance. (Provincial Policy Statement, 2005)

Urban Growth Centres

Locations set out in Schedule 4. Urban growth centres will be delineated pursuant to Policies 2.2.4.2 and 2.2.4.3.

Watershed

An area that is drained by a lake or river, and its tributaries.

Watershed Plan

A watershed plan provides a framework for integrated decision-making for the management of human activities, land, water, aquatic life and aquatic resources within a *watershed*. It includes matters such as a water budget and conservation plan; land and water use management strategies; an environmental monitoring plan; requirements for the use of environmental management practices and programs; criteria for evaluating the protection of water quality and quantity, and hydrologic features and functions; and targets for the protection and restoration of riparian areas.

Ontario

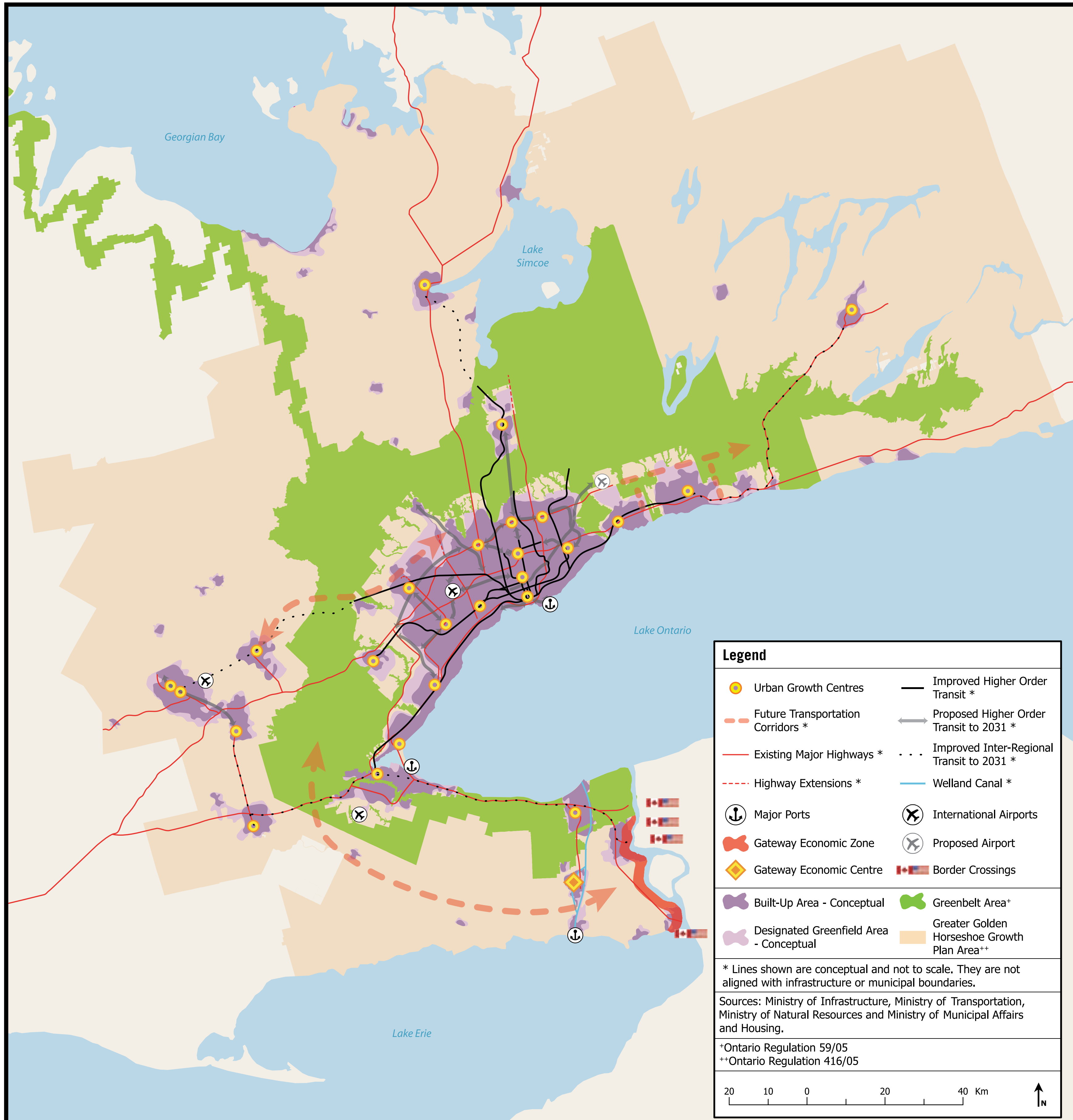
PLACES TO GROW

GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE 2006

SCHEDULE 1

Greater Golden Horseshoe Growth Plan Area

Note: The information displayed on this map is not to scale, does not accurately reflect approved land-use and planning boundaries, and may be out of date. For more information on precise boundaries, the appropriate municipality should be consulted. For more information on Greenbelt Area boundaries, the Greenbelt Plan 2005 should be consulted. The Province of Ontario assumes no responsibility or liability for any consequences of any use made of this map.



Ontario

PLACES TO GROW

GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE 2006

SCHEDULE 2

Places to Grow Concept

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Distribution of Population and Employment for the Greater Golden Horseshoe to 2041 (figures in 000s)								
			UPDATED FORECASTS					
	POPULATION	EMPLOYMENT	POPULATION			EMPLOYMENT		
	2031A	2031A	2031B	2036	2041	2031B	2036	2041
Region of Durham	960	350	970	1,080	1,190	360	390	430
Region of York	1,500	780	1,590	1,700	1,790	790	840	900
City of Toronto	3,080	1,640	3,190	3,300	3,400	1,660	1,680	1,720
Region of Peel	1,640	870	1,770	1,870	1,970	880	920	970
Region of Halton	780	390	820	910	1,000	390	430	470
City of Hamilton	660	300	680	730	780	310	330	350
GTAH TOTAL*	**8,620**	**4,330**	**9,010**	**9,590**	**10,130**	**4,380**	**4,580**	**4,820**
County of Northumberland	96	33	100	105	110	36	37	39
County of Peterborough	61	18	70	73	76	20	21	24
City of Peterborough	88	42	103	109	115	52	54	58
City of Kawartha Lakes	100	27	100	101	107	29	30	32
County of Simcoe				456	497		141	152
City of Barrie	See Schedule 7	See Schedule 7	See Schedule 7	231	253	See Schedule 7	114	129
City of Orillia				44	46		22	23
County of Dufferin	80	27	80	81	85	29	31	32
County of Wellington	122	54	122	132	140	54	57	61
City of Guelph	175	92	177	184	191	94	97	101
Region of Waterloo	729	366	742	789	835	366	383	404
County of Brant	47	19	49	53	57	22	24	26
City of Brantford	126	53	139	152	163	67	72	79
County of Haldimand	56	20	57	60	64	22	24	25
Region of Niagara	511	218	543	577	610	235	248	265
OUTER RING TOTAL*	**2,880**	**1,240**	**2,940**	**3,150**	**3,350**	**1,280**	**1,360**	**1,450**
TOTAL GGH*	**11,500**	**5,560**	**11,950**	**12,740**	**13,480**	**5,650**	**5,930**	**6,270**

Note: Numbers rounded off to nearest 10,000 for GTAH municipalities, GTAH Total and Outer Ring Total, and to nearest 1,000 for outer ring municipalities.
** Total may not add up due to rounding.*

Ontario

PLACES TO GROW

GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE 2006

SCHEDULE 3

Distribution of Population and Employment for the Greater Golden Horseshoe to 2041

Ontario

PLACES TO GROW

GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE 2006

SCHEDULE 4

Urban Growth Centres

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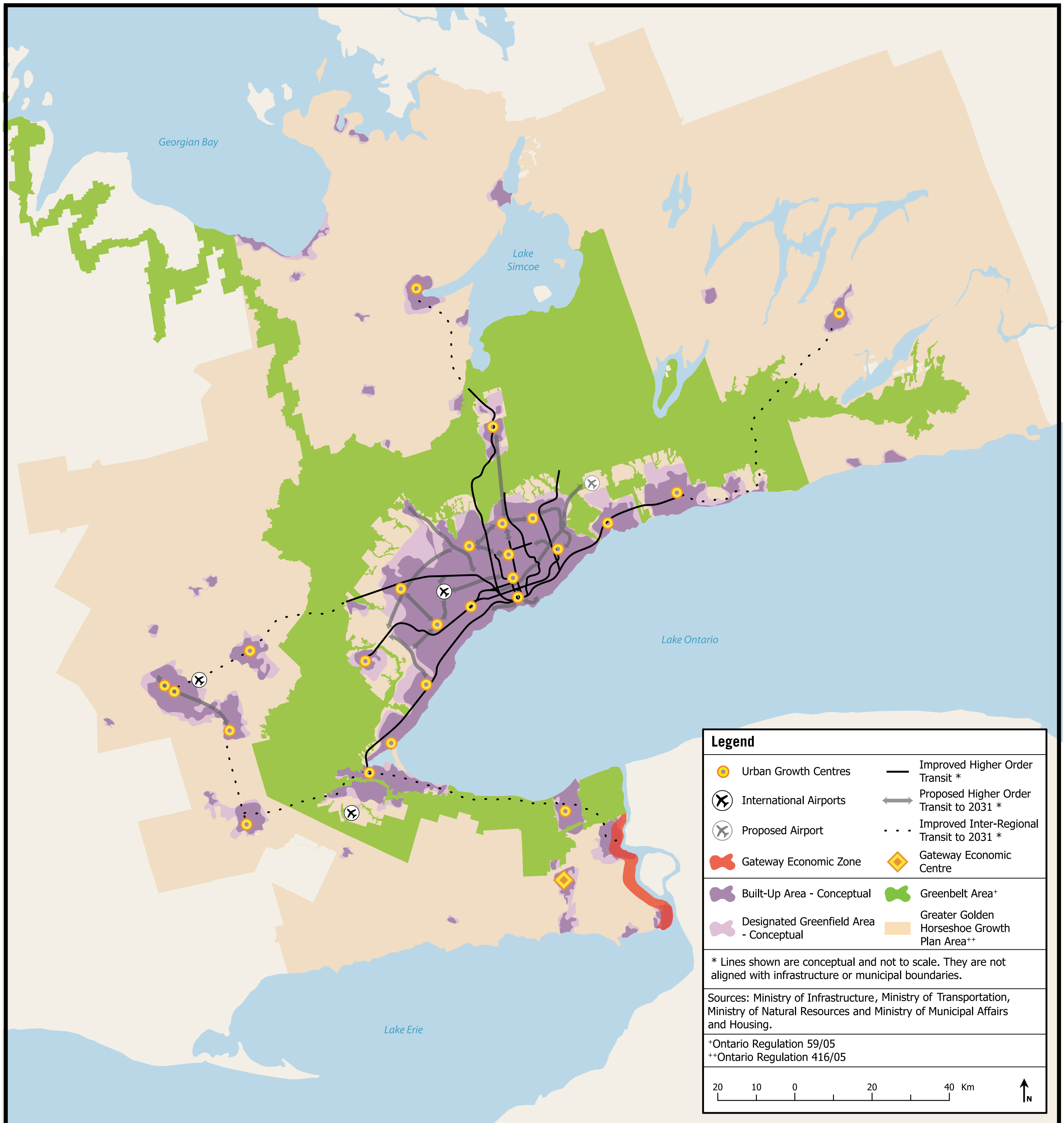

Ontario

PLACES TO GROW

GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE 2006

SCHEDULE 5

Moving People – Transit

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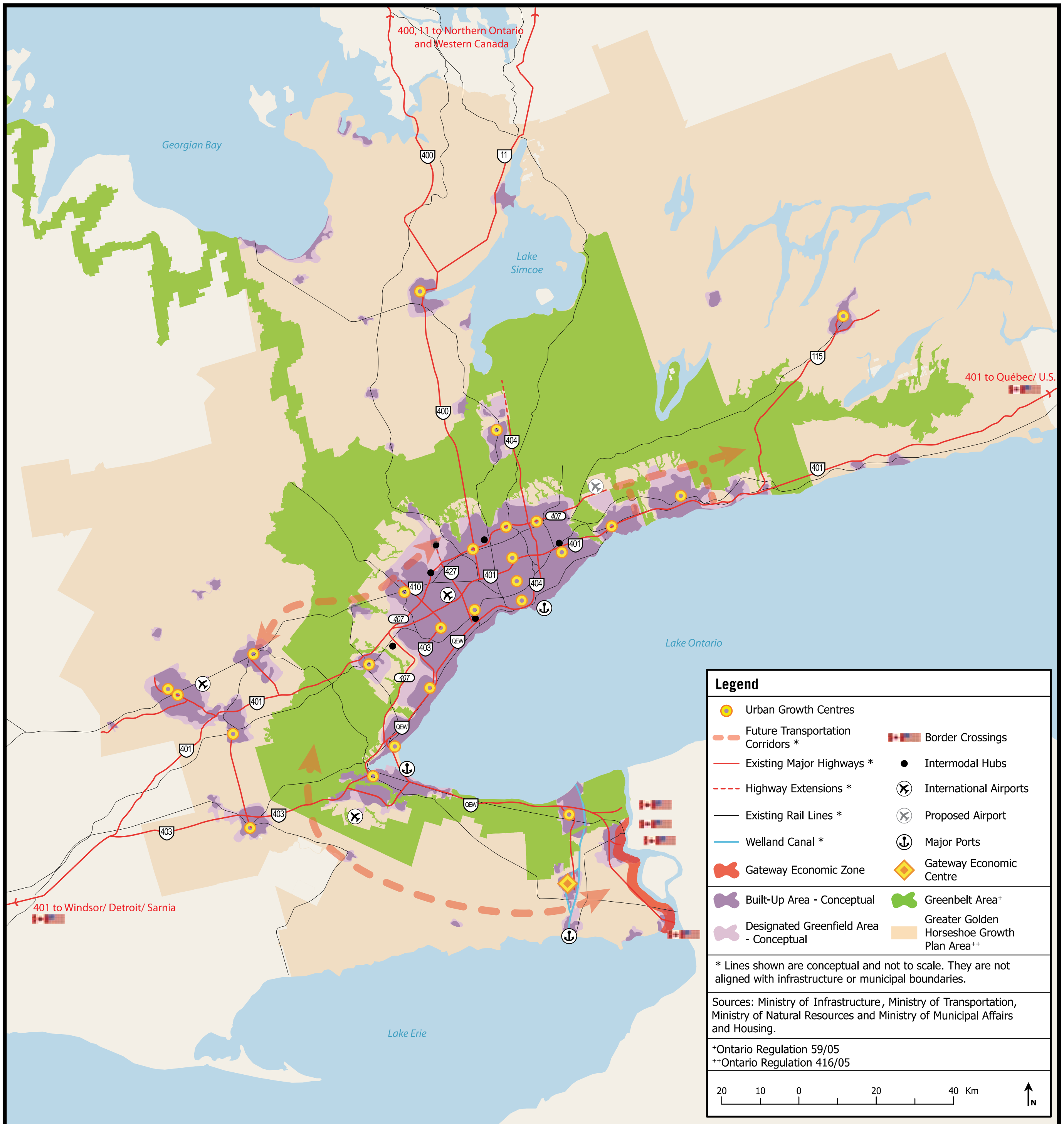

Ontario

PLACES TO GROW

GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE 2006

SCHEDULE 6

Moving Goods

Note: The information displayed on this map is not to scale, does not accurately reflect approved land-use and planning boundaries, and may be out of date. For more information on precise boundaries, the appropriate municipality should be consulted. For more information on Greenbelt Area boundaries, the Greenbelt Plan 2005 should be consulted. The Province of Ontario assumes no responsibility or liability for any consequences of any use made of this map.

Distribution of Population and Employment for the City of Barrie, City of Orillia and County of Simcoe to 2031		
	POPULATION	**EMPLOYMENT**
City of Barrie	210,000	101,000
City of Orillia	41,000	21,000
Township of Adjala-Tosorontio	13,000	1,800
Town of Bradford West Gwillimbury	50,500	18,000
Township of Clearview	19,700	5,100
Town of Collingwood	33,400	13,500
Township of Essa	21,500	9,000
Town of Innisfil	56,000	13,100
Town of Midland	22,500	13,800
Town of New Tecumseth	56,000	26,500
Township of Oro-Medonte	27,000	6,000
Town of Penetanguishene	11,000	6,000
Township of Ramara	13,000	2,200
Township of Severn	17,000	4,400
Township of Springwater	24,000	5,600
Township of Tay	11,400	1,800
Township of Tiny	12,500	1,700
Town of Wasaga Beach	27,500	3,500
TOTAL SIMCOE SUB-AREA	667,000	254,000

Ontario

PLACES TO GROW

GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE 2006

SCHEDULE 7

Distribution of Population and Employment for the City of Barrie, City of Orillia and County of Simcoe to 2031

Ontario

PLACES TO GROW

GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE 2006

SCHEDULE 8

Simcoe Sub-area

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Ontario

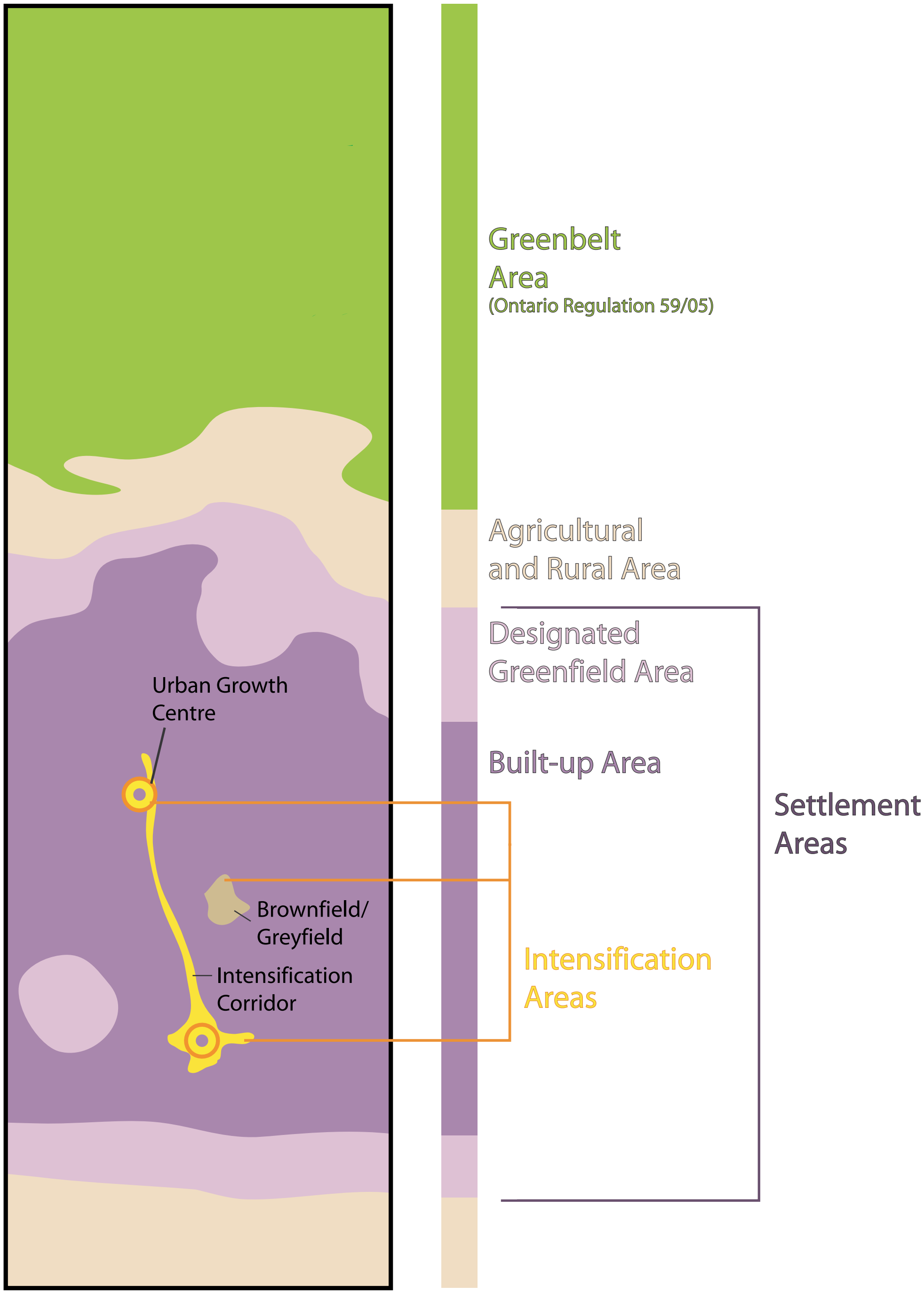
PLACES TO GROW

GROWTH PLAN FOR
THE GREATER GOLDEN HORSESHOE 2006

APPENDIX 1

Context Map: Location of the Greater Golden Horseshoe within Ontario

The information displayed in the map above is not to scale. This appendix is included for information only and should not be read as a part of the Growth Plan for the Greater Golden Horseshoe.



Ontario

PLACES TO GROW

GROWTH PLAN FOR
THE GREATER GOLDEN HORSESHOE 2006

APPENDIX 2

Illustration Diagram: Growth Plan Land-use Terminology

The information displayed in the map above is not to scale. This appendix is included for information only and should not be read as a part of the Growth Plan for the Greater Golden Horseshoe.

Get Involved

Planning for growth means carefully looking ahead and better informing our actions. It's a partnership among all of us.

You can contact the Ontario Growth Secretariat,
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Proposed

GROWTH PLAN

for the Greater Golden Horseshoe, 2016

MAY 2016

Ontario.ca/landuseplanningreview

Ontario

Preface

Four provincial land use plans work together to manage growth, build complete communities, curb sprawl and protect the natural environment in Ontario's Greater Golden Horseshoe region: the Growth Plan for the Greater Golden Horseshoe, 2006, the Greenbelt Plan (2005), the Oak Ridges Moraine Conservation Plan (2002), and the Niagara Escarpment Plan (2005).

A co-ordinated review of these four land use plans began in 2015. The Government of Ontario received extensive feedback. An Advisory Panel also provided its recommendations in December 2015 in their report *Planning for Health, Prosperity and Growth in the Greater Golden Horseshoe: 2015–2041*.

The Government of Ontario has reviewed and considered all feedback received from stakeholders, the public and Indigenous communities, as well as the Advisory Panel's recommendations. The government is now proposing changes to the four plans, and is asking for your feedback.

For an overview of the proposed changes to the four provincial land use plans, please see *Shaping Land Use in the Greater Golden Horseshoe* at www.ontario.ca/landuseplanningreview.

Proposed Growth Plan for the Greater Golden Horseshoe, 2016

The Minister of Municipal Affairs and Housing is issuing the Proposed Growth Plan for the Greater Golden Horseshoe, 2016 pursuant to the Places to Grow Act, 2005 for consultation. After considering all submissions and comments received, the Minister may modify the Proposed Growth Plan for the Greater Golden Horseshoe, 2016 and can then submit it, along with recommendations, to the Lieutenant Governor in Council for a decision. If approved, the revised Growth Plan for the Greater Golden Horseshoe would come into effect on the date set out in the decision.

This document includes the table of contents, text, schedules and appendices of the Proposed Growth Plan for the Greater Golden Horseshoe, 2016. This is one of four proposed revised plans on which the government is seeking input. All comments and feedback will be taken into consideration prior to a final decision on the revised plans.

Seeking Feedback (page 111)

Your feedback on the proposed changes is greatly appreciated. This section, which is included after the proposed plan, provides details for submitting comments and feedback on the Proposed Growth Plan for the Greater Golden Horseshoe, 2016.

Proposed

GROWTH PLAN

for the Greater Golden Horseshoe, 2016

This annotated version of the Proposed Growth Plan for the Greater Golden Horseshoe, 2016 includes explanatory text boxes. The explanatory text boxes have been included **for information purposes only**, to assist users in reading the Proposed Growth Plan for the Greater Golden Horseshoe, 2016. The explanatory text boxes would not be included in the final Growth Plan for the Greater Golden Horseshoe, 2016, if approved.

The explanatory text boxes highlight selected proposed changes compared to the Growth Plan for the Greater Golden Horseshoe, 2006 (as amended). The description in the explanatory text boxes is limited to selected points and not inclusive of all proposed changes.

Nothing in the explanatory text boxes should be interpreted as deviating from or modifying the proposed policies. The explanatory text boxes should not be relied on in place of specialized legal or professional advice regarding a particular matter.

Proposed Growth Plan for the Greater Golden Horseshoe, 2016

Table of Contents

1 Introduction

1.1 The Greater Golden Horseshoe

Explanatory Text

Proposed changes/additions to the context for Section 1 of the Growth Plan, if approved, would include:

- Updated profile of the regional economy and its global prominence;
- Increased focus on natural assets and the importance of protection for future generations;
- Recognition of the long history of human settlement in the area;
- Key challenges on the horizon for the fast-growing region (some of which have recently emerged or gained prominence over the past 10 years); and
- Acknowledgement of the importance of consulting with First Nations and Métis communities and the requirement to implement the Plan in a manner consistent with the recognition and affirmation of existing Aboriginal and treaty rights.

The *Greater Golden Horseshoe* (*GGH*) is one of the most dynamic and fastest growing regions in North America. It is the destination of choice for many people and businesses relocating from other parts of Canada and around the world. They settle here because of the high quality of life and the economic opportunities. It is a place of prosperity where, through their skills and talents, people are building a great future for themselves.

The *GGH* has one of the most vibrant and thriving economies in the world, is the largest urban region in Canada – generating upwards of 25 per cent of Canada's Gross Domestic Product (GDP)[1] – and is the economic engine of Ontario. While the *GGH*'s competitive advantage has historically been its location in the heart of the Great Lakes region with close proximity to major United States markets, today the region is widely recognized for its highly educated workforce and uniquely multicultural population, whose social and economic diversity are critical factors for success in a knowledge-based economy. Central to the region is the City of Toronto, which is continually recognized as one of the most livable cities[2] and most important financial centres[3] in the world.

1 Calculated from Statistics Canada (Metropolitan Gross Domestic Product, 2014) and Conference Board of Canada (Metropolitan Outlook 1 & 2, 2014)
2 "The Safe Cities Index 2015", The Economist Intelligence Unit, 2015
3 "The Global Financial Centres Index 18", Qatar Financial Centre, 2015

The *GGH* contains many of Ontario's most significant ecological and hydrologic natural environments and scenic landscapes, including the Oak Ridges Moraine, the Niagara Escarpment and the other natural areas in the *Greenbelt Area*. These natural areas provide drinking water for the region's nine million inhabitants, sustain its many resource-based industries, support recreational activities that benefit public health and overall quality of life and help moderate the impacts of climate change. The region also has some of Canada's most important and productive farmland. Its fertile soil, moderate climate and abundant water resources support agricultural production that cannot be duplicated elsewhere in the country.

The First Nations and Métis communities within the Great Lakes region continue to shape the history and economy of the area. Ontario recognizes the unique role that Indigenous peoples have had and will continue to have in the growth and development of this region.

As the *GGH* grows and changes, we must continue to value what makes this region unique in order to ensure the sustained prosperity of Ontario, its people and future generations. While growth is an important component of vibrant, diversified urban and rural communities and economies, the magnitude of growth that is expected over the coming decades for the *GGH* presents a number of challenges:

- Rates of obesity, diabetes and cardiovascular illnesses are on the rise in the region, in part due to growing rates of inactivity linked to low-density and automobile dependent development patterns.[4]
- The impacts of globalization are transforming the regional economy at a rapid pace, which makes long-term planning for employment more uncertain.
- A growing and aging population will result in the need for a more appropriate range and mix of housing options and for health care and other amenities in accessible locations.
- Increased demand for major *infrastructure* investments, the need to renew aging *infrastructure*, continuing *infrastructure* deficits associated with low-density urban sprawl, and scarce financial resources means an ever greater need to plan to optimize existing assets and make the best use of limited resources by considering full life cycle costs.
- Increased traffic congestion, and the resulting delays in the movement of people and goods in the *GGH,* is costing billions of dollars in lost GDP every year.

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4 "Improving Health by Design in the Greater Toronto-Hamilton Area. A Report of Medical Officers of Health in the GTHA", Mowat, D. et al., 2014

- Urban sprawl can degrade the region's air quality; water resources; natural heritage resources, such as rivers, lakes, *woodlands* and *wetlands*; and *cultural heritage resources*.
- The finite supply of quality agricultural lands that feed the region and beyond must be protected to ensure a vibrant rural and agricultural economy and a secure food supply for future generations.
- The impacts of climate change are already being felt. Communities and *infrastructure* must be adapted to be more resilient; greenhouse gas emissions across all sectors of the economy need to be reduced; and valuable water resources and natural areas need to be protected.

To address these challenges and ensure the protection and effective use of finite resources, the Growth Plan for the Greater Golden Horseshoe, together with the Greenbelt Plan, Oak Ridges Moraine Conservation Plan and the Niagara Escarpment Plan, builds on the Provincial Policy Statement (PPS) to establish a unique land use planning framework for the *GGH* that supports the creation of resilient and sustainable *complete communities*, a thriving economy, a clean and healthy environment, and social equity.

In implementing these provincial plans, the Province recognizes the importance of consulting with First Nations and Métis communities on planning matters that may affect their rights and interests. Provincial plans must be implemented in a manner that is consistent with the recognition and affirmation of existing Aboriginal and treaty rights under section 35 of the Constitution Act, 1982.

1.2 The Growth Plan for the Greater Golden Horseshoe

Explanatory Text

Section 1 is proposed to be restructured to clearly set out the evolution from Growth Plan, 2006 to the Proposed Growth Plan, 2016, if approved. While the original Vision Statement by the Central Ontario Smart Growth Panel (Shape the Future, April 2003) would see minimal changes, the Guiding Principles would be expanded to include additional detail to reflect the proposed changes to the Growth Plan. The section on "How to Read this Plan" would be updated to align with Part III of the Provincial Policy Statement, 2014 (PPS) to help clarify the policy hierarchies in the provincial land use planning framework.

Places to Grow is the Ontario government's initiative to plan for growth and development in a way that supports economic prosperity, protects the environment and helps communities achieve a high quality of life. The Places to Grow Act, 2005 enables the development of regional growth plans that guide government investments and land use planning policies.

The Growth Plan for the Greater Golden Horseshoe, 2006 (Growth Plan, 2006) was the first growth plan to provide a framework for implementing Ontario's vision for building stronger, prosperous communities by better managing growth in this region. It established the long-term framework for where and how the region will grow, while recognizing the realities facing our cities and smaller communities and acknowledging what governments can and cannot influence. It also demonstrated leadership for improving the ways in which our cities, suburbs, towns and villages will grow over the long-term.

Vision for the *GGH*

More than anything, the *Greater Golden Horseshoe* (*GGH*) will continue to be a great place to live. Its communities will be supported by the pillars of a strong economy, a clean and healthy environment, and social equity.

The *GGH* will offer a wide variety of choices for living. Thriving, livable, vibrant and productive urban and rural areas will foster community health and individual well-being. The region will be supported by modern, well-maintained, sustainable and resilient *infrastructure* built in accordance with the broad plan for managing growth. Residents will have easy access to shelter, food, education and health-care facilities, arts and recreation and information technology. Public services will be co-located in community hubs that are broadly accessible.

Getting around will be easy. An integrated transportation network will allow people choices for easy travel both within and between urban centres throughout the region. Public transit will be fast, convenient and affordable. Automobiles will be only one of a variety of effective and well-used choices for transportation. Transit and *active transportation* will be practical elements of our urban *transportation systems*.

A healthy natural environment with clean air, land and water will characterize the *GGH*. The Greenbelt, including significant natural features, such as the Oak Ridges Moraine and the Niagara Escarpment, will continue to be enhanced and protected in perpetuity. These will form the key building blocks of the *GGH*'s natural systems. The *GGH*'s rivers and streams, forests and natural areas will be protected and accessible for residents to enjoy their beauty. Open spaces in our cities, towns and countryside will provide people with a sense of place.

Natural areas and agricultural lands will provide a significant contribution to the region's resilience and our ability to adapt to a changing climate. Unique and high quality agricultural lands will be protected for the provision of healthy, local food for future generations. Farming will be productive, diverse and sustainable.

Urban centres will be characterized by vibrant and more compact settlement and development patterns, will provide a diversity of opportunities for living, working and enjoying culture and will support climate change mitigation. The evolving regional economy of the *GGH* will have matured into an economic powerhouse of global significance. It will function as Canada's principal international gateway.

The Greater Toronto and Hamilton Area (GTHA) will be a thriving metropolis with an extraordinary waterfront. At the heart of this metropolis will be Toronto, a celebrated centre of influence for commerce, culture and innovation.

All of this will translate into a place where residents enjoy a high standard of living and an exceptional quality of life.

The original Vision Statement by the Central Ontario Smart Growth Panel (Shape the Future, April 2003) has been updated in 2016 for the purposes of this Plan.

The implementation of the Growth Plan has been supported by the creation of Metrolinx and The Big Move (the regional transportation plan for the GTHA) to implement the Growth Plan's transit and transportation policies. Since 2006, the Province has made significant investments in transit projects in the GTHA, and continues to invest in rapid transit projects to support the regional transit network.

Since the introduction of the Growth Plan for the Greater Golden Horseshoe in 2006, the region has seen a shift to more compact development patterns, a greater variety of housing types, more mixed-use development in *urban growth centres* and other *strategic growth areas* and greater integration of transit and land use planning.

Despite these early successes, there is still more work to do. Now is the time to build on the progress that has been made towards creating more *complete communities* that are compact, *transit-supportive*, and make effective use of *infrastructure* investments, while protecting our agricultural and natural areas and supporting climate change mitigation as Ontario moves towards *net-zero communities* in the long-term.

The Growth Plan for the Greater Golden Horseshoe, 2016 (“this Plan”), builds upon the success of the initial Growth Plan, 2006 and responds to the key challenges that the region will continue to face over the coming decades with enhanced policy directions.

1.2.1 Guiding Principles

The successful realization of this vision for the *GGH* centres on effective collaboration amongst the Province, other levels of government, First Nations and Métis communities, residents, private and non-profit sectors across all industries, and other stakeholders. The policies in this Plan regarding how land is developed, resources are managed and protected, and public dollars are invested are based on the following principles:

- Design *complete communities* to meet people’s needs for daily living throughout an entire lifetime, and support healthy and active living.
- Prioritize *intensification* and higher densities to make efficient use of land and *infrastructure* and support transit viability.
- Provide flexibility to capitalize on new economic and employment opportunities as they emerge, while providing certainty for traditional industries, including resource-based sectors.
- Provide for a mix and range of housing types to serve all sizes, incomes and ages of households.
- Improve the integration of land use planning with planning and investment in *infrastructure* and *public service facilities*, including integrated service delivery through community hubs, by all levels of government.
- Provide for different approaches to manage growth that recognize the diversity of communities in the *GGH.*
- Protect and enhance natural heritage, hydrologic and landform features and functions.
- Support and enhance the long-term viability of the agricultural sector by protecting *prime agricultural areas* and the *agricultural support network*.
- Conserve and promote *cultural heritage resources* to support the social, economic, and cultural well-being of all communities, including First Nations and Métis communities.
- Integrate climate change considerations into planning and managing growth such as planning for more resilient *infrastructure* and moving towards *net-zero communities* by incorporating techniques to reduce greenhouse gas emissions.

1.2.2 Legislative Authority

This Plan is issued under the authority of section 7 of the Places to Grow Act, 2005. It was approved through an Order in Council made under that Act and came into effect on [placeholder for effective date]. This Plan replaces the Growth Plan, 2006 that initially took effect on June 16, 2006 and was amended by Amendment 1 (January 19, 2012) and Amendment 2 (June 17, 2013).

This Plan applies to the area designated by Ontario Regulation 416/05. All decisions made on or after [placeholder for effective date] in respect of the exercise of any authority that affects a planning matter will conform with this Plan, subject to any legislative or regulatory provisions providing otherwise.

1.2.3 How to Read this Plan

This Plan informs decision-making regarding growth management and environmental protection in the *GGH*. It consists of policies, schedules, definitions and appendices. It also includes non-policy contextual commentary to provide background and describe the purpose of the policies.

Relationship with the Provincial Policy Statement

The PPS provides overall policy directions on matters of provincial interest related to land use and development in Ontario, and applies to the *GGH*, except where this Plan or another provincial plan provides otherwise.

Like other provincial plans, this Plan builds upon the policy foundation provided by the PPS and provides additional and more specific land use planning policies to address issues facing specific geographic areas in Ontario. This Plan is to be read in conjunction with the PPS. The policies of this Plan take precedence over the policies of the PPS to the extent of any conflict, except where the relevant legislation provides otherwise. Where the policies in this Plan address the same, similar, related or overlapping matters as policies in the PPS, applying the more specific policies in this Plan satisfies the requirements of the more general policies in the PPS.

As provided for in the Places to Grow Act, 2005, this Plan prevails where there is a conflict between this Plan and the PPS. The only exception is where the conflict is between policies relating to the natural environment or human health. In that case, the direction that provides more protection to the natural environment or human health prevails.

Relationship with Other Provincial Plans

This Plan must also be read in conjunction with other provincial plans as defined in the Planning Act that may apply within the same geography. Within the *GGH*, this includes the Greenbelt Plan, the Oak Ridges Moraine Conservation Plan and the Niagara Escarpment Plan, as well as the Parkway Belt West Plan and the Central Pickering Development Plan. Other plans, including the Lake Simcoe Protection Plan under the Lake Simcoe Protection Act, 2008 and some source protection plans under the Clean Water Act, 2006, also apply within the *GGH*. Each of these plans applies to certain defined parts of the *GGH* and provides specific policy on certain matters.

As provided in the Places to Grow Act, 2005, where there is a conflict between the Greenbelt, Oak Ridges Moraine Conservation or Niagara Escarpment Plans and this Plan regarding the natural environment or human health, the direction that provides more protection to the natural environment or human health prevails. Detailed conflict provisions are set out in the Places to Grow Act, 2005.

Horizon of this Plan

While the PPS, 2014 provides for a time horizon of up to 20 years for making sufficient land available to meet projected needs, policy 1.1.2 of the PPS, 2014 provides that a provincial plan may provide an alternate time horizon for specific areas of the province. Within the *GGH*, this Plan provides that the applicable time horizon for land use planning is 2041. While certain policies have specific target dates, the goals and policies of this Plan are intended to be achieved within the horizon of this Plan.

Nothing in this Plan limits the planning for *infrastructure* and *public service facilities* beyond the horizon of this Plan. However, planning for *infrastructure* will not predetermine the form, pattern or extent of *settlement area* boundary expansions. Planning authorities may also plan for the long-term protection of employment area*s* provided lands are not designated beyond the horizon of this Plan.

Read the Entire Plan

This Plan is to be read in its entirety and the relevant policies are to be applied to each situation. The language of each policy, including the policies in Section 5, will assist decision-makers in understanding how the policies are to be implemented.

While some policies refer to other policies for ease of use, these cross-references do not take away from the need to read the Plan as a whole. There is no implied priority in the order in which the policies appear.

Consider Specific Policy Language

Each policy provides direction on how it is to be implemented, how it is situated within this Plan, and how it relates to other policies. The choice of language in the policies is intended to distinguish between the types of policies and the nature of implementation.

Policies Represent Minimum Standards

The policies of this Plan represent minimum standards. Within the framework of the provincial policy-led planning system, decision-makers are encouraged to go beyond these minimum standards to address matters of importance, unless doing so would conflict with any policy of this Plan.

Defined Terms and Meanings

Italicized terms in this Plan are defined in Section 7. For non-italicized terms, the normal meaning of the word applies. Defined terms are intended to capture both singular and plural forms of these terms in the policies.

Guidance Material

Guidance material and technical criteria may be issued to assist decision-makers with implementing the policies of this Plan. Information, technical criteria and approaches outlined in guidance material are meant to support, but not add to or detract from, the policies of this Plan.

2 Where and How to Grow

2.1 Context

Explanatory Text

Proposed changes/additions to the context for Section 2, if approved, would include:

- References to the Ontario Climate Change Strategy, 2015, and long-term greenhouse gas emissions reduction targets to 2030 and 2050;
- Connecting how planning for "complete communities" helps Ontario move toward "net-zero communities" (a proposed new defined term); and
- Introduction of a proposed new defined term "strategic growth areas", which would replace the term "intensification areas".

The *GGH* is a dynamic and diverse area, and one of the fastest growing regions in North America. By 2041, this area is forecast to grow to 13.5 million people and 6.3 million jobs. The magnitude and pace of this growth necessitates a plan for building healthy and balanced communities and maintaining and improving our quality of life.

To better co-ordinate planning for growth across the region, this Plan provides population and employment forecasts for all upper- and single-tier municipalities in the *GGH*. These growth forecasts are a foundational component of this Plan. They are to be reviewed in consultation with municipalities at least every five years.

This Plan is about accommodating forecasted growth in *complete communities*, whether urban or rural, existing or new. These are communities that are well designed to meet people's needs for daily living throughout an entire lifetime by providing convenient access to an appropriate mix of jobs, local services and a full range of housing to accommodate a range of incomes and household sizes. *Complete communities* support quality of life and human health by encouraging the use of *active transportation* and providing high quality public open space, adequate parkland, opportunities for recreation, and access to local and healthy food. They also support climate change mitigation by providing public transportation and options for safe, non-motorized travel, and by minimizing land consumption through *compact built form*.

Building more compact and *complete communities*, and protecting agricultural lands, water resources and natural areas will help reduce greenhouse gas emissions and help Ontario move towards *net-zero communities*. Ontario's Climate Change Strategy, 2015 reaffirms the government's commitment to meet its long-term targets to reduce greenhouse gas emissions below 1990 levels by 37 per cent by 2030 and by 80 per cent by 2050.

To ensure the development of *complete communities* that are healthy and safe, choices about where and how growth occurs in the *GGH* need to be made carefully. Better use of land and *infrastructure* can be made by directing growth to *settlement areas* and prioritizing *intensification* in *built-up areas*, with a focus on *strategic growth areas*, including *urban growth centres* and *major transit station areas*, as well as *brownfield sites* and *greyfields*. Concentrating new development in these areas provides a focus for investments in transit as well as other types of *infrastructure* and *public service facilities* to support forecasted growth, while also supporting a more diverse range and mix of housing types. However, in order to protect public safety and prevent future flood risks, growth should be generally directed away from hazardous areas, including those that have been identified as special policy areas in accordance with the PPS.

The Growth Plan, 2006 identified 25 *urban growth centres* and this Plan continues to recognize those *urban growth centres* as regional focal points for accommodating population and employment growth. The continued revitalization of *urban growth centres* as meeting places, locations for cultural facilities, public institutions and major services and transit hubs with the potential to become more vibrant, mixed-use, *transit-supportive* communities is particularly important.

This Plan recognizes transit as a first priority for major transportation investments. It sets out a regional vision for transit, and seeks to align transit with growth by directing growth to *major transit station areas* and other *strategic growth areas*, including *urban growth centres*, and promoting transit investments in these areas. In order to optimize provincial investments in *higher order transit*, this Plan also identifies *priority transit corridors* and the Province expects municipalities to complete detailed planning for these corridors and associated *mobility hubs* to support planned service levels in a timely manner.

Although traditional industries will continue to play an important role, globalization and technology are transforming the *GGH*'s economy and increasing the significance of the service and knowledge-based sectors. Providing opportunities for a variety of types of businesses to locate and grow in the *GGH* is fundamental to using land wisely and ensuring a more prosperous economic future. Therefore, it is important to ensure an adequate supply of land within *employment areas* – both for traditional industries and for knowledge and service sector businesses that warrant such locations – and sites for a broad range of other employment uses.

Many communities in the *GGH* are facing issues of housing affordability, which are being driven by many factors beyond the land use planning system. As in many thriving metropolitan regions, housing demand in the *GGH* is driven by sustained population growth, low rental vacancy rates and other complex socio-economic factors. This Plan addresses this challenge by encouraging a mix of housing types, including *affordable* housing and, in particular, higher density housing types that can accommodate a range of household sizes in locations that can provide access to transit and other amenities.

Building more compact greenfield communities reduces the rate at which land is consumed. Communities need to grow at *transit-supportive* densities, with walkable street configurations. *Compact built form* and *intensification* efforts go hand-in-hand with more effective transit and *active transportation* networks and are fundamental to where and how we grow. They are necessary to ensure the viability of transit, connect people to homes, jobs and other aspects of daily living, and meet climate change mitigation and adaptation objectives. Moreover, an increased *modal share* for transit and *active transportation* ensures reduced air pollution and improved public health outcomes.

There is a large supply of land already designated for future urban development in the *GGH* and, in some communities, there may be more land designated for development than is required to accommodate forecasted growth to the horizon of this Plan. Regardless, it is important to optimize the use of the existing land supply as well as the existing building and housing stock to avoid further over-designating land for future urban development. This Plan's emphasis on optimizing the use of the existing land supply represents an *intensification* first approach to development and city building in the *GGH*, one which concentrates more on making better use of our existing *infrastructure* and *public service facilities*, and less on continuously expanding the urban area.

Strong, healthy and prosperous rural communities are also vital to the economic success of the *GGH* and contribute to our quality of life. This Plan recognizes and promotes the important role of rural towns and villages as a focus of economic, cultural and social activities that support surrounding rural and agricultural areas across the *GGH*. Healthy rural communities are key to the vitality and well-being of the whole area.

2.2 Policies for Where and How to Grow

Explanatory Text

In some cases, the changes that are proposed for Section 2 of the Growth Plan, if approved, involve reorganizing and revising existing policy directions (e.g., policies for managing growth). In other cases, new concepts are proposed to be added (e.g., methodology for land needs assessment).

Proposed changes/additions to this section of the Growth Plan would include:

- New policy, built on existing policy direction, that would provide more detail about how the application of the policies in this Plan would support the achievement of "complete communities";

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- Additional direction and criteria for developing an integrated approach to planning and managing growth, which would be implemented through a "municipal comprehensive review";
- New policy that requires the Minister to develop a standard methodology for assessing land needs and requiring the use of this methodology by municipalities;
- The minimum intensification target would be increased from 40 per cent to 60 per cent, and revisions would be made to the requirements and eligibility for an alternative target;
- New policies would establish specific minimum density targets for "major transit station areas", as delineated by municipalities, which would be scaled to reflect type of transit (e.g., subways, light rail);
- New policies would support prioritizing planning and zoning for "priority transit corridors", which would be identified in Schedule 5 (or by the province);
- New policies would require municipalities to identify and designate suitable lands near "major goods movement facilities and corridors" as "prime employment areas", which would be protected over the long-term for uses that are land extensive and/or have low employment densities and require such locations. Certain uses would be strictly prohibited in "prime employment areas" and these areas would not be eligible for conversion to non-employment uses;
- Municipalities would also be required to designate other "employment areas" where a wider range of employment uses would be permitted;
- New policy would direct that existing "office parks" should be planned to improve transit connectivity (including appropriate use of "transportation demand management" strategies), provide for an appropriate mix of amenities, and encourage intensification of employment uses;
- The minimum density target for "designated greenfield areas" would be increased from 50 to 80 residents and jobs per hectare, and revisions would be made to the requirements and eligibility for an alternative target. Additional features would be excluded when measuring this target, including floodplains, rights-of-way for certain types of linear "infrastructure" as well as "prime employment areas";
- Where the need for a "settlement area" boundary expansion is demonstrated (based on the proposed standard methodology for land needs assessment), there would be additional new criteria for assessing feasibility of an expansion and determining the most appropriate location, including:
  - The financial viability over the life cycle of the "infrastructure" and "public service facilities" that would be needed to service growth;

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  - Completion of master plans for water and wastewater, informed by "watershed planning", to protect water quality and quantity and to service growth and development in a manner that would not exceed the assimilative capacity of the receiving water body;
  - Completion of "stormwater master plans" informed by "watershed planning" to address flood risk vulnerability;
  - Direction to avoid where possible "natural heritage systems", "key hydrologic areas" and "prime agricultural areas" and to minimize impact on the "agricultural system"; and
  - Additional specific tests for "settlement areas" within the Protected Countryside in the "Greenbelt Area";
- New direction to municipalities in the "outer ring" to identify and manage any "excess lands" that will not be required for growth to 2041; these municipalities would be given some flexibility to potentially expand the boundaries of "settlement areas" that are the primary focus for growth, provided all requirements for managing "excess lands" are satisfied and the total amount of lands designated for development would be reduced; and
- New policies would recognize existing employment areas on "rural lands" and clarify the parameters for planning for resource-based recreational uses.

2.2.1 Managing Growth

1. Population and employment forecasts contained in Schedule 3 will be used for planning and managing growth in the *GGH* to the horizon of this Plan in accordance with the policies in subsection 5.2.4.
2. Population and employment growth will be accommodated by:
   a) directing a significant portion of forecasted growth to *built-up areas* through *intensification* and focusing growth in *strategic growth areas*;
   b) building *complete communities* with *compact built form* in *settlement areas*;
   c) ensuring the availability of sufficient land for employment to support the economic competitiveness of the *GGH*;
   d) directing growth to locations within *settlement areas* with existing and planned *public service facilities*;
   e) focusing growth in areas with existing or planned transit, with a priority on *higher order transit*;

f) planning and investing for a balance of jobs and housing in communities across the *GGH* to reduce the need for long distance commuting and to increase the *modal share* for transit and *active transportation*;

g) providing convenient, *multimodal* access to intra- and inter-municipal transit, giving priority to connections between residents and jobs;

h) directing development to *settlement areas*, except where permitted in accordance with policy 2.2.9.3;

i) directing the vast majority of growth to *settlement areas* that offer *municipal water and wastewater systems*, and limiting growth in *settlement areas* that are serviced by other forms of water and wastewater systems;

j) generally directing *development* away from *hazardous lands*; and

k) prohibiting the establishment of new *settlement areas*.

3. Applying the policies of this Plan will support the achievement of *complete communities* that:

   a) feature a diverse mix of land uses, including residential and employment uses, and convenient access to local stores, services and *public service facilities*;

   b) provide for a diverse range and mix of housing, including secondary suites and *affordable* housing, to accommodate people at all stages of life, and to accommodate the needs of all household sizes and incomes;

   c) integrate and sustain the viability of transit services, where such services are planned or available;

   d) support overall quality of life, including human health, for people of all ages and abilities through the planning for and provision of:

      i. a range of transportation options, including options for the safe, comfortable and convenient use of *active transportation*;

      ii. a *compact built form* that reduces dependence on the automobile;

      iii. *public service facilities,* co-located and integrated in community hubs, that are accessible by *active transportation* and transit;

      iv. convenient access to local, healthy and affordable food options, including through urban agriculture; and

      v. a supply of parks, trails and other recreation facilities needed to support planned population and employment growth in a timely manner, particularly as *built-up areas* are intensified;

   e) mitigate climate change impacts, build resilience, reduce greenhouse gas emissions and contribute towards the achievement of *net-zero communities*;

f) integrate *green infrastructure* and *low impact development*; and

g) have high quality built form and publicly-accessible open spaces that are safe and accessible with site design standards that create an attractive and vibrant *public realm*.

4. Upper- and single-tier municipalities will each develop an integrated approach to planning and managing growth to the horizon of this Plan, which will be implemented through a *municipal comprehensive review* and other supporting documents and will:

   a) be based on forecasted growth to the horizon of this Plan and the other policies in this Plan;

   b) consider the entire existing supply of land designated for development within the municipality;

   c) identify a hierarchy of *settlement areas*, or of areas within *settlement areas*, where forecasted growth to the horizon of this Plan will be accommodated based on:

      i. *strategic growth areas* as the primary focus for accommodating growth;

      ii. the amount of growth that can be accommodated in *built-up areas* and existing *designated greenfield areas* based on an assessment of land needs; and

      iii. integrated planning for *infrastructure* and *public service facilities* that considers the full life cycle costs of these assets and identifies options to pay for these costs over the long-term;

   d) identify areas where development is to be prohibited; and

   e) where applicable, provide direction to lower-tier municipalities on how to implement this approach.

5. The Minister will establish a methodology for assessing land needs to implement this Plan. This methodology will be used for the purposes of assessing land needs to accommodate forecasted growth to the horizon of this Plan.

6. Upper- and single-tier municipalities in the *outer ring* will, in consultation with lower-tier municipalities where applicable, identify any *excess lands* in official plans and prohibit development on all *excess lands* to the horizon of this Plan.

2.2.2 Built-up Areas

1. The *built boundary* will be delineated in official plans.
2. The minimum intensification target contained in the applicable upper- or single-tier official plan that is approved and in effect as of

[placeholder for effective date] will apply until the time of the next *municipal comprehensive review*.

3. All upper- and single-tier municipalities will, at the time of their next *municipal comprehensive review*, increase their minimum intensification target such that a minimum of 60 per cent of all residential development occurring annually within each upper- and single-tier municipality will be within the *built-up area*.
4. For an upper- or single-tier municipality located within the *outer ring* and that does not have an *urban growth centre*:
   a) council may request an alternative minimum intensification target at the time of each *municipal comprehensive review*; and
   b) the Minister may permit an alternative minimum intensification target that is appropriate given factors such as the size, location and capacity of *built-up areas*.
5. In planning for the *intensification* of *built-up areas*, municipalities will:
   a) identify the appropriate type and scale of development in *strategic growth areas* to support achievement of the minimum intensification target in this Plan;
   b) provide for an appropriate transition of built form to adjacent areas; and
   c) ensure the development of high quality urban form and public open spaces.

2.2.3 Urban Growth Centres

1. The boundaries of *urban growth centres* will be delineated in official plans.
2. *Urban growth centres* will be planned:
   a) as focal areas for investment in regional *public service facilities*, as well as commercial, recreational, cultural and entertainment uses;
   b) to accommodate and support the transit network at the regional scale and provide connection points for inter- and intra-regional transit;
   c) to serve as high-density major employment centres that will attract provincially, nationally or internationally significant employment uses; and
   d) to accommodate significant population and employment growth.
3. *Urban growth centres* will be planned to achieve, by 2031 or earlier, a minimum gross density target of:
   a) 400 residents and jobs combined per hectare for each of the *urban growth centres* in the City of Toronto;

b) 200 residents and jobs combined per hectare for each of the Downtown Brampton, Downtown Burlington, Downtown Hamilton, Downtown Milton, Markham Centre, Downtown Mississauga, Newmarket Centre, Midtown Oakville, Downtown Oshawa, Downtown Pickering, Richmond Hill Centre/Langstaff Gateway, Vaughan Metropolitan Centre, Downtown Kitchener and Uptown Waterloo *urban growth centres*; and

c) 150 residents and jobs combined per hectare for each of the Downtown Barrie, Downtown Brantford, Downtown Cambridge, Downtown Guelph, Downtown Peterborough and Downtown St. Catharines *urban growth centres*.

4. If an *urban growth centre* is already planned to achieve, or has already achieved, a gross density that exceeds the minimum density target in policy 2.2.3.3, this higher density will be considered the minimum density target for that *urban growth centre*.

2.2.4 Transit Corridors and Station Areas

1. *Priority transit corridors* will be delineated in official plans.
2. Planning will be prioritized for *mobility hubs* associated with *priority transit corridors*, including through updated zoning.
3. Upper- and single-tier municipalities, in consultation with lower-tier municipalities, will determine the size and shape of *major transit station areas* and delineate their boundaries in official plans.
4. *Major transit station areas* will be planned and designed to be *transit-supportive* and to achieve *multimodal* access to stations and connections to nearby *trip generators* by providing, where appropriate:
    a) connections to local and regional transit services to support *transit service integration*;
    b) *infrastructure* to support *active transportation*, including sidewalks, bicycle lanes and secure bicycle parking; and
    c) commuter pick-up/drop-off areas.
5. *Major transit station areas* will be planned to achieve, by 2041 or earlier, a minimum gross density target of:
    a) 200 residents and jobs combined per hectare for those that are served by subways;
    b) 160 residents and jobs combined per hectare for those that are served by light rail transit or bus rapid transit; or
    c) 150 residents and jobs combined per hectare for those that are served by express rail service on the GO Transit network.

6. The minimum density targets in policy 2.2.4.5 do not apply to lands that have been designated as *prime employment areas*.
7. Within *major transit station areas*, development will be supported by:
   a) planning in a timely manner, including through updated zoning, particularly along *priority transit corridors*;
   b) planning for a diverse mix of uses, including *affordable* housing, to support planned transit service levels;
   c) fostering collaboration between public and private sectors, such as *joint development* projects, as appropriate;
   d) providing alternative development standards, such as reduced parking standards; and
   e) prohibiting land uses and built form that would adversely affect the achievement of the minimum density targets in policy 2.2.4.5, and the other policies of this Plan.
8. In planning lands adjacent to, or in the vicinity of, *higher order transit* corridors and facilities, municipalities will identify and protect lands that may be needed for future enhancement or expansion of transit *infrastructure*, in consultation with Metrolinx, as appropriate.
9. Lands with easy access to *frequent transit* service, including *higher order transit*, should be identified as *strategic growth areas* and should be planned and developed to be *transit-supportive*, including through setting minimum density targets to reflect existing and planned transit service levels where no minimum density target is specified in this Plan.
10. The Province may identify additional *priority transit corridors* or *mobility hubs* and planning requirements for *priority transit corridors* or *mobility hubs*, to support the optimization of transit investments across the *GGH*, which may specify:
    a) the timeframes for implementation of the planning requirements;
    b) the boundaries of the planning area that will be subject to the planning requirements; and
    c) any additional requirements that may apply in relation to these areas.

2.2.5 Employment

1. Economic development and competitiveness in the *GGH* will be promoted by:
   a) making more efficient use of existing *employment areas* and vacant and underutilized employment lands and increasing employment densities, as appropriate;

b) planning to better connect areas with high employment densities to transit; and

c) integrating and aligning land use planning and economic development goals and strategies to retain and attract investment and employment.

2. Appropriate locations will be provided for a variety of employment uses to accommodate forecasted growth to the horizon of this Plan.

3. Suitable lands within *settlement areas* that are adjacent to, or in the vicinity of, *major goods movement facilities and corridors*, including major highway interchanges, should be identified as *prime employment areas*. Upper- and single-tier municipalities may also identify other existing *employment areas* within *settlement areas* as *prime employment areas*, where appropriate.

4. The Minister may identify other *prime employment areas*.

5. *Prime employment areas* identified in accordance with policies 2.2.5.3 and 2.2.5.4 will be designated in official plans and protected for appropriate employment uses over the long-term by:

   a) prohibiting residential and other *sensitive land uses*, institutional uses, and retail, commercial and office uses that are not ancillary to the primary employment use; and

   b) planning for *freight-supportive* land use patterns.

6. With the exception of *prime employment areas*, *employment areas* within *settlement areas* will be designated and planned to:

   a) direct any permitted commercial uses to locations that support *active transportation* and are serviced by transit, where that service is available;

   b) prohibit residential land uses and limit other *sensitive land uses* to preserve the long-term integrity of the *employment area* for uses that require those locations; and

   c) integrate *employment areas* with adjacent non-employment areas and develop vibrant, mixed-use areas and innovation hubs, where appropriate.

7. The conversion of lands within *prime employment areas* to *employment areas*, or lands within *employment areas* to non-employment uses may be permitted only through a *municipal comprehensive review* where it has been demonstrated that:

   a) there is a need for the conversion;

   b) the lands are not required over the horizon of this Plan for the employment purposes for which they are designated;

c) the municipality will maintain sufficient employment lands to accommodate forecasted employment growth to the horizon of this Plan;

d) the proposed uses would not adversely affect the overall viability of the *prime employment area* or the *employment area* or the achievement of the minimum intensification and density targets in this Plan, as well as the other policies of this Plan; and

e) there are existing or planned *infrastructure* and *public service facilities* to accommodate the proposed uses.

8. The conversion of lands within *prime employment areas* to non-employment uses is prohibited.

9. *Major office* and appropriate major institutional development will be directed to *urban growth centres*, *major transit station areas* or other *strategic growth areas* with existing or planned *frequent transit* service.

10. Existing *office parks* should be supported by:

a) improving connectivity with transit and *active transportation* networks;

b) providing for an appropriate mix of amenities and open space to serve the workforce;

c) planning for *intensification* of employment uses; and

d) approaches to *transportation demand management* that reduce reliance on single-occupancy vehicle use.

11. In planning for employment, surface parking will be minimized and the development of *active transportation* networks and *transit-supportive* built form will be facilitated.

12. In recognition of the importance of cross-border trade with the United States, this Plan recognizes a *Gateway Economic Zone* and *Gateway Economic Centre* near the Niagara-United States border. Planning and economic development in these areas will support economic diversity and promote increased opportunities for cross-border trade, movement of goods and tourism.

2.2.6 Housing

1. Upper- and single-tier municipalities, in consultation with lower-tier municipalities, the Province and other appropriate stakeholders, will each develop a housing strategy that:

a) aligns with applicable housing and homelessness plans required under the Housing Services Act, 2011;

b) identifies policies for official plans, including *affordable* housing targets, that address the needs of all residents, including through *affordable* ownership housing and rental housing; and

c) plans for a diverse range of housing types and densities, including secondary suites, to support the achievement of the minimum intensification and density targets in this Plan, as well as the other policies of this Plan.

2. Notwithstanding policy 1.4.1 of the PPS, 2014, to provide for a range and mix of housing types and densities municipalities will:

   a) plan to accommodate forecasted growth to the horizon of this Plan;

   b) plan to achieve the minimum intensification and density targets in this Plan;

   c) consider the range of housing types and densities of the existing housing stock; and

   d) plan to diversify their overall housing supply to achieve *complete communities*.

2.2.7 Designated Greenfield Areas

1. The *designated greenfield area* will be delineated in official plans.

2. The *designated greenfield area* of each upper- or single-tier municipality will be planned to achieve a minimum density target that is not less than 80 residents and jobs combined per hectare within the horizon of this Plan.

3. The minimum density target will be measured over the entire *designated greenfield area* of each upper- or single-tier municipality, excluding the following:

   a) *natural heritage features and areas, natural heritage systems* and *floodplains*, provided *development* is prohibited in these areas;

   b) rights-of-way for:

      i. electricity transmission lines;

      ii. *energy transmission pipelines*;

      iii. freeways, as defined by and mapped as part of the Ontario Road Network; and

      iv. railways; and

   c) *prime employment areas* that have been designated in official plans in accordance with policy 2.2.5.5.

4. For an upper- or single-tier municipality that is located in the *outer ring* and that does not have an *urban growth centre*:

a) council may request an alternative minimum density target for the *designated greenfield area* at the time of each *municipal comprehensive review*; and

b) the Minister may permit an alternative minimum density target that is appropriate given the characteristics of the municipality and adjacent communities.

5. Municipalities will develop and implement official plan policies for *designated greenfield areas*, including phasing policies, and other strategies to achieve the minimum intensification and density targets in this Plan.

6. New development taking place in *designated greenfield areas* will be planned, designated, zoned and designed in a manner that contributes to creating *complete communities* in accordance with policy 2.2.1.3.

2.2.8 Settlement Area Boundary Expansions

1. A *settlement area* boundary expansion may only occur as part of a *municipal comprehensive review* where it has been demonstrated that:

   a) based on the minimum intensification and density targets in this Plan and the land needs assessment provided for in policy 2.2.1.5, sufficient opportunities to accommodate forecasted growth to the horizon of this Plan are not available through *intensification* and in *designated greenfield areas*:

      i. within the upper- or single-tier municipality, and

      ii. within the applicable lower-tier municipality to accommodate the growth allocated to the municipality under this Plan;

   b) the expansion makes available sufficient lands not exceeding the horizon of this Plan, based on the analysis provided for in policy 2.2.8.1 a), while minimizing land consumption; and

   c) the timing of the expansion and the phasing of development within the *designated greenfield areas* will not adversely affect the achievement of the minimum intensification and density targets in this Plan, as well as the other policies of this Plan.

2. Where the need for a *settlement area* boundary expansion has been justified in accordance with policy 2.2.8.1, the *municipal comprehensive review* will determine the feasibility of a *settlement area* boundary expansion and identify the most appropriate location based on the following:

   a) there are existing or planned *infrastructure* and *public services facilities* to support proposed growth and the development of *complete communities*;

b) the *infrastructure* and *public service facilities* needed would be financially viable over the full life cycle of these assets, based on mechanisms such as asset management planning and revenue generation analyses;

c) the proposed expansion aligns with a water and wastewater master plan or equivalent that has been completed in accordance with the policies in subsection 3.2.6;

d) the proposed expansion aligns with a *stormwater master plan* or equivalent that has been completed in accordance with the policies in subsection 3.2.7;

e) a *subwatershed plan* or equivalent has demonstrated that the proposed expansion, including the associated servicing, would not negatively impact the *water resource system*, including the *quality and quantity of water*;

f) *key hydrologic areas* and *natural heritage systems* should be avoided where possible;

g) for *settlement areas* that receive their water from or discharge their sewage to inland lakes, rivers or groundwater, a completed environmental assessment for new or expanded services has identified how expanded water and wastewater treatment capacity would be addressed in a manner that is fiscally and environmentally sustainable;

h) *prime agricultural areas* should be avoided where possible. Where *prime agricultural areas* cannot be avoided, an *agricultural impact assessment* will be used in determining the location of the expansion based on minimizing and mitigating the impact on the *agricultural system* and evaluating alternative locations across the upper-or single-tier municipality in accordance with the following:

   i. the lands do not comprise *specialty crop areas*;

   ii. there are no reasonable alternatives that avoid *prime agricultural areas*; and

   iii. there are no reasonable alternatives on lower priority agricultural lands in *prime agricultural areas*;

i) the *settlement area* to be expanded is in compliance with the *minimum distance separation formulae*;

j) any impacts on agricultural operations and on the *agricultural support network* from expanding *settlement areas* would be avoided or, if avoidance is not possible, minimized and to the extent feasible mitigated as determined through an *agricultural impact assessment*;

k) the policies of Sections 2 (Wise Use and Management of Resources) and 3 (Protecting Public Health and Safety) of the PPS are applied;

l) the proposed expansion would meet any applicable requirements of the Greenbelt, Oak Ridges Moraine Conservation, Niagara Escarpment and Lake Simcoe Protection Plans and any applicable source protection plan; and

m) within the Protected Countryside in the *Greenbelt Area*:

   i. the *settlement area* to be expanded is identified in the Greenbelt Plan as a Town/Village;

   ii. the proposed expansion would be modest in size;

   iii. the proposed expansion would be serviced by *municipal water and wastewater systems*; and

   iv. expansion into the Natural Heritage System that has been identified in the Greenbelt Plan is prohibited.

3. Upper- and single-tier municipalities in the *outer ring* that have identified *excess lands* in their in effect official plan in accordance with policy 2.2.1.6, may undertake a *settlement area* boundary expansion only as part of a *municipal comprehensive review* where it has been demonstrated that:

   a) the *settlement area* to be expanded has been identified as the primary focus for growth in the hierarchy identified in accordance with policy 2.2.1.4 c) and the expansion will:

      i. be contiguous to the existing *settlement area* boundary; and

      ii. be entirely identified as *designated greenfield area*;

   b) the overall quantum of *excess lands* are reduced by redesignation to remove development permissions and the municipality will ensure that any applicable lower-tier official plans are amended accordingly;

   c) *development* is prohibited on all *excess lands* to the horizon of this Plan in accordance with policy 2.2.1.6, including any lands that will become *excess lands* as a result of the proposed expansion;

   d) where appropriate, the municipality has used additional tools to reduce the land that is available for *development*, such as those set out in policies 5.2.8.2 and 5.2.8.3; and

   e) all requirements of policies 2.2.8.1 and 2.2.8.2 have been satisfied. For the purposes of policy 2.2.8.1 a), *excess lands* will be considered to be not available.

2.2.9 Rural Areas

1. Municipalities are encouraged to plan for a variety of cultural and economic opportunities within rural *settlement areas* to serve the needs of rural residents and area businesses.
2. *Public service facilities* in rural *settlement areas* should be co-located and integrated in community hubs, and priority should be given to maintaining and adapting existing *public service facilities* in community hubs to meet the needs of the community, where feasible.
3. Development outside of *settlement areas* may be permitted on *rural lands* if necessary for the management or use of resources, resource-based recreational uses, or other rural land uses that are not appropriate in *settlement areas*, subject to the policies in Section 4.
4. Where permitted on *rural lands*, resource-based recreational uses should be limited to tourism-related and recreational uses that are compatible with the scale, character and capacity of the resource and the surrounding rural landscape, and may include:
   a) commercial uses to serve the needs of visitors; and
   b) where appropriate, resource-based recreational dwellings for seasonal accommodation.
5. Existing employment areas outside of *settlement areas* on *rural lands* with approved zoning or designation in an official plan for employment uses as of June 16, 2006 may continue to be permitted. Expansions to these existing employment areas may be permitted only if necessary to support the immediate needs of existing businesses and if compatible with the surrounding uses.
6. *New multiple lots or units for residential development* will be directed to *settlement areas*, but may be allowed on *rural lands* in site-specific locations with approved zoning or designation in an official plan that permitted this type of development as of June 16, 2006.

3 Infrastructure to Support Growth

3.1 Context

Explanatory Text

Proposed changes/additions to the context for Section 3, if approved, would include:

- New details on stormwater management to emphasize the connections between preparing for extreme weather events and adapting to a changing climate; and
- Updated references to Building Together, the Infrastructure for Jobs and Prosperity Act, 2015, the Ontario Great Lakes Strategy and the Great Lakes Protection Act, 2015.

Well planned and accessible *infrastructure* is essential to the viability of Ontario's communities and critical to economic competitiveness, quality of life and the delivery of public services. This Plan provides the framework to guide and prioritize *infrastructure* planning and investments in the *GGH* to support and accommodate forecasted growth to the horizon of this Plan and beyond.

The *infrastructure* framework in this Plan requires that municipalities undertake an integrated approach to land use planning, *infrastructure* investments and environmental protection to achieve the outcomes of the Plan. Co-ordination of these different dimensions of planning allows municipalities to identify the most cost-effective options for sustainably accommodating forecasted growth to the horizon of this Plan in support of *complete communities*. It is estimated that up to 30 per cent of *infrastructure* capital costs, and 15 per cent of operating costs, could be saved by moving from lower density development to more efficient and *compact built form*.[5]

This Plan is supported by Building Together, Ontario's long-term infrastructure plan, which was released in 2011, as well as the Municipal Infrastructure Strategy, which was launched in 2012 as part of the implementation of Building Together. The Municipal Infrastructure Strategy requires municipalities to demonstrate how projects fit within a comprehensive asset management plan and encourages municipalities to improve integration of planning for land use and *infrastructure*.

The Province will align its *infrastructure* investments with this Plan. Once in force, the Infrastructure for Jobs and Prosperity Act, 2015, will ensure the Province regularly prepares long-term infrastructure plans. Under the Act, the

5 "Building Together: Guide for Municipal Asset Management Plans", Ministry of Infrastructure, 2012

criteria for evaluating and prioritizing proposed *infrastructure* projects include considering whether an *infrastructure* asset is included in a provincial plan or official plan and whether it supports public policy goals.

Significant cost savings can be achieved by ensuring that existing *infrastructure* is optimized before new *infrastructure* is built. This principle is integrated into the policies of this Plan and applies to all forms of *infrastructure*.

The *transportation system* for the *GGH* must be planned and managed for the safe and efficient movement of goods and people, and to reduce greenhouse gas emissions and other environmental impacts.

Transit is the first priority for transportation planning and investment. The transit network will support and facilitate improved linkages between *strategic growth areas* and other areas planned for a mix of uses and *transit-supportive* densities. System users will benefit from improved linkages between and within municipalities as well as *transit service integration*.

A comprehensive and continuous *active transportation* network will offer a viable alternative to the private automobile for personal travel. Using a complete streets approach to roadway design will ensure that the needs and safety of all road users are considered when planning and building the street network.

To support goods movement, this Plan calls for a co-ordinated goods movement network that links *major goods movement facilities and corridors* to the provincial highway network and areas of significant commercial activity. This Plan also calls for the long-term protection *of planned corridors* and the co-location of *infrastructure* in these corridors where appropriate.

A clean and sustainable supply of water is essential to the long-term health and prosperity of the region. There is a need to co-ordinate investment in water, wastewater and stormwater *infrastructure* to service future growth in ways that are fiscally sustainable and linked to the determination of how these systems are paid for and administered. Water *infrastructure* planning will be informed by *watershed planning* to ensure that water quality and quantity is maintained.

The importance of the Great Lakes is reflected in a number of provincial initiatives, including the Great Lakes Protection Act, 2015 and Ontario's Great Lakes Strategy. This Plan supports these initiatives by providing direction on *watershed*-based, integrated water, wastewater and stormwater master planning and by restricting future extensions of water and wastewater servicing from the Great Lakes.

Climate change poses a serious challenge for maintaining existing *infrastructure* and planning for new *infrastructure*, however, these risks can be mitigated through vulnerability assessments. Similarly, comprehensive stormwater management planning, including considering the use of *low impact development*, can increase the resiliency of our communities.

Investment in *public service facilities* – such as hospitals, long-term care facilities and schools – should be planned to keep pace with changing needs and to promote *complete communities* and support *strategic growth areas* as appropriate.

3.2 Policies for Infrastructure to Support Growth

Explanatory Text

For the most part, it is proposed that the existing policy directions for Infrastructure to Support Growth would be retained and, in some cases, updated and clarified.

Proposed changes/additions to this section of the Growth Plan would include:

- More direction on integrated planning for "infrastructure" and requirements for financial, environmental and "infrastructure" planning analysis;
- New policy would specifically link "infrastructure" investments to facilitate higher-density development in "strategic growth areas";
- Goods movement policies would be updated to align with the PPS, 2014 and Ontario's Freight-Supportive Guidelines (2016). The concept of "freight-supportive" land use planning would also be integrated throughout the Growth Plan (e.g., planning for "prime employment areas");
- New subsection on "infrastructure" corridors would encourage the co-location of linear "infrastructure" and would ensure that "planned corridors" would be protected in accordance with the PPS, 2014;
- Planning for "infrastructure" corridors would be required to avoid, minimize or mitigate impacts on the "agricultural system", "key natural heritage features", "key hydrologic features" and "key hydrologic areas";
- New policy (adapted from existing policy in the Greenbelt Plan) would prevent the extension of water and wastewater services from areas that are currently serviced by an inland source to the Great Lakes, except for reasons of public health or safety. This would not apply to municipalities that have "urban growth centres", and in these cases extension from the Great Lakes would be permitted only if there is a demonstrated need for the extension of services and there is an approved environmental assessment for the project;

Continued on next page

- Existing criteria for the expansion of water and wastewater services would be supplemented by requiring a water and wastewater master plan, or equivalent, to demonstrate no negative impact on water quality and quantity, financial viability, and assimilative capacity;
- New policy would require municipalities to create "stormwater master plans" for serviced "settlement areas" informed by "watershed planning";
- New policy would require large-scale development to be supported by a "stormwater management plan" or equivalent informed by a "subwatershed plan" or equivalent;
- New requirements for "low impact development" and "green infrastructure" would be incorporated throughout the Growth Plan to help address climate change; and
- The defined term "community infrastructure" would be changed to "public service facilities" to align with the PPS, 2014 and more direction would be provided for locating "public service facilities", including community hubs, in locations that are accessible by "active transportation" and transit.

3.2.1 Integrated Planning

1. *Infrastructure* planning, land use planning, and *infrastructure* investment will be co-ordinated to implement this Plan.
2. Planning for new or expanded *infrastructure* will occur in an integrated manner, including evaluations of long-range scenario-based land use planning and financial planning, and will be supported by *infrastructure* master plans, asset management plans, community energy plans, *watershed planning*, environmental assessments and other relevant studies where appropriate, and should involve:
   a) leveraging *infrastructure* investment to direct growth and development in accordance with the policies and schedules in this Plan, including the achievement of the minimum intensification and density targets in this Plan;
   b) providing sufficient *infrastructure* capacity in *strategic growth areas*;
   c) identifying the full life cycle costs of *infrastructure* to service growth and developing options to pay for these costs over the long-term; and
   d) considering the impacts of a changing climate.
3. *Infrastructure* investment and other implementation tools and mechanisms will be used to facilitate *intensification* and higher density development in *strategic growth areas*. Priority will be given to *infrastructure* investments made by the Province that support the policies and schedules in this Plan.

4. As part of municipal asset management planning, municipalities will assess *infrastructure* vulnerability and identify priority actions and investments to increase *infrastructure* resilience and adapt to a changing climate.
5. The Province will work with public sector partners, including Metrolinx, to identify strategic *infrastructure* needs to support the implementation of this Plan through multi-year *infrastructure* planning for the *transportation system* and *public service facilities*.

3.2.2 Transportation – General

1. *Transportation system* planning, land use planning, and transportation investment will be co-ordinated to implement this Plan.
2. The *transportation system* within the *GGH* will be planned and managed to:
   a) provide connectivity among transportation modes for moving people and for moving goods;
   b) offer a balance of transportation choices that reduces reliance upon the automobile and promotes transit and *active transportation*;
   c) be sustainable and reduce greenhouse gas emissions by encouraging the most financially and environmentally appropriate mode for trip-making;
   d) offer *multimodal* access to jobs, housing, schools, cultural and recreational opportunities, and goods and services; and
   e) provide for the safety of system users.
3. In the design, refurbishment or reconstruction of the existing and planned street network, a complete streets approach will be adopted that ensures the needs and safety of all road users, including pedestrians, cyclists, transit-users and operators, and drivers of cars and trucks are considered and appropriately accommodated.
4. Municipalities will develop and implement *transportation demand management* policies in official plans or other planning documents or programs to:
   a) reduce trip distance and time;
   b) increase the *modal share* of alternatives to the automobile, which may include setting *modal share* targets;
   c) prioritize *active transportation,* transit and goods movement over single-occupant automobiles; and
   d) target significant *trip generators.*

3.2.3 Moving People

1. Public transit will be the first priority for transportation *infrastructure* planning and major transportation investments.
2. All decisions on transit planning and investment will be made according to the following criteria:
   a) prioritizing areas with existing or planned higher residential and employment densities to optimize return on investment and the efficiency and viability of existing and planned transit service levels;
   b) increasing the capacity of existing transit systems to support *strategic growth areas*;
   c) expanding transit service to areas that have achieved, or will be planned to achieve, *transit-supportive* densities and provide a mix of residential, office, institutional and commercial development, wherever possible;
   d) facilitating improved linkages between and within municipalities from nearby neighbourhoods to *urban growth centres*, *major transit station areas* and other *strategic growth areas*;
   e) aligning with, and supporting, the priorities identified in Schedule 5;
   f) increasing the *modal share* of transit; and
   g) contributing towards the provincial greenhouse gas emissions reduction targets.
3. Municipalities will work with transit operators, the Province, Metrolinx where applicable, and each other to support *transit service integration* within and across municipal boundaries.
4. Municipalities will ensure that *active transportation* networks are comprehensive and integrated into transportation planning to provide:
   a) safe, comfortable travel for pedestrians, bicyclists and other users of *active transportation*; and
   b) continuous linkages between *strategic growth areas*, adjacent neighbourhoods, key *trip generators*, and transit stations, including dedicated lane space for bicyclists on the major street network, where feasible, or other safe and convenient alternatives.

3.2.4 Moving Goods

1. Linking *major goods movement facilities and corridors,* international gateways and *prime employment areas* to facilitate efficient goods movement will be the first priority of highway investment.
2. The Province and municipalities will work with agencies and transportation service providers to:
   a) co-ordinate, optimize and ensure the long-term viability of *major goods movement facilities and corridors*;
   b) improve corridors for moving goods across the *GGH* in accordance with Schedule 6; and
   c) promote and better integrate *multimodal* goods movement and *freight-supportive* land use and *transportation system* planning.
3. Municipalities will provide for the establishment of priority routes for goods movement, where feasible, to facilitate the movement of goods into and out of *prime employment areas* and other areas of significant commercial activity and to provide alternate routes connecting to the provincial network.

3.2.5 Infrastructure Corridors

1. In planning for the development, optimization or expansion of existing and *planned corridors* and supporting facilities, the Province, other public agencies and upper- and single-tier municipalities will:
   a) encourage the co-location of linear *infrastructure* where appropriate;
   b) ensure that existing and *planned corridors* are protected to meet current and projected needs in accordance with the transportation and *infrastructure* corridor protection policies in the PPS;
   c) where applicable, demonstrate through an environmental assessment, informed by an *agricultural impact assessment* or equivalent, that any impacts to the *agricultural system* have been avoided or, if avoidance is not possible, minimized and to the extent feasible mitigated;
   d) where applicable, demonstrate through an environmental assessment, that any impacts to *key natural heritage features* in *natural heritage systems*, *key hydrologic features* and *key hydrologic areas* have been avoided or, if avoidance is not possible, minimized and to the extent feasible mitigated; and

e) for existing or *planned corridors* for transportation:

i. consider increased opportunities for moving people and goods by rail;

ii. consider separation of modes within corridors; and

iii. provide opportunities for inter-modal linkages.

2. The planning and design of *planned corridors* and the land use designations along these corridors will support the policies of this Plan, in particular that development is directed to *settlement areas* in accordance with policy 2.2.1.2 h).

3.2.6 Water and Wastewater Systems

1. Municipalities should generate sufficient revenue to recover the full cost of providing and maintaining *municipal water and wastewater systems*.

2. *Municipal water and wastewater systems* and *private communal water and wastewater systems* will be planned, designed, constructed or expanded in accordance with the following:

a) strategies for water conservation and other water demand management initiatives are being implemented in the existing service area;

b) the system will serve growth in a manner that supports achievement of the minimum intensification and density targets in this Plan;

c) a comprehensive water or wastewater master plan or equivalent, informed by *watershed planning* has been prepared to:

i. demonstrate that the system will not negatively impact the quantity and quality of ground and surface water;

ii. identify the preferred option for servicing growth and development, subject to the hierarchy of services provided in policies 1.6.6.2, 1.6.6.3, 1.6.6.4 and 1.6.6.5 of the PPS, 2014, which must not exceed the assimilative capacity of the effluent receiver and available water supply for servicing and ecological needs; and

iii. identify the full life cycle costs of the system and develop options to pay for these costs over the long-term;

d) in the case of *large subsurface sewage disposal systems*, the proponent has demonstrated attenuation capacity; and

e) plans have been considered in the context of applicable inter-provincial, national, bi-national, or state-provincial Great Lakes Basin agreements or provincial legislation or strategies.

3. For *settlement areas* that are serviced by rivers, inland lakes or groundwater, municipalities will not be permitted to extend water or wastewater services from a Great Lakes source unless:
   a) the extension is required for reasons of public health and safety, in which case, the capacity of the water or wastewater services provided in these circumstances will be limited to that required to service the affected *settlement area*, including capacity for planned development within the approved *settlement area* boundary;
   b) in the case of an upper- or single-tier municipality with an *urban growth centre* outside of the *Greenbelt Area*, the need for the extension has been demonstrated and the extension:
      i. will service only the growth allocated to the *settlement area* with the *urban growth centre*; and
      ii. has been approved under an environmental assessment; or
   c) the extension had all necessary approvals as of [placeholder for effective date] and is only to service growth within a *settlement area* boundary that was approved and in effect as of that date.
4. Municipalities that share an inland water source or receiving water body will co-ordinate their planning for potable water, stormwater, and wastewater systems based on *watershed planning* to ensure that the *quality and quantity of water* is protected, improved or restored.

3.2.7 Stormwater Management

1. Municipalities will develop *stormwater master plans* or equivalent for serviced *settlement areas* that:
   a) are informed by *watershed planning*;
   b) examine the cumulative environmental impacts of stormwater from existing and planned development, including an assessment of how extreme weather events will exacerbate these impacts;
   c) incorporate appropriate *low impact development* and *green infrastructure*;
   d) identify the need for stormwater retrofits, where appropriate;
   e) identify the full life cycle costs of the stormwater *infrastructure*, including maintenance costs, and develop options to pay for these costs over the long-term; and
   f) include an implementation and maintenance plan.

2. Proposals for large-scale *development* proceeding by way of secondary plans, plans of subdivision and vacant land plans of condominium, and proposals for resort *development*, will be supported by a *stormwater management plan* or equivalent, that:
   a) is informed by a *subwatershed plan* or equivalent;
   b) uses an integrated approach that includes *low impact development* and *green infrastructure*;
   c) establishes planning, design and construction practices to minimize vegetation removal, grading and soil compaction, sediment erosion and impervious surfaces; and
   d) aligns with the *stormwater master plan* for the *settlement area* in accordance with policy 3.2.7.1, where applicable.

3.2.8 Public Service Facilities

1. Planning for *public service facilities*, land use planning and investment in *public service facilities* will be co-ordinated to implement this Plan.
2. *Public service facilities* and public services should be co-located in community hubs and integrated to promote cost-effectiveness.
3. Priority should be given to maintaining and adapting existing *public service facilities* and spaces as community hubs to meet the needs of the community and optimize the long-term viability of public investments.
4. Existing *public service facilities* that are in the vicinity of *strategic growth areas* and are easily accessible by *active transportation* and transit, where that service is available, should be the preferred location for community hubs.
5. Municipalities will collaborate and consult with service planning, funding and delivery sectors to facilitate the co-ordination and planning of community hubs and other *public service facilities*.
6. In locating new *public service facilities*, including hospitals and schools, preference should be given to sites that are easily accessible by *active transportation* and transit, where that service is available.

4 Protecting What is Valuable

4.1 Context

Explanatory Text

Proposed changes/additions to the context for Section 4, if approved, would include:

- New components in this section refer to the identification and protection of "water resource systems", "natural heritage systems" and the "agricultural system" and their importance with regard to climate change;
- Recognition of the importance of "cultural heritage resources" and "mineral aggregate resources";
- Setting out context of natural areas as carbon sinks to sequester carbon and that the province will develop guidance materials to support municipalities in developing inventories and strategies to reduce greenhouse gas emissions in support of provincial emissions reduction targets and the move towards "net-zero communities".

The *GGH* contains a broad array of important hydrologic and natural heritage features and areas, a vibrant and diverse *agricultural system*, irreplaceable *cultural heritage resources*, and valuable renewable and non-renewable resources. These systems, features and resources are essential for the long-term quality of life, economic prosperity, environmental health and ecological integrity of the region. They collectively provide essential ecological goods and services, including water storage and filtration, cleaner air, biodiversity, habitats, crop pollination, carbon storage and resilience to climate change.

These valuable assets must be wisely protected and managed as part of planning for future growth. This is of particular importance in the fast-growing *GGH*, which supports some of the most diverse vegetation and wildlife in Canada, including the Niagara Escarpment (a UNESCO World Biosphere Reserve) and the Oak Ridges Moraine - two of Ontario's most significant landforms.

There are existing legislation and policies in place to identify and protect these features, areas and sites, including the Ontario Heritage Act, statements of provincial policy such as the PPS, and provincial plans such as the Greenbelt, Oak Ridges Moraine Conservation, Niagara Escarpment and Lake Simcoe Protection Plans. A balanced approach to the wise use and management of all resources, including those related to water, natural heritage, agriculture, cultural heritage and mineral aggregates, will be implemented in the *GGH*.

This Plan recognizes and supports the role of municipal policy in providing leadership and innovation in developing a culture of conservation and addressing climate change. As the *GGH* grows, so will the overall demand for water, energy, air and land. The ongoing availability of these natural resources is essential for the sustainability of all communities.

This Plan requires the identification of *water resource systems* and the protection of *key hydrologic features* and *key hydrologic areas*, similar to the level of protection provided in the Greenbelt. This provides a consistent framework for water protection across the *GGH*, and builds on existing plans and policies, including the Lake Simcoe Protection Plan and source protection plans developed under the Clean Water Act, 2006. Recognizing that *watersheds* are the most important scale for protecting the *quality and quantity of water*, municipalities are required to undertake *watershed planning* to inform the protection of *water resource systems* and decisions related to planning for growth.

This Plan also provides for the identification and protection of *natural heritage systems* in the *GGH* outside of the *Greenbelt Area* and *settlement areas*. This Plan applies protections for n*atural heritage systems* similar to those in the Greenbelt Plan in order to provide consistent and long-term protection for *natural heritage systems* in the *GGH*.

The *GGH* is home to some of Canada's most important and productive farmland, which is a finite, non-renewable resource. The region's fertile soil, favourable climate and access to water make it significant on both a national and international scale. The *agricultural system* includes a continuous land base, comprised of *prime agricultural areas*, including *specialty crop areas,* and *rural lands*, as well as a complementary *agricultural support network* that helps support long-term agricultural production and the economic viability of the agri-food sector. Many of the farms within the *agricultural system* also contain important natural heritage and hydrologic features, and farmers play a vital role in their stewardship. Protecting the *agricultural system* will support the viability of the agricultural sector as the region grows.

The *GGH* also contains important *cultural heritage resources* that contribute to a sense of identity, support a vibrant tourism industry and attract investment based on cultural amenities. Accommodating growth can put pressure on these resources through *site alteration* and *development*. It is necessary to plan in a way that protects and maximizes the benefits of these resources that make our communities unique and attractive places to live.

Building compact communities and the *infrastructure* needed to support growth requires significant *mineral aggregate resources*. The Aggregate Resources Act establishes the overall process for the management of *mineral aggregate operations*, and this Plan works within this framework to provide guidance on where and how aggregate resource extraction can occur, while balancing other planning priorities. The *GGH* contains significant deposits of *mineral aggregate resources*, which require long-term management, including aggregate reuse and recycling. Ensuring *mineral aggregate resources* are available in proximity to demand can support the timely provision of *infrastructure* and reduce transportation-related greenhouse gas emissions.

The *water resource systems*, *natural heritage systems* and *agricultural system* in the *GGH* also play an important role in addressing climate change. Greenhouse gas emissions will be offset by natural areas that act as carbon sinks. Municipalities play a crucial role in managing Ontario's greenhouse gas emissions and supporting adaptation to the changing climate. The Province will work with municipalities to develop approaches to inventory and reduce greenhouse gas emissions in support of provincial targets as we move towards *net-zero communities*.

4.2 Policies for Protecting What is Valuable

Explanatory Text

Significant changes to Section 4 are proposed to provide policies for the identification and protection of "natural heritage systems", "water resource systems" and an "agricultural system" that are generally aligned with the protections in the Greenbelt Plan.

Proposed changes/additions to this Section of the Growth Plan would include:

- New policy would require municipalities to identify and protect a "water resource system", including both "key hydrologic features" and "key hydrologic areas"; municipalities would undertake "watershed planning" as a basis for identifying and protecting the "water resource system";
- New policy would require municipalities to incorporate a "natural heritage system" as mapped by the province in their official plans including "key natural heritage features" and their connectivity and diversity, and to apply appropriate policies;
- New policies to incorporate Greenbelt-level protections for "natural heritage systems", "key natural heritage features", "key hydrologic features" and "key hydrologic areas" outside "settlement areas", while allowing some flexibility in order to accommodate growth;
- New policies for "mineral aggregate operations" within the "natural heritage system" would be similar to those for the Protected Countryside in the current Greenbelt Plan;
- Within "settlement areas", the PPS, 2014 would apply for the protection of the "natural heritage system" and the "water resource system", with the added requirement that the diversity and connectivity of the "natural heritage system" would continue to be protected;

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- New policy would require the province to identify an "agricultural system" for the GGH, which would be comprised of "prime agricultural areas", "specialty crop areas", "rural lands" and an "agricultural support network";
- Municipalities would be required to minimize impacts on the "agricultural system" and implement strategies to sustain and enhance the "agricultural system" and the long-term economic prosperity and viability of the agri-food sector; and
- New policies would require municipalities to develop official plan policies to address climate change and encourage them to prepare climate change strategies and greenhouse gas inventories.

4.2.1 Water Resource Systems

1. Municipalities, partnering with conservation authorities as appropriate, will ensure that *watershed planning* is undertaken to provide for a comprehensive, integrated and long-term approach for the protection, improvement or restoration of the *quality and quantity of water* within a *watershed*.
2. Building on *watershed planning*, *water resource systems* will be identified, and the appropriate designations and policies will be applied in official plans to provide for the long-term protection of *key hydrologic features*, *key hydrologic areas* and their functions.
3. Decisions on allocation of growth and planning for water, wastewater and stormwater *infrastructure* will be informed by *watershed planning*. Decisions on *settlement area* boundary expansions and secondary plans for *designated greenfield areas* will be informed by a *subwatershed plan* or equivalent.
4. Municipalities will consider the Great Lakes Strategy, the targets and goals of the Great Lakes Protection Act, 2015, and any applicable Great Lakes agreements as part of *watershed planning* and coastal or waterfront planning initiatives.

4.2.2 Natural Heritage Systems

1. A comprehensive, integrated and long-term approach will be implemented to maintain, restore or enhance the diversity and connectivity of natural heritage features and areas in a given area, and their long-term ecological functions.

2. Official plans will incorporate a *natural heritage system* as mapped by the Province, and will apply appropriate designations and policies to maintain, restore or improve the diversity and connectivity of the system and the long-term ecological or *hydrologic functions* of the features and areas as set out in the policies in this subsection and the policies in subsections 4.2.3 and 4.2.4.
3. In implementing policy 4.2.2.2, a municipality may refine the boundaries of the *natural heritage system* in a manner that is consistent with this Plan as well as the upper-tier official plan, where applicable.
4. Within the *natural heritage system* identified in accordance with policy 4.2.2.2:
   a) the full range of existing and new *agricultural uses*, *agriculture-related uses*, *on-farm diversified uses* and normal farm practices are permitted, subject to policy 4.2.2.4 c);
   b) a proposal for *development* or *site alteration* will demonstrate that:
      i. there will be no negative impacts on *key hydrologic features* or *key natural heritage features* and their functions;
      ii. connectivity for the movement of plants and animals along the *natural heritage system*, and between *key natural heritage features* and *key hydrologic features* located within 240 metres of each other will be maintained and, where possible, enhanced;
      iii. the removal of other natural features not identified as *key natural heritage features* should be avoided, and the features should be incorporated into the planning and design of proposed uses where possible;
      iv. the disturbed area of the site, including buildings and structures, will not exceed 25 per cent (40 per cent for golf courses) of the *total developable area*;
      v. the impervious surface will not exceed 10 per cent of the *total developable area*;
      vi. uses will be planned to optimize the compatibility of the project with the natural surroundings; and
      vii. at least 30 per cent of the *total developable area* of the site will remain or be returned to natural self-sustaining vegetation, except where specified in accordance with the policies in subsection 4.2.8;
   c) new buildings or structures for *agricultural uses*, *agriculture-related uses* and *on-farm diversified uses* are not subject to policy 4.2.2.4 b) but are subject to the policies for *key natural heritage features*, *key hydrologic features* and adjacent lands as set out in the policies in subsections 4.2.3 and 4.2.4;

d) notwithstanding policy 4.2.2.4 b), an official plan may, based on an environmental impact study, establish alternative standards for *development* within the *natural heritage system* outside of the *key natural heritage features*, *key hydrologic features* and associated *vegetation protection zones*, provided that any alternative standards will maintain, restore or enhance the diversity and connectivity of the system and the long-term ecological or *hydrologic functions* of the features.

5. Policies 4.2.2.1, 4.2.2.2, 4.2.2.3 and 4.2.2.4 do not apply to a *natural heritage system* that is within a *settlement area* boundary as it exists as of [placeholder for effective date], but policy 2.1 of the PPS, 2014 will continue to apply.

6. Where a *natural heritage system* identified in accordance with policy 4.2.2.2 has been brought into a *settlement area* under the policies in subsection 2.2.8, policy 4.2.2.4 does not apply, but municipalities will establish policies and designations to ensure that the connectivity, diversity and functions of the natural heritage features and areas will be maintained, restored or enhanced.

4.2.3 Key Hydrologic Features, Key Hydrologic Areas and Key Natural Heritage Features

1. *Development* or *site alteration* is not permitted in *key hydrologic features* or *key natural heritage features*, with the exception of:
   a) forest, fish and wildlife management;
   b) conservation and flood or erosion control projects, but only if the projects have been demonstrated to be necessary, and after all alternatives have been considered;
   c) activities that create or maintain *infrastructure* authorized under an environmental assessment process;
   d) *mineral aggregate operations* and wayside pits and quarries;
   e) existing uses as of [placeholder for effective date], subject to the following criteria:
      i. expansions to existing buildings and structures, accessory structures and uses, and conversions of legally existing uses which bring the use more into conformity with this Plan are permitted subject to a demonstration that the use does not expand into the *key hydrologic feature* or *key natural heritage feature* or its associated *vegetation protection zone,* unless there is no other alternative in which case any expansion shall be limited

in scope and kept within close geographical proximity to the existing structure; and

ii. expansions to existing buildings and structures for *agricultural uses*, *agriculture-related uses*, *on-farm diversified uses* and residential dwellings may be considered within *key hydrologic features* or *key natural heritage features* and their associated *vegetation protection zones* if it is demonstrated that there is no alternative, and the expansion in the feature is minimized and mitigated and, in the *vegetation protection zone*, is directed away from the feature to the maximum extent possible; and

f) small scale structures for recreational uses, including boardwalks, footbridges, fences, docks and picnic facilities, if measures are taken to minimize negative impacts.

2. Within a *key hydrologic area*, large-scale *development* proceeding by way of secondary plans, plans of subdivision and vacant land plans of condominium, and resort *development* may be permitted where it is demonstrated that *hydrologic functions* will be protected and that the *development* will maintain, improve, or restore the *quality and quantity of water*, such that:

   a) in relation to *significant groundwater recharge areas*, pre-development infiltration on the site will be maintained, improved, or restored;

   b) in relation to *highly vulnerable aquifers*, the quality of water infiltrating the site will be maintained; and

   c) in relation to *significant surface water contribution areas*, the *quality and quantity of water*, including baseflow, will be protected.

3. Policies 4.2.3.1 and 4.2.3.2 do not apply within *settlement area* boundaries but policies 2.1 and 2.2 of the PPS, 2014 will continue to apply.

4. Policy 4.2.3.1 does not apply to *key natural heritage features* that are not in the *natural heritage system* identified in accordance with policy 4.2.2.2, but policy 2.1 of the PPS, 2014 will continue to apply.

4.2.4 Lands Adjacent to Key Hydrologic Features and Key Natural Heritage Features

1. A proposal for *development* or *site alteration* within 120 metres of a *key natural heritage feature* or *key hydrologic feature* will require a natural heritage evaluation or hydrologic evaluation that identifies a *vegetation protection zone*. The *vegetation protection zone* for *key hydrologic features*, *fish habitat*, and *significant woodlands* will be no less than 30 metres wide.

The *vegetation protection zone* will be established to achieve and be maintained as natural, self-sustaining vegetation.

2. Evaluations undertaken in accordance with policy 4.2.4.1 will identify any additional restrictions to be applied before, during and after *development* to protect the *hydrologic functions* and ecological functions of the feature.
3. No *development* other than uses described in policy 4.2.3.1 will be permitted in the *vegetation protection zone*.
4. Notwithstanding policies 4.2.4.1, 4.2.4.2 and 4.2.4.3:
   a) a natural heritage evaluation will not be required for a proposal for *development* or *site alteration* on a site where the only *key natural heritage feature* is the *habitat of endangered species and threatened species*;
   b) new buildings and structures for *agricultural uses* will be required to provide a 30 metre *vegetation protection zone* from a *key hydrologic feature* or *key natural heritage feature*, but are exempt from the requirement of establishing a condition of natural self-sustaining vegetation if the land is, and will continue to be, used for agricultural purposes. Despite this exemption, *agricultural uses* should pursue best management practices to protect or restore *key hydrologic features* or *key natural heritage feature* and their functions;
   c) a natural heritage evaluation or hydrologic evaluation is not required for new buildings and structures for *agricultural uses*, *agriculture-related uses* and *on-farm diversified uses* located within 120 metres of a *key hydrologic feature* or *key natural heritage feature*, provided that these features and their functions will be protected from the impacts of the proposal by meeting the following conditions:
      i. a 30 metre *vegetation protection zone* is maintained in accordance with policy 4.2.4.4 b) of this Plan, and the *key hydrologic feature* or *key natural heritage feature* is maintained;
      ii. connectivity between the *key hydrologic features* and *key natural heritage features* can be maintained and where feasible, improved;
      iii. the new building or structure is located away from the *key hydrologic feature* or *key natural heritage feature* to the maximum extent possible, and where possible clustered with existing buildings or structures;
      iv. best management practices are pursued to protect or restore *key hydrologic features* or *key natural heritage features* and functions;
      v. measures are put in place, especially for stormwater management and erosion control, so that potential impacts of the building or structure on the *key hydrologic feature* or *key natural heritage feature* and functions will be mitigated, before, during and after construction; and

vi. the municipality has considered the following in relation to determining any potential impacts of the proposal:

a) the nature and purpose of the building or structure;

b) the size and scale of the building or structure, including where appropriate, the cumulative impact of existing development;

c) the site characteristics such as topography; and

d) the sensitivity of the adjacent *key hydrologic feature* or *key natural heritage feature*.

5. Outside of *settlement areas* and subject to municipal and agency planning requirements, minor rounding out, infill *development*, redevelopment and resort *development* in developed shoreline areas designated or zoned for concentrations of *development* as of [placeholder for effective date], is permitted if the *development* will:

a) be in accordance with the policies of subsections 4.2.1, 4.2.2, 4.2.3 and 4.2.4 of this Plan;

b) be integrated with existing or proposed parks and trails, and will not constrain ongoing or planned stewardship and remediation efforts;

c) restore, to the maximum extent possible, the ecological features and functions in developed shoreline areas; and

d) in the case of redevelopment and resort *development*:

i. establish, or increase the extent and width of, a *vegetation protection zone* along the shoreline to a minimum of 30 metres, except for structures, which may be permitted in the *vegetation protection zone* if the area occupied by such structures is minimized;

ii. increase the extent of *fish habitat* in the littoral zone;

iii. be planned, designed and constructed to protect *hydrologic functions*, minimize erosion, and avoid or mitigate sedimentation and the introduction of nutrient or other pollutants into the lake;

iv. exclude shoreline structures that will impede the natural flow of water or exacerbate algae concerns along the shoreline;

v. enhance the ability of native plants and animals to use the shoreline as both *wildlife habitat* and a movement corridor;

vi. use lot-level stormwater controls to reduce stormwater runoff volumes and pollutant loadings;

vii. use natural shoreline treatments, where practical, for shoreline stabilization, erosion control or protection;

viii. be informed by *watershed planning*;

ix. be serviced by *sewage works* which reduce nutrient inputs to groundwater and the lake from baseline levels; and

x. demonstrate available capacity in the receiving water body based on inputs from existing and approved development.

6. Policies 4.2.4.1, 4.2.4.2, 4.2.4.3, 4.2.4.4 and 4.2.4.5 do not apply, but policies 2.1 and 2.2 of the PPS, 2014 will continue to apply, to:
   a) *key hydrologic features* that are within a *settlement area* boundary;
   b) *key natural heritage features* that are within a *settlement area* boundary;
   c) *key natural heritage features* that are outside a *settlement area* boundary but are not in the *natural heritage system* identified in accordance with policy 4.2.2.2.

4.2.5 Public Open Space

1. Municipalities, conservation authorities, non-governmental organizations, and other interested parties are encouraged to develop a system of publicly accessible parkland, open space and trails, including in shoreline areas, within the *GGH* that:
   a) clearly demarcates where public access is and is not permitted;
   b) is based on a co-ordinated approach to trail planning and development; and
   c) is based on good land stewardship practices for public and private lands.
2. Municipalities are encouraged to establish an open space system within *settlement areas*, which may include opportunities for urban agriculture, rooftop gardens, communal courtyards, and public parks.

4.2.6 Agricultural System

1. The Province will identify the *agricultural system* for the *GGH*.
2. *Prime agricultural areas*, including *specialty crop areas*, will be designated in accordance with mapping identified by the Province and these areas will be protected for long-term use for agriculture.
3. Where *agricultural uses* and non-agricultural uses interface, land use compatibility will be promoted to avoid or minimize and, to the extent feasible, mitigate impacts on the *agricultural system*. This may include official plan policies to address the impacts of *development* in proximity to *agricultural uses*.

4. The geographic continuity of the agricultural land base and the functional and economic connections to the *agricultural support network* will be maintained and enhanced.
5. The retention of existing lots of record for *agricultural uses* is encouraged, and the use of these lots for non-agricultural uses is discouraged.
6. Municipalities are encouraged to implement strategies and other approaches to sustain and enhance the *agricultural system* and the long-term economic prosperity and viability of the agri-food sector, including the maintenance and improvement of the *agricultural support network* by:
   a) providing opportunities to support local food, urban and near-urban agriculture, and promoting the sustainability of agricultural, agri-food and agri-product businesses through protecting agricultural resources and minimizing land use conflicts;
   b) considering the *agricultural support network* in planning decisions to protect or enhance critical agricultural assets. Where negative impacts on the *agricultural system* are unavoidable, they will be assessed and mitigated to the extent feasible;
   c) undertaking long-term planning for agriculture, integrating agricultural economic development, *infrastructure*, goods movement and freight considerations with land use planning;
   d) preparing regional agri-food strategies or establishing or consulting with agricultural advisory committees or liaison officers; and
   e) maintaining, improving and providing opportunities for agriculture-supportive *infrastructure* both on and off farms.

4.2.7 Cultural Heritage Resources

1. *Cultural heritage resources* will be conserved in accordance with the policies in the PPS, to foster a sense of place and benefit communities, particularly in *strategic growth areas*.
2. Municipalities will work with stakeholders, as well as First Nations and Métis communities, to develop and implement official plan policies and strategies for the identification, wise use and management of *cultural heritage resources*.
3. Municipalities are encouraged to prepare and consider archaeological management plans and municipal cultural plans in their decision-making.

4.2.8 Mineral Aggregate Resources

1. The Province will work with municipalities, producers of *mineral aggregate resources*, and other stakeholders to identify significant deposits of *mineral aggregate resources* in the *GGH*, and to develop a long-term approach to ensuring the wise use, conservation, availability and management of these resources, including the identification of opportunities for resource recovery and for co-ordinated approaches to rehabilitation where feasible.
2. Municipalities will develop and implement official plan policies and other strategies to conserve *mineral aggregate resources*, including:
   a) the recovery and recycling of manufactured materials derived from *mineral aggregate resources* for reuse in construction, manufacturing, industrial or maintenance projects as a substitute for new *mineral aggregate resources*; and
   b) the wise use of *mineral aggregate resources*, including utilization or extraction of on-site *mineral aggregate resources* prior to development occurring.
3. Notwithstanding the policies of subsections 4.2.2, 4.2.3 and 4.2.4, within the *natural heritage system* identified in accordance with policy 4.2.2.2, *mineral aggregate operations* and wayside pits and quarries are subject to the following:
   a) no new *mineral aggregate operation* and no wayside pit and quarry, or any ancillary or accessory use thereto will be permitted in the following *key natural heritage features* and *key hydrologic features*:
      i. *significant wetlands*;
      ii. *habitat of endangered species and threatened species*; and
      iii. *significant woodlands* unless the *woodland* is occupied by young plantation or early successional habitat, as defined by the Province, in which case, the application must demonstrate that policies 4.2.8.5 b) and c) and 4.2.8.6 c) have been addressed and that they will be met by the operation;
   b) an application for a new *mineral aggregate operation* or new wayside pit and quarry may only be permitted in *key natural heritage features* and *key hydrologic features* not identified in 4.2.8.3 a) and any *vegetation protection zone* associated with such features where the application demonstrates:
      i. how the *water resource system* will be protected or enhanced; and
      ii. that policies 4.2.8.5 b) and c) and 4.2.8.6 c) have been addressed, and that they will be met by the operation; and

c) any application for a new *mineral aggregate operation* will be required to demonstrate:

   i. how the connectivity between *key hydrologic features* and *key natural heritage features* will be maintained before, during and after the extraction of *mineral aggregate resources*;

   ii. how the operator could immediately replace any habitat that would be lost from the site with equivalent habitat on another part of the site or on adjacent lands; and

   iii. how the *water resource system* will be protected or enhanced; and

d) an application to expand an existing *mineral aggregate operation* may be approved in the *natural heritage system* identified in accordance with policy 4.2.2.2, including *key hydrologic features* and *key natural heritage features*, and in any associated *vegetation protection zone* only if the related decision is consistent with the PPS, 2014 and satisfies the rehabilitation requirements of this section.

4. In *prime agricultural areas*, applications for new *mineral aggregate operations* will be supported by an *agricultural impact assessment* and, where possible, will seek to maintain or improve connectivity of the *agricultural system*.

5. When operators are undertaking rehabilitation of *mineral aggregate operation* sites, the following apply:

   a) the disturbed area of a site will be rehabilitated to a state of equal or greater ecological value and, for the entire site, long-term ecological integrity will be maintained or restored and, to the extent possible, improved;

   b) if there are *key hydrologic features* or *key natural heritage features* on the site, or if such features existed on the site at the time of the application:

      i. the health, diversity and size of these *key hydrologic features* and *key natural heritage features* will be maintained, restored or, where possible, enhanced; and

      ii. any permitted extraction of *mineral aggregate resources* that occurs in a feature will be completed, and the area will be rehabilitated, as early as possible in the life of the operation.

   c) aquatic areas remaining after extraction are to be rehabilitated to aquatic enhancement, which shall be representative of the natural ecosystem in that particular setting or ecodistrict, and the combined terrestrial and aquatic rehabilitation shall meet the intent of policy 4.2.8.5 b); and

d) outside the *natural heritage system* identified in accordance with policy 4.2.2.2, and except as provided in policies 4.2.8.5 a), b) and c), final rehabilitation will appropriately reflect the long-term land use of the general area, taking into account applicable policies of this Plan and, to the extent permitted under this Plan, existing municipal and provincial policies. In *prime agricultural areas*, on prime agricultural lands, the site will be rehabilitated back to an agricultural condition, in accordance with policy 2.5.4 of the PPS, 2014.

6. Final rehabilitation for new *mineral aggregate operations* in the *natural heritage system* identified in accordance with policy 4.2.2.2 will meet these additional criteria:

   a) where there is no underwater extraction, an amount of land equal to that under natural vegetated cover prior to extraction, and no less than 35 per cent of the land subject to each license in the *natural heritage system*, is to be rehabilitated to forest cover, which shall be representative of the natural ecosystem in that particular setting or ecodistrict;

   b) where there is underwater extraction, no less than 35 per cent of the non-aquatic portion of the land subject to each license in the *natural heritage system* is to be rehabilitated to forest cover, which shall be representative of the natural ecosystem in that particular setting or ecodistrict; and

   c) rehabilitation will be implemented so that the connectivity of the *key hydrologic features* and the *key natural heritage features* on the site and on adjacent lands will be maintained or restored and, to the extent possible, improved.

4.2.9 A Culture of Conservation

1. Municipalities will develop and implement official plan policies and other strategies in support of the following conservation objectives:

   a) water conservation, including through:

      i. water demand management for the efficient use of water; and

      ii. water recycling to maximize the reuse and recycling of water;

   b) energy conservation for existing buildings and planned developments, including municipally owned facilities, including through:

i. identification of opportunities for conservation, energy efficiency and demand management, as well as district energy, *renewable energy systems* and *alternative energy systems* generation and distribution through community, municipal and regional energy planning processes, and in the development of conservation and demand management plans;

ii. land use patterns and urban design standards that support energy-efficiency and demand reductions, and opportunities for *alternative energy systems*, including district energy systems; and

iii. other conservation, energy efficiency and demand management techniques to use energy wisely as well as reduce consumption;

c) air quality improvement and protection, including through reduction in emissions from municipal, commercial, industrial and residential sources; and

d) integrated waste management, including through:

i. enhanced waste reduction, composting and recycling initiatives, and the identification of new opportunities for energy from waste, source reduction, reuse and diversion, where appropriate;

ii. a comprehensive plan with integrated approaches to waste management, including reduction, reuse, recycling, composting, diversion and the disposal of residual waste;

iii. promotion of building conservation and adaptive reuse, reuse and recycling of construction materials; and

iv. consideration of waste management initiatives within the context of long-term regional planning, and in collaboration with neighbouring municipalities.

2. Municipalities are encouraged to develop soil reuse strategies as part of planning for growth and to integrate sustainable soil management practices into planning approvals.

3. Municipalities and industry will use best practices for the management of excess soil and fill generated during any *development* or *site alteration*, including *infrastructure* development, so as to ensure that:

a) any excess soil or fill is reused on-site or locally to the maximum extent possible; and

b) fill received at a site will not cause an adverse effect with regard to the current or proposed use of the property or the natural environment.

4.2.10 Climate Change

1. Upper- and single-tier municipalities will develop policies in their official plans to identify actions that will reduce greenhouse gas emissions and address climate change adaptation goals, aligned with the Ontario Climate Change Strategy, 2015 and Action Plan.
2. In planning to reduce greenhouse gas emissions and address the impacts of climate change, municipalities are encouraged to:
   a) develop strategies to reduce greenhouse gas emissions and to improve resilience to climate change through land use planning, planning for *infrastructure*, including transit and energy, and the conservation objectives in policy 4.2.9.1;
   b) develop greenhouse gas inventories for transportation, buildings, waste management and municipal operations; and
   c) establish municipal interim and long-term greenhouse gas emission reduction targets that support provincial targets and reflect consideration of the goal of *net-zero communities*, and monitor and report on progress made towards the achievement of these targets.

5 Implementation and Interpretation

5.1 Context

Explanatory Text

Proposed changes/additions to the context for Section 5, if approved, would include:

- Overview of mechanisms that would help to implement the Growth Plan, 2016, if approved;
- Expectations for the role of upper- and single-tier municipalities in implementing the Growth Plan through "municipal comprehensive review", the definition of which would be updated to clarify that it must be implemented under section 26 of the Planning Act and is to be undertaken by the upper- or single-tier municipality; and
- Clarification that the province would ensure ongoing consultation with its partners in the implementation of the Growth Plan, 2016, if approved, including First Nations and Métis communities.

Key to the success of this Plan is its effective implementation. Successful implementation will require that all levels of government, First Nations and Métis communities, non-governmental organizations, the private sector, and citizens work together in a co-ordinated and collaborative way to implement the policies of this Plan and to realize its goals.

The timely implementation of this Plan relies on the strong leadership of upper- and single-tier municipalities to provide more specific planning direction for their respective jurisdictions through the process of a *municipal comprehensive review*. While it may take some time before all official plans have been amended to conform with this Plan, the Planning Act requires that all decisions in respect of planning matters shall conform with this Plan as of its effective date (subject to any legislative or regulatory provisions providing otherwise).

With the exception of some minor matters, most planning decisions have the ability to impact the achievement of the policies in this Plan. It is therefore in the best interest of all municipalities to complete their work to conform with this Plan, including all official plans and zoning by-laws, as expeditiously as possible within required timeframes.

Where a municipality must make a decision on a planning matter before its official plan has been amended to conform with this Plan, or before other applicable planning instruments have been updated accordingly, it must still consider the impact of the decision as it relates to the policies of this Plan which require comprehensive municipal implementation.

The success of this Plan is also dependant on a range of mechanisms being in place to implement this Plan's policies. In addition to the legislative framework provided by the Places to Grow Act, 2005, this includes a wide range of complementary planning and fiscal tools, including instruments found in the Planning Act and the Municipal Act, 2001.

In order to continue to make steady progress towards the desired outcomes, the Province will provide information to build understanding of growth management and facilitate informed involvement in the implementation of this Plan. The Province will also ensure ongoing consultation with the public, stakeholders, municipalities and First Nations and Métis communities on the implementation of this Plan.

Measuring the success of this Plan will require rigorous and consistent evaluation of its progress. The Province will work with its public sector partners, including municipalities and agencies, and other stakeholders to compile and share the base of information that is needed to support the ongoing monitoring of the implementation of this Plan.

5.2 Policies for Implementation and Interpretation

Explanatory Text

For the most part, the existing policy directions for Implementation and Interpretation would be retained and the policies in Section 5 would be updated and clarified to provide additional direction for policy implementation and interpretation. Other technical policies that are currently located in other parts of the Growth Plan are proposed to be moved to this more technical section.

Proposed changes/additions to this Section of the Growth Plan would include:

- Sub-area assessments would be changed to outline the priorities for supplementary direction to implement the Proposed Growth Plan;
- Clarification that intensification and density targets would not require or enable growth beyond what is permitted under the PPS for special policy areas and other "hazardous lands";

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- New policy would require revisiting existing alternative targets at the time of the next "municipal comprehensive review". Future requests for alternative targets would need to be council-endorsed and approved by the province, otherwise the minimum targets set out in the Growth Plan, 2016, would apply; and
- New policies would support the establishment of a comprehensive monitoring program for the Greater Golden Horseshoe by allowing the province to require municipalities to provide data for the purposes of monitoring implementation of the Growth Plan.
- New policy would require that all schedules be reviewed and updated every five years.

5.2.1 General Interpretation

1. The policies and schedules of this Plan should be read in a manner that recognizes this Plan as an integrated policy framework.
2. Where the policies of this Plan address the same, similar, related or overlapping matters as the PPS, applying the more specific policies in this Plan satisfies the requirements of the more general policies in the PPS.
3. A *municipal comprehensive review* that is undertaken in accordance with this Plan will be deemed to fulfill the requirements in the PPS to undertake a comprehensive review.
4. Within the *Greenbelt Area*, policies of this Plan that address the same, similar, related or overlapping matters as the Greenbelt Plan, the Oak Ridges Moraine Conservation Plan or the Niagara Escarpment Plan do not apply within that part of the *Greenbelt Area* covered by the relevant plan except where the policies of this Plan, the Greenbelt Plan, the Oak Ridges Moraine Conservation Plan or the Niagara Escarpment Plan provide otherwise.
5. References to the responsibilities of the Minister set out in this Plan should be read as the Minister of Municipal Affairs and Housing, his or her assignee, his or her delegate pursuant to the Places to Grow Act, 2005, or any other member of Executive Council given responsibility for the Places to Grow Act, 2005.
6. References to the responsibilities of the Province set out in this Plan should be read as one or more members of Executive Council.

5.2.2 Supplementary Direction

1. In order to implement this Plan,the Minister will, where appropriate, identify, establish or update the following:
   a) the *built boundary*;
   b) the size and location of the *urban growth centres*;
   c) a standard methodology for land needs assessment;
   d) *prime employment areas*, where necessary; and
   e) data standards for monitoring implementation of this Plan.
2. In order to implement this Plan, the Province will, where appropriate, identify, establish or update the following:
   a) *priority transit corridors* and planning requirements for *priority transit corridors*;
   b) mapping of the *agricultural system* for the *GGH* and related guidance;
   c) mapping of the *natural heritage system* for the *GGH*; and
   d) guidance on *watershed planning*.
3. Where this Plan indicates that supplementary direction will be provided for implementation but the direction has not yet been issued, all relevant policies of this Plan continue to apply, and any policy that relies on supplementary direction should be implemented to the fullest extent possible.

5.2.3 Co-ordination

1. A co-ordinated approach will be taken to implement this Plan, in particular for issues that cross municipal boundaries, both between Provincial ministries and agencies, and by the Province in its dealings with municipalities, local boards and other related planning agencies.
2. Upper-tier municipalities, in consultation with lower-tier municipalities, will, through a *municipal comprehensive review*, provide policy direction to implement the policies of this Plan, including:
   a) identifying minimum intensification targets for lower-tier municipalities based on the capacity of *built-up areas*, including the applicable minimum density targets for *strategic growth areas* in this Plan, to achieve the minimum intensification target in this Plan;
   b) identifying minimum density targets for *strategic growth areas* in accordance with this Plan;

c) identifying minimum density targets for the *designated greenfield areas* of the lower-tier municipalities, to achieve the minimum density target for *designated greenfield areas* in this Plan;

d) allocating forecasted growth to the horizon of this Plan to the lower-tier municipalities; and

e) providing policy direction on matters that cross municipal boundaries.

3. Municipalities are encouraged to engage the public, First Nations and Métis communities, and stakeholders in local efforts to implement this Plan and to provide the necessary information to ensure the informed involvement of local citizens.

4. In cases where lower-tier official plans are not updated to implement this Plan in a timely or appropriate manner, upper-tier municipalities are encouraged to take action in accordance with subsection 27(2) of the Planning Act.

5. Single-tier municipalities in the *outer ring* and adjacent municipalities should ensure a co-ordinated approach to implement the policies of this Plan.

6. Planning authorities are encouraged to co-ordinate planning matters with First Nations and Métis communities throughout the planning process.

7. Municipalities are encouraged to build constructive, cooperative relationships with First Nations and Métis communities and to facilitate knowledge sharing in growth management and land use planning processes.

5.2.4 Growth Forecasts

1. All upper- and single-tier municipalities will, at the time of their next *municipal comprehensive review*, apply the forecasts in Schedule 3 for planning and managing growth to the horizon of this Plan.

2. The population and employment forecasts contained in the applicable upper- or single-tier official plan that is approved and in effect as of [placeholder for effective date] will apply to all planning matters in that municipality, including lower-tier planning matters where applicable, until the upper- or single-tier municipality has applied the forecasts in Schedule 3 in accordance with policy 5.2.4.1 and those forecasts are in effect in the upper- or single-tier official plan.

3. All references to forecasted growth to the horizon of this Plan are references to the population and employment forecasts in Schedule 3.

5.2.5 Targets

1. The minimum intensification and density targets in this Plan, including any alternative targets that have been permitted by the Minister, are minimum standards and municipalities are encouraged to go beyond these minimum targets, where appropriate, except where doing so would conflict with any policy of this Plan, the PPS or any other provincial plan.
2. Except as provided in policies 2.2.4.6 and 2.2.7.3, the minimum intensification and density targets in this Plan will be measured across all lands within the relevant area, including any lands that are subject to more than one target.
3. A lower-tier municipality with an *urban growth centre* will have a minimum intensification target that is equal to or higher than the minimum intensification target for the corresponding upper-tier municipality.
4. The minimum intensification and density targets in this Plan do not require or permit:
   a) in a special policy area that has been approved by the Province in accordance with policy 3.1.4 of the PPS, 2014, *development* that is beyond what has been permitted; or
   b) in other *hazardous lands*, *development* that is not permitted by the PPS.
5. Where alternative targets have been permitted by the Minister, these minimum targets will continue to apply until the time of a *municipal comprehensive review*. If no request is made, or the Minister does not permit an alternative target, the minimum intensification and density targets in this Plan will apply.

5.2.6 Performance Indicators and Monitoring

1. The Minister will develop a set of performance indicators to measure the implementation of the policies in this Plan. The Minister will monitor the implementation of this Plan, including reviewing performance indicators concurrent with any review of this Plan.
2. Municipalities will monitor and report on the implementation of this Plan's policies within their municipality, in accordance with any reporting requirements, data standards and any other guidelines that may be issued by the Minister.
3. The Minister may require municipalities and conservation authorities to provide data and information to the Minister as collected in accordance with policy 5.2.6.2, to demonstrate progress made towards the implementation of this Plan.

5.2.7 Schedules and Appendices

1. The Minister will review the schedules in this Plan, including the forecasts contained in Schedule 3, at least every five years in consultation with municipalities, and may revise the schedules, where appropriate.
2. Unless otherwise stated, the boundaries and lines displayed on the schedules are not to scale and provide general direction only.
3. The *built boundary* has been issued for the purpose of measuring the minimum intensification target in this Plan. The conceptual *built-up area* is shown on Schedules 2, 4, 5, and 6 for information purposes. For the actual *built-up area*, the *built boundary* that has been issued by the Minister should be consulted.
4. The *designated greenfield area*, shown on Schedules 2, 4, 5, and 6, is conceptual. For the actual *settlement area* boundary, the appropriate official plans should be consulted.
5. The appendices in this Plan are provided for information purposes only.

5.2.8 Other Implementation

1. The identification of *strategic growth areas, built-up areas* and *designated greenfield areas* are not land use designations and their delineation does not confer any new land use designations, nor alter existing land use designations. Any development on lands within the boundary of these identified areas is still subject to the relevant provincial and municipal land use planning policies and approval processes.
2. Draft plans of subdivision will include a lapsing date under subsection 51(32) of the Planning Act. When determining whether draft approval should be extended for lapsing draft plans of subdivision, the policies of this Plan must be considered in the development review process.
3. If a plan of subdivision or part thereof has been registered for eight years or more and does not meet the growth management objectives of this Plan, municipalities are encouraged to use their authority under subsection 50 (4) of the Planning Act to deem it not to be a registered plan of subdivision and, where appropriate, amend site-specific designations and zoning accordingly.

6 Simcoe Sub-area

6.1 Context

Explanatory Text	Proposed changes to the context for Section 6, if approved, would provide clarity that the policy changes to the remainder of the Growth Plan would apply in the "Simcoe Sub-area" in addition to the policies in Section 6.

While this Plan is to be read in its entirety and all policies are applicable to all municipalities within the *GGH*, this section provides additional, more specific direction on how this Plan's vision will be achieved in the *Simcoe Sub-area*. The *Simcoe Sub-area* is comprised of the County of Simcoe and the cities of Barrie and Orillia.

The policies in Section 6 direct a significant portion of growth within the *Simcoe Sub-area* to communities where development can be most effectively serviced, and where growth improves the range of opportunities for people to live, work, and play in their communities, with a particular emphasis on *primary settlement areas*. The City of Barrie is the principal *primary settlement area*. Downtown Barrie is the only *urban growth centre* in the *Simcoe Sub-area*. The policies in Section 6 recognize and support the vitality of urban and rural communities in the *Simcoe Sub-area*. All municipalities will play an important role in ensuring that future growth is planned for and managed in an effective and sustainable manner that conforms with this Plan. The intent is that by 2031 development for all the municipalities within Simcoe County will not exceed the overall population and employment forecasts contained in Schedule 7.

Ensuring an appropriate supply of land for employment and residential growth, and making the best use of existing *infrastructure* is also important to the prosperity of the *Simcoe Sub-area*. Section 6 identifies specific employment areas that will enable municipalities in the *Simcoe Sub-area* to benefit from existing and future economic opportunities. By providing further direction on where growth to 2031 is to occur in the *Simcoe Sub-area*, it also establishes a foundation for municipalities to align *infrastructure* investments with growth management, optimize the use of existing and planned *infrastructure*, co-ordinate water and wastewater services, and promote *green infrastructure* and innovative technologies.

A more livable, compact, complete urban structure with good design and built form will support the achievement of economic and environmental benefits. Through effective growth management, municipalities will ensure that the natural environment is protected from the impacts of growth in the *Simcoe Sub-area*, while providing amenities for the residents and visitors to this area from across the *GGH* and beyond.

Explanatory Text

Most of the policies in Section 6, which apply to the "Simcoe Sub-area" exclusively, would be retained. However, some changes are being proposed to clarify how the policies in this section would be implemented and to ensure alignment with the changes that are being proposed for the other Sections of the Proposed Growth Plan. This includes a sunset date for policy 6.3.2.1 (January 19, 2022) that is 10 years from the date that the policy first took effect (through Amendment 1 to the Growth Plan).

6.2 Growth Forecasts

1. Notwithstanding policy 5.2.3.2 d), lower-tier municipalities in the County shall use the population and employment forecasts contained in Schedule 7 for planning and managing growth in the *Simcoe Sub-area* to 2031.
2. Beyond 2031, Simcoe County will allocate the growth forecasts in Schedule 3 to lower-tier municipalities in accordance with policy 5.2.3.2 d) in a manner that implements the policies in this Plan, such that a significant portion of population and employment growth is directed to lower-tier municipalities that contain *primary settlement areas*.
3. Population and employment growth in Simcoe County will be accommodated on *lands for urban uses* as of January 19, 2017 prior to redesignating any additional *lands not for urban uses* to *lands for urban uses*.
4. The employment forecasts in this Plan include employment located in the *strategic settlement employment areas* and *economic employment districts*.

6.3 Managing Growth

6.3.1 Primary Settlement Areas

1. *Primary settlement areas* for the *Simcoe Sub-area* are identified in Schedule 8.
2. *Municipalities with primary settlement areas* will, in their official plans and other supporting documents:
   a) identify *primary settlement areas*;
   b) identify and plan for *strategic growth areas* within *primary settlement areas*;

c) plan to create *complete communities* within *primary settlement areas*; and

d) ensure the development of high quality urban form and public open spaces within *primary settlement areas* through site design and urban design standards that create attractive and vibrant places that support walking and cycling for everyday activities and are *transit-supportive*.

3. *Primary settlement areas* in the County will be identified in the official plan of the County of Simcoe.

4. The Town of Innisfil, Town of Bradford West Gwillimbury and the Town of New Tecumseth will direct a significant portion of population and employment growth forecasted to the applicable *primary settlement areas*. The Town of Bradford West Gwillimbury and the Town of Innisfil, in planning to meet their employment forecasts, may direct appropriate employment to the *Bradford West Gwillimbury strategic settlement employment area* and the *Innisfil Heights strategic settlement employment area* respectively.

6.3.2 Settlement Areas

1. Notwithstanding policy 2.2.1.6, development may be approved in *settlement areas* in excess of what is needed to accommodate the forecasts in Schedule 7, provided the development:

   a) contributes to the achievement of the minimum intensification and density targets that have been identified by the Minister , subject to policy 6.5.5;

   b) is on *lands for urban uses* as of January 19, 2012;

   c) can be serviced in accordance with applicable provincial plans and provincial policies; and

   d) is in accordance with the requirements of the Lake Simcoe Protection Plan, 2009, if applicable.

2. Notwithstanding policy 2.2.1.6, the County may approve adopted official plans or adopted official plan amendments regarding lands within a *settlement area* that redesignate *lands not for urban uses* to *lands for urban uses* that are in excess of what is needed for a time horizon of up to 20 years or to accommodate the forecasts in Schedule 7, whichever is sooner, provided it is demonstrated that this growth:

   a) can be serviced in accordance with applicable provincial plans and provincial policies;

   b) contributes to the achievement of the minimum intensification and density targets that have been identified by the Minister in accordance with policy 6.5.5;

c) contributes to the development of a *complete community*;

d) is subject to phasing policies;

e) contributes to the achievement of the jobs to residents ratio in Schedule 7 for the lower-tier municipality;

f) is in accordance with the requirements of the Lake Simcoe Protection Plan, 2009, if applicable;

g) is supported by appropriate transportation *infrastructure* and is in accordance with any transportation guidelines and policies developed by the County of Simcoe; and

h) is in accordance with any additional growth management policies specified by the County of Simcoe that do not conflict with the policies in this Plan.

3. The sum of all population growth accommodated on *lands for urban uses* approved pursuant to policy 6.3.2.2 shall not exceed a total population of 20,000 for the County of Simcoe.
4. Municipalities in the County of Simcoe may approve development on *lands for urban uses* approved pursuant to policies 6.3.2.2 and 6.3.2.3 prior to January 19, 2017.
5. Policies 6.3.2.2, 6.3.2.3 and 6.3.2.6 will apply in the County of Simcoe and its lower-tier municipalities until January 19, 2017.
6. The County of Simcoe Council will monitor and report annually on approvals made pursuant to policies 6.3.2.2 and 6.3.2.3.
7. The County of Simcoe and the lower-tier municipalities in the County shall establish and implement phasing policies to ensure the orderly and timely progression of development on *lands for urban uses*.
8. The County of Simcoe will develop and implement through its official plan, policies to implement the policies in subsection 6.3.2.

6.4 Employment Lands

1. The *Bradford West Gwillimbury strategic settlement employment area*, the *Innisfil Heights strategic settlement employment area*, the *Lake Simcoe Regional Airport economic employment district* and the *Rama Road economic employment district* are identified in Schedule 8.
2. The Minister, in consultation with affected municipalities and stakeholders, has determined the location and boundaries of *strategic settlement employment areas*, and has established as appropriate the following:

a) permitted uses, and the mix and percentage of certain uses;

b) permitted uses for specific areas within the *strategic settlement employment areas*;

   c) lot sizes; and
   d) any additional policies and definitions that apply to these areas.

3. The Minister, in consultation with affected municipalities and stakeholders, has determined the location and boundaries, and established as appropriate the uses permitted in the *economic employment districts*.
4. The Minister may review and amend decisions made pursuant to policies 6.4.2 and 6.4.3. Municipalities in the *Simcoe Sub-area* may request the Minister to consider a review.
5. The County of Simcoe and lower-tier municipalities in the County in which the *strategic settlement employment areas* and *economic employment districts* are located, will delineate the areas and districts, as determined by the Minister, in their official plans.
6. The lower-tier municipalities in the County in which the *strategic settlement employment areas* and *economic employment districts* are located will develop official plan policies to implement the matters determined by the Minister in accordance with policies 6.4.2, 6.4.3, and 6.4.4, as applicable.
7. Although not *settlement areas*, the *strategic settlement employment areas* and *economic employment districts* are considered *designated greenfield area* for the purposes of policies 2.2.7.2, 2.2.7.3, and 2.2.7.4.
8. For lands within *strategic settlement employment areas* and the *economic employment districts* the municipality can identify the *natural heritage systems*, features, and areas for protection.

6.5 Implementation

1. The policies in Section 6 apply only to the *Simcoe Sub-area*.
2. For the *Simcoe Sub-area*, where there is a conflict between policies in Section 6, Schedule 7, and Schedule 8 and the remainder of this Plan, the policies in Section 6, Schedule 7, and Schedule 8 prevail.
3. Policy 2.2.8.3 will not apply to Simcoe County until such time as the County has commenced a *municipal comprehensive review* to allocate the growth forecasts in Schedule 3 to lower-tier municipalities in accordance with policy 6.2.2.
4. Policy 6.3.2.1 will apply until January 19, 2022.
5. The Minister has identified minimum intensification and density targets for lower-tier municipalities in the County of Simcoe to 2031. These minimum targets are considered to be alternative targets for the purposes of this Plan and will continue to apply subject to policy 5.2.5.5.

7 Definitions

Explanatory Text

Proposed changes to this section would support the proposed changes to other parts of the Plan through the addition of new defined terms. Many of the new defined terms that are proposed to be added (e.g., “freight-supportive”) would be replicated from the PPS, 2014 and, where possible, would align with the terms that would be used in the Greenbelt Plan, Oak Ridges Moraine Conservation Plan and the Niagara Escarpment Plan. Some of the Growth Plan’s defined terms, including “complete communities” and “municipal comprehensive review” would be revised. Other defined terms (e.g., “transit-supportive”) would be updated to harmonize with the PPS, 2014.

As defined in this glossary, a number of the defined terms in this Plan have the same meaning or are based on the meaning of another provincial document, particularly the PPS, 2014. For convenience, a parenthetical note following definitions indicates where this is the case.

Active Transportation
Human-powered travel, including but not limited to, walking, cycling, inline skating and travel with the use of mobility aids, including motorized wheelchairs and other power-assisted devices moving at a comparable speed. (PPS, 2014)

Affordable

a) in the case of ownership housing, the least expensive of:
   i. housing for which the purchase price results in annual accommodation costs which do not exceed 30 per cent of gross annual household income for low and moderate income households; or
   ii. housing for which the purchase price is at least 10 per cent below the average purchase price of a resale unit in the regional market area;

b) in the case of rental housing, the least expensive of:
   i. a unit for which the rent does not exceed 30 per cent of gross annual household income for low and moderate income households; or
   ii. a unit for which the rent is at or below the average market rent of a unit in the regional market area.

For the purposes of this definition:

Low and moderate income households means, in the case of ownership housing, households with incomes in the lowest 60 per cent of the income distribution for the regional market area; or in the case of rental housing, households with incomes in the lowest 60 per cent of the income distribution for renter households for the regional market area.

Regional market area means an area, generally broader than a lower-tier municipality that has a high degree of social and economic interaction. In the *GGH*, the upper- or single-tier municipality will normally serve as the regional market area. Where a regional market area extends significantly beyond upper- or single-tier boundaries, it may include a combination of upper-, single- and/or lower-tier municipalities. (Based on PPS, 2014 and modified for this Plan)

Agricultural Impact Assessment
A study that evaluates the potential impacts of non-agricultural development on agricultural operations and the *agricultural system* and recommends ways to avoid or, if avoidance is not possible, minimize and mitigate adverse impacts.

Agricultural Support Network
A network that is part of the *agricultural system* and includes elements important to the viability of the agri-food sector such as: regional agricultural *infrastructure* and transportation networks, on-farm buildings and *infrastructure*, agricultural services, farm markets, distributors and first-level processing, and vibrant, agriculture-supportive communities.

Agricultural System
A group of inter-connected elements that collectively create a viable, thriving agricultural sector. It has two components: 1. An agricultural land base comprised of *prime agricultural areas*, including *specialty crop areas* and *rural lands* that together create a continuous productive land base for agriculture; 2. An *agricultural support network* which includes *infrastructure*, services and agri-food assets important to the viability of the sector.

Agricultural Uses
The growing of crops, including nursery, biomass, and horticultural crops; raising of livestock; raising of other animals for food, fur or fibre, including poultry and fish; aquaculture; apiaries; agro-forestry; maple syrup production; and associated on-farm buildings and structures, including, but not limited to livestock facilities, manure storages, value-retaining facilities, and accommodation for full-time farm labour when the size and nature of the operation requires additional employment. (PPS, 2014)

Agriculture-related Uses
Farm-related commercial and farm-related industrial uses that are directly related to the farm operations in the area, support agriculture, benefit from being in close proximity to farm operations, and provide direct products and/or services to farm operations as a primary activity. (PPS, 2014)

Alternative Energy System
A system that uses sources of energy or energy conversion processes to produce power, heat and/or cooling that significantly reduces the amount of harmful emissions to the environment (air, earth and water) when compared to conventional energy systems. (PPS, 2014)

Alvars
Naturally open areas of thin or no soil over essentially flat limestone, dolostone or marble rock, supporting a sparse vegetation cover of mostly shrubs and herbs. (Proposed Greenbelt Plan, 2016)

Archaeological Resources
Includes artifacts, archaeological sites, marine archaeological sites, as defined under the Ontario Heritage Act. The identification and evaluation of such resources are based upon archaeological fieldwork undertaken in accordance with the Ontario Heritage Act. (PPS, 2014)

Areas of Natural and Scientific Interest (ANSI)
Areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study or education. (PPS, 2014)

Bradford West Gwillimbury Strategic Settlement Employment Area
Location set out in Schedule 8. The *Bradford West Gwillimbury strategic settlement employment area* boundary is determined by the Minister of Municipal Affairs and Housing and planned for in accordance with the policies in subsection 6.4.

Brownfield Sites
Undeveloped or previously developed properties that may be contaminated. They are usually, but not exclusively, former industrial or commercial properties that may be underutilized, derelict or vacant. (PPS, 2014)

Built Boundary
The limits of the developed urban area as defined by the Minister in consultation with affected municipalities for the purpose of measuring the minimum intensification target in this Plan. The *built boundary* consists of delineated and undelineated *built-up areas*.

Built Heritage Resource

A building, structure, monument, installation or any manufactured remnant that contributes to a property's cultural heritage value or interest as identified by a community, including an Aboriginal community. *Built heritage resources* are generally located on property that has been designated under Parts IV or V of the Ontario Heritage Act, or included on local, provincial and/or federal registers. (PPS, 2014)

Built-up Area

All land within the *built boundary*. Where the *built boundary* is undelineated, the entire *settlement area* is considered *built-up area*.

Compact Built Form

A land use pattern that encourages the efficient use of land, walkable neighbourhoods, mixed land uses (residential, retail, workplace and institutional) all within one neighbourhood, proximity to transit and reduced need for *infrastructure*. *Compact built form* can include detached and semi-detached houses on small lots as well as townhouses and walk-up apartments, multi-storey commercial developments, and apartments or offices above retail. Walkable neighbourhoods can be characterized by roads laid out in a well-connected network, destinations that are easily accessible by *active transportation*, sidewalks with minimal interruptions for vehicle access, and a pedestrian friendly environment along roads to encourage *active transportation*.

Complete Communities

Places such as mixed-use neighbourhoods or other areas within cities, towns and *settlement areas* that offer and support opportunities for people of all ages and abilities to conveniently access most of the necessities for daily living, including an appropriate mix of jobs, local stores and services, a full range of housing and *public service facilities*. *Complete communities* may take different shapes and forms appropriate to their contexts.

Cultural Heritage Landscape

A defined geographical area that may have been modified by human activity and is identified as having cultural heritage value or interest by a community, including an Aboriginal community. The area may involve features such as structures, spaces, archaeological sites or natural elements that are valued together for their interrelationship, meaning or association. Examples may include, but are not limited to, heritage conservation districts designated under the Ontario Heritage Act; villages, parks, gardens, battlefields, mainstreets and neighbourhoods, cemeteries, trailways, viewsheds, natural areas and industrial complexes of heritage significance; and areas recognized by federal or international designation authorities (e.g., a National Historic Site or District designation, or a UNESCO World Heritage Site). (PPS, 2014)

Cultural Heritage Resources
Built heritage resources, *cultural heritage landscapes* and *archaeological resources*.

Designated Greenfield Area
The area within a *settlement area* that is required to accommodate forecasted growth to the horizon of this Plan and is not *built-up area*. *Designated greenfield areas* do not include *excess lands*.

Development
The creation of a new lot, a change in land use, or the construction of buildings and structures requiring approval under the Planning Act, but does not include:

a) activities that create or maintain *infrastructure* authorized under an environmental assessment process; or
b) works subject to the Drainage Act.

(Based on PPS, 2014 and modified for this Plan)

Drinking-water System
A system of works, excluding plumbing, that is established for the purpose of providing users of the system with drinking water and that includes:

a) any thing used for the collection, production, treatment, storage, supply or distribution of water;
b) any thing related to the management of residue from the treatment process or the management of the discharge of a substance into the natural environment from the treatment system; and
c) a well or intake that serves as the source or entry point of raw water supply for the system.

(Safe Drinking Water Act, 2002)

Economic Employment Districts
Areas that have been identified by the Minister that are to be planned and protected for locally significant employment uses. These areas are not *settlement areas* or *prime employment areas*.

Employment Area
Areas designated in an official plan for clusters of business and economic activities including, but not limited to, manufacturing, warehousing, offices, and associated retail and ancillary facilities. (PPS, 2014)

Energy Transmission Pipeline
A pipeline for transporting large quantities of oil or natural gas within a province or across provincial or international boundaries. *Energy transmission pipelines* do not include local distribution pipelines.

Excess Lands
Lands within a *settlement area* that are in excess of what is required to accommodate forecasted growth to the horizon of this Plan.

Fish Habitat
As defined in the Fisheries Act, means spawning grounds and any other areas, including nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes. (PPS, 2014)

Freight-supportive
In regard to land use patterns, means *transportation systems* and facilities that facilitate the movement of goods. This includes policies or programs intended to support efficient freight movement through the planning, design and operation of land use and *transportation systems*. Approaches may be recommended by the Province or based on municipal approaches that achieve the same objectives. (PPS, 2014)

Frequent Transit
A public transit service that runs at least every 15 minutes in both directions throughout the day and into the evening every day of the week.

Gateway Economic Centre
Settlement areas identified in this Plan, as conceptually depicted on Schedules 2, 5, and 6 that, due to their proximity to major international border crossings, have unique economic importance to the region and Ontario.

Gateway Economic Zone
Settlement areas identified in this Plan within the zone that is conceptually depicted on Schedules 2, 5, and 6, that, due to their proximity to major international border crossings, have unique economic importance to the region and Ontario.

Greater Golden Horseshoe (GGH)
The geographic area identified as the Greater Golden Horseshoe growth plan area in Ontario Regulation 416/05 under the Places to Grow Act, 2005.

Green Infrastructure
Natural and human-made elements that provide ecological and *hydrologic functions* and processes. *Green infrastructure* can include components such as natural heritage features and systems, parklands, stormwater management systems, street trees, urban forests, natural channels, permeable surfaces, and green roofs. (PPS, 2014)

Greenbelt Area
The geographic area identified as the *Greenbelt Area* in Ontario Regulation 59/05 under the Greenbelt Act, 2005.

Greyfields
Previously developed properties that are not contaminated. They are usually, but not exclusively, former commercial properties that may be underutilized, derelict or vacant.

Ground Water Features
Water-related features in the earth's subsurface, including recharge/discharge areas, water tables, aquifers and unsaturated zones that can be defined by surface and subsurface hydrogeologic investigations. (PPS, 2014)

Habitat of Endangered Species and Threatened Species

a) With respect to a species listed on the Species at Risk in Ontario List as an endangered or threatened species for which a regulation made under clause 55(1)(a) of the Endangered Species Act, 2007 is in force, the area prescribed by that regulation as the habitat of the species; or

b) With respect to any other species listed on the Species at Risk in Ontario List as an endangered or threatened species, an area on which the species depends, directly or indirectly, to carry on its life processes such as reproduction, rearing, hibernation, migration or feeding, as approved by the Ontario Ministry of Natural Resources and Forestry; and

places in the areas described in clauses (a) and (b), whichever is applicable, that are used by members of the species as dens, nests, hibernacula or other residences. (PPS, 2014)

Hazardous Lands
Property or lands that could be unsafe for development due to naturally occurring processes. Along the shorelines of the Great Lakes–St Lawrence River System, this means the land, including that covered by water, between the international boundary, where applicable, and the furthest landward limit of the flooding hazard, erosion hazard or dynamic beach hazard limits. Along the shorelines of large, inland lakes, this means the land, including that covered by water, between a defined offshore distance or depth and the furthest landward limit of the flooding hazard, erosion hazard or dynamic beach hazard limits. Along river, stream and small inland lake systems, this means the land, including that covered by water, to the furthest landward limit of the flooding hazard or erosion hazard limits. (PPS, 2014)

Higher Order Transit
Transit that generally operates in its own dedicated right-of-way, outside of mixed traffic, and therefore can achieve a frequency of service greater than mixed-traffic transit. *Higher order transit* can include heavy rail (such as subways and inter-city rail), light rail, and buses in dedicated rights-of-way.

Highly Vulnerable Aquifer
An aquifer on which external sources have, or are likely to have, a significant adverse effect, including the lands above the aquifer.

Hydrologic Function
The functions of the hydrological cycle that include the occurrence, circulation, distribution and chemical and physical properties of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere, and water's interaction with the environment including its relation to living things. (PPS, 2014)

Infrastructure
Physical structures (facilities and corridors) that form the foundation for development. *Infrastructure* includes: sewage and water systems, septage treatment systems, stormwater management systems, waste management systems, electricity generation facilities, electricity transmission and distribution systems, communications/telecommunications, transit and transportation corridors and facilities, oil and gas pipelines and associated facilities. (PPS, 2014)

Inner Ring
The geographic area consisting of the cities of Hamilton and Toronto and the Regions of Durham, Halton, Peel and York.

Innisfil Heights Strategic Settlement Employment Area
Location set out in Schedule 8. The *Innisfil Heights strategic settlement employment area* boundary is determined by the Minister of Municipal Affairs and Housing and planned for in accordance with the policies in subsection 6.4.

Intensification
The development of a property, site or area at a higher density than currently exists through:

a) *redevelopment*, including the reuse of *brownfield sites*;
b) the development of vacant and/or underutilized lots within previously developed areas;
c) infill development; or
d) the expansion or conversion of existing buildings.

(PPS, 2014)

Joint Development
Agreements entered into voluntarily between the public sector and property owners or third parties, whereby private entities share some of the costs of *infrastructure* improvements or contribute some benefits back to the public sector based on a mutual recognition of the benefits of such *infrastructure* improvements. Approaches to *joint development* may be recommended in guidelines developed by the Province.

Key Hydrologic Areas
Significant groundwater recharge areas, highly vulnerable aquifers and *significant surface water contribution areas* that are necessary for the ecologic and hydrological integrity of a *watershed*. The identification and delineation of *key hydrologic areas* will be informed by *watershed planning*, and other evaluations and assessments.

Key Hydrologic Features
Permanent streams, intermittent streams, inland lakes, seepage area and springs and *wetlands*. The identification and delineation of *key hydrologic features* will be informed by *watershed planning*, and other evaluations and assessments.

Key Natural Heritage Features
Habitat of endangered species and threatened species; *fish habitat*; *wetlands*; life science *areas of natural and scientific interest* (ANSIs), *significant valleylands*, *significant woodlands*; *significant wildlife habitat*; *sand barrens*, *savannahs*, and *tallgrass prairies*; and *alvars*. (Proposed Greenbelt Plan, 2016)

Lake Simcoe Regional Airport Economic Employment District
Location set out in Schedule 8. The *Lake Simcoe Regional Airport economic employment district* boundary is determined by the Minister of Municipal Affairs and Housing and planned for in accordance with the policies in subsection 6.4. *Major retail* and residential uses are not permitted.

Lands for Urban Uses
Lands that are not designated for *agricultural uses* or rural uses within a *settlement area* identified in the approved official plan for the municipality.

Lands Not for Urban Uses
Lands that are designated for *agricultural uses* or rural uses within a *settlement area* identified in the approved official plan for the municipality.

Large Subsurface Sewage Disposal Systems
Subsurface disposal systems with a design capacity in excess of 10,000 litres per day. These systems are to be designed in accordance with Section 22 of "Design Guidelines for Sewage Works, 2008".

Low Impact Development
An approach to stormwater management that seeks to manage rain and other precipitation as close as possible to where it falls in order to mitigate the impacts of increased runoff and stormwater pollution. It comprises a set of site design strategies and distributed, small scale structural practices to mimic the natural hydrology to the greatest extent possible through infiltration, evapotranspiration, harvesting, filtration and detention of stormwater. *Low impact development* can include: bio-swales, permeable pavement, rain gardens, green roofs and exfiltration systems. *Low impact development* often employs vegetation and soil in its design, however, that does not always have to be the case.

Major Goods Movement Facilities and Corridors
The transportation facilities and corridors associated with the inter- and intra-provincial movement of goods. Examples include: inter-modal facilities, ports, airports, truck terminals, freight corridors, freight facilities, and haul routes and primary transportation corridors used for the movement of goods. Approaches that are *freight-supportive* may be recommended in guidelines developed by the Province or based on municipal approaches that achieve the same objectives. (PPS, 2014)

Major Office
Freestanding office buildings of approximately 4,000 square metres of floorspace or greater, or with approximately 200 jobs or more.

Major Retail
Large-scale or large-format stand-alone retail stores or retail centres that have the primary purpose of commercial activities.

Major Transit Station Area
The area including and around any existing or planned *higher order transit* station or stop within a *settlement area*; or the area including and around a major bus depot in an urban core. *Major transit station areas* generally are defined as the area within an approximate 500m radius of a transit station, representing about a 10-minute walk.

Mineral Aggregate Operations

a) lands under license or permit, other than for wayside pits and quarries issued in accordance with the Aggregate Resources Act;

b) for lands not designated under the Aggregate Resources Act, established pits and quarries that are not in contravention of municipal zoning by-laws and including adjacent lands under agreement with or owned by the operator, to permit continuation of the operation; and

c) associated facilities used in extraction, transport, beneficiation, processing, or recycling of *mineral aggregate resources* and derived products, such as asphalt and concrete, or the production of secondary related products.

(PPS, 2014)

Mineral Aggregate Resources
Gravel, sand, clay, earth, shale, stone, limestone, dolostone, sandstone, marble, granite, rock or other material prescribed under the Aggregate Resources Act suitable for construction, industrial, manufacturing and maintenance purposes but not including metallic ores, asbestos, graphite, kyanite, mica, nepheline syenite, salt, talc, wollastonite, mine tailings or other material prescribed under the Mining Act. (PPS, 2014)

Minimum Distance Separation Formulae
Formulae and guidelines developed by the Province, as amended from time to time, to separate uses so as to reduce incompatibility concerns about odour from livestock facilities. (PPS, 2014)

Mobility Hubs
Major transit station areas that are particularly significant given the level of transit service that is planned for them and the development potential around them. *Mobility hubs* are identified in The Big Move, a Regional Transportation Plan for the Greater Toronto and Hamilton Area and can also be identified in accordance with policy 2.2.4.10.

Modal Share
The percentage of person-trips or of freight movements made by one travel mode, relative to the total number of such trips made by all modes.

Multimodal
Relating to the availability or use of more than one form of transportation, such as automobiles, walking, cycling, buses, rapid transit, rail (such as commuter and freight), trucks, air and marine. (PPS, 2014)

Municipal Comprehensive Review
A new official plan, or an official plan amendment, initiated by an upper- or single-tier municipality under section 26 of the Planning Act that comprehensively applies the policies and schedules of this Plan.

Municipal Water and Wastewater Systems
Municipal water systems, are all or part of a *drinking-water system*:

a) that is owned by a municipality or by a municipal service board established under section 195 of the Municipal Act, 2001;

b) that is owned by a corporation established under section 203 of the Municipal Act, 2001;

c) from which a municipality obtains or will obtain water under the terms of a contract between the municipality and the owner of the system; or

d) that is in a prescribed class of municipal *drinking-water systems* as defined in regulation under the Safe Drinking Water Act, 2002.

And, municipal wastewater systems are any *sewage works* owned or operated by a municipality.

Municipalities with Primary Settlement Areas
City of Barrie, City of Orillia, Town of Bradford West Gwillimbury, Town of Collingwood, Town of Innisfil, Town of Midland, Town of New Tecumseth, and Town of Penetanguishene.

Natural Heritage Features and Areas
Features and areas, including *significant wetlands*, significant coastal *wetlands*, other coastal *wetlands* in Ecoregions 5E, 6E and 7E, *fish habitat*, *significant valleylands* in Ecoregions 6E and 7E (excluding islands in Lake Huron and the St. Marys River), *habitat of endangered species and threatened species*, *significant wildlife habitat*, and significant *areas of natural and scientific interest*, which are important for their environmental and social values as a legacy of the natural landscapes of an area. (PPS, 2014)

Natural Heritage System
A system made up of natural heritage features and areas, and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species, and ecosystems. These systems can include *key natural heritage features*, federal and provincial parks and conservation reserves, other natural heritage features and areas, lands that have been restored or have the potential to be restored to a natural state, associated areas that support *hydrologic functions*, and working landscapes that enable ecological functions to continue. (Based on PPS, 2014 and modified for this Plan)

Net-Zero Communities
Communities that meet their energy demand through low-carbon or carbon-free forms of energy and offset, preferably locally, any releases of greenhouse gas emissions that cannot be eliminated. *Net-zero communities* include a higher density built form, and denser and mixed-use development patterns that ensure energy efficiency, reduce distances travelled, and improve integration with transit, energy, water and wastewater systems.

New Multiple Lots or Units for Residential Development
The creation of more than three units or lots through either plan of subdivision, consent or plan of condominium.

Office Parks
Employment areas designated in an official plan where there are significant concentrations of offices with high employment densities.

On-farm Diversified Uses
Uses that are secondary to the principal *agricultural use* of the property, and are limited in area. *On-farm diversified uses* include, but are not limited to, home occupations, home industries, agri-tourism uses, and uses that produce value-added agricultural products. (PPS, 2014)

Outer Ring
The geographic area consisting of the cities of Barrie, Brantford, Guelph, Kawartha Lakes, Orillia and Peterborough; the Counties of Brant, Dufferin, Haldimand, Northumberland, Peterborough, Simcoe, and Wellington; and the Regions of Niagara and Waterloo.

Planned Corridors
Corridors or future corridors which are required to meet projected needs, and are identified through this Plan, preferred alignment(s) determined through the Environmental Assessment Act process, or identified through planning studies where the Ministry of Transportation, Ministry of Energy, Metrolinx or Independent Electricity System Operator (IESO) or any successor to those Ministries or entities, is actively pursuing the identification of a corridor. Approaches for the protection of *planned corridors* may be recommended in guidelines developed by the Province. (Based on PPS, 2014 and modified for this Plan)

Primary Settlement Areas
Locations set out in Schedule 8. *Primary settlement areas* are the *settlement areas* of the City of Barrie, the City of Orillia, the Town of Collingwood, the Town of Midland together with the Town of Penetanguishene, and the *settlement areas* of the communities of Alcona in the Town of Innisfil, Alliston in the Town of New Tecumseth and Bradford in the Town of Bradford West Gwillimbury.

Prime Agricultural Area
Areas where prime agricultural lands predominate. This includes areas of prime agricultural lands and associated Canada Land Inventory Class 4 through 7 lands, and additional areas where there is a local concentration of farms which exhibit characteristics of ongoing agriculture. *Prime agricultural areas* will be identified using guidelines and mapping developed by the Province. (Based on PPS, 2014 and modified for this Plan)

For the purposes of this definition:

Prime agricultural land includes *specialty crop areas* and/or Canada Land Inventory Classes 1, 2, and 3 soils, as amended from time to time, in this order of priority for protection.

Prime Employment Area
Areas of employment within *settlement areas* that are designated in an official plan and protected over the long-term for uses that are land extensive or have low employment densities and require these locations, including manufacturing, warehousing and logistics and appropriate associated uses and ancillary facilities.

Priority Transit Corridors
Emerging *higher order transit* corridors identified as a focus for planning and *intensification*. *Priority transit corridors* are shown in Schedule 5 and can also be identified in accordance with policy 2.2.4.10.

Private Communal Water and Wastewater Systems
Private communal water systems are *drinking-water systems* that are not municipal water systems and that serve six or more lots or private residences, and

Private communal wastewater systems are *sewage works* that serve six or more lots or private residences and are not owned or operated by a municipality.

Public Service Facilities
Lands, buildings and structures for the provision of programs and services provided or subsidized by a government or other body, such as social assistance, recreation, police and fire protection, health and educational programs, and cultural services. *Public service facilities* do not include *infrastructure*. (PPS, 2014)

Public Realm
All spaces to which the public has unrestricted access, such as streets, parks and sidewalks.

Quality and Quantity of Water
Measured by indicators associated with *hydrologic function* such as minimum base flow, depth to water table, aquifer pressure, oxygen levels, suspended solids, temperature, bacteria, nutrients and hazardous contaminants, and hydrologic regime. (PPS, 2014)

Rama Road Economic Employment District
Location set out in Schedule 8. The *Rama Road economic employment district* boundary is determined by the Minister of Municipal Affairs and Housing and planned for in accordance with the policies in subsection 6.4. *Major retail* uses are not permitted.

Redevelopment
The creation of new units, uses or lots on previously developed land in existing communities, including *brownfield sites*. (PPS, 2014)

Renewable Energy System
A system that generates electricity, heat and/or cooling from a renewable energy source.

For the purposes of this definition:

A renewable energy source is an energy source that is renewed by natural processes and includes wind, water, biomass, biogas, biofuel, solar energy, geothermal energy and tidal forces. (PPS, 2014).

Rural Lands
Lands which are located outside *settlement areas* and which are outside *prime agricultural areas*. (PPS, 2014)

Sand Barren
Land (not including land that is being used for agricultural purposes or no longer exhibits sand barren characteristics) that:

a) has sparse or patchy vegetation that is dominated by plants that are:
    i. adapted to severe drought and low nutrient levels; and
    ii. maintained by severe environmental limitations such as drought, low nutrient levels and periodic disturbances such as fire;
b) has less than 25 per cent tree cover;
c) has sandy soils (other than shorelines) exposed by natural erosion, depositional process or both; and
d) has been further identified, by the Ministry of Natural Resources and Forestry or by any other person, according to evaluation procedures established by the Ministry of Natural Resources and Forestry, as amended from time to time.

(Proposed Greenbelt Plan, 2016)

Savannah
Land (not including land that is being used for agricultural purposes or no longer exhibits savannah characteristics) that:

a) has vegetation with a significant component of non-woody plants, including *tallgrass prairie* species that are maintained by seasonal drought, periodic disturbances such as fire, or both;
b) has from 25 per cent to 60 per cent tree cover;
c) has mineral soils; and
d) has been further identified, by the Ministry of Natural Resources and Forestry or by any other person, according to evaluation procedures established by the Ministry of Natural Resources and Forestry, as amended from time to time.

(Proposed Greenbelt Plan, 2016)

Sensitive Land Uses
Buildings, amenity areas, or outdoor spaces where routine or normal activities occurring at reasonably expected times would experience one or more adverse effects from contaminant discharges generated by nearby major facilities. *Sensitive land uses* may be a part of the natural or built environment. Examples may include, but are not limited to: residences, day care centres, and educational and health facilities. (PPS, 2014)

Settlement Areas
Urban areas and rural *settlement areas* within municipalities (such as cities, towns, villages and hamlets) that are:

a) built up areas where development is concentrated and which have a mix of land uses; and
b) lands which have been designated in an official plan for development.

(Based on PPS, 2014 and modified for this Plan)

Sewage Works
Any works for the collection, transmission, treatment and disposal of sewage or any part of such works, but does not include plumbing to which the Building Code Act, 1992 applies. (Ontario Water Resources Act)

For the purposes of this definition:

Sewage includes, but is not limited to drainage, stormwater, residential wastewater, commercial wastewater and industrial wastewater.

Significant Groundwater Recharge Area
An area that has been identified:

a) as a *significant groundwater recharge area* by any public body for the purposes of implementing the PPS, 2014;
b) as a *significant groundwater recharge area* in the assessment report required under the Clean Water Act, 2006; or
c) as an ecologically *significant groundwater recharge area* delineated in a *subwatershed plan* or equivalent in accordance with provincial guidelines.

For the purposes of this definition, ecologically *significant groundwater recharge areas* are areas of land that are responsible for replenishing groundwater systems that directly support sensitive areas like cold water streams and *wetlands*.

Significant Surface Water Contribution Areas
Areas, generally associated with headwater catchments, that contribute to baseflow volumes which are significant to the overall surface water flow volumes within a *watershed*.

Significant Wetland
A *wetland* that has been identified as provincially significant by the Province. (Based on PPS, 2014 and modified for this Plan)

Significant Wildlife Habitat
A *wildlife habitat* that is ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or *natural heritage system*. These are to be identified using criteria established by the Province. (Based on PPS, 2014 and modified for this Plan)

Significant Woodland
A *woodland* which is ecologically important in terms of features such as species composition, age of trees and stand history; functionally important due to its contribution to the broader landscape because of its location, size or due to the amount of forest cover in the planning area; or economically important due to site quality, species composition, or past management history. These are to be identified using criteria established by the Province. (Based on PPS, 2014 and modified for this Plan)

Significant Valleyland
A *valleyland* which is ecologically important in terms of features, functions, representation or amount, and contributing to the quality and diversity of an identifiable geographic area or *natural heritage system*. These are to be identified using criteria established by the Province. (Based on PPS, 2014 and modified for this Plan)

Simcoe Sub-area
The geographic area consisting of the County of Simcoe, the City of Barrie and the City of Orillia.

Site Alteration
Activities, such as grading, excavation and the placement of fill that would change the landform and natural vegetative characteristics of a site. (PPS, 2014)

Specialty Crop Area
Areas designated using guidelines established by the Province, as amended from time to time. In these areas, specialty crops are predominantly grown such as tender fruits (peaches, cherries, plums), grapes, other fruit crops, vegetable crops, greenhouse crops, and crops from agriculturally developed organic soil usually resulting from:

a) soils that have suitability to produce specialty crops, or lands that are subject to special climatic conditions, or a combination of both;
b) farmers skilled specialty crops; and
c) a long-term investment of capital in areas such as crops, drainage, *infrastructure* and related facilities and services to produce, store, or process specialty crops.

(PPS, 2014)

Stormwater Master Plan
A long range plan that outlines stormwater *infrastructure* requirements for new and existing development within a *settlement area*. *Stormwater master plans* are informed by *watershed planning* and are completed in accordance with the Municipal Class Environmental Assessment.

Stormwater Management Plan
A plan that provides direction to avoid or minimize and mitigate stormwater volume, contaminant loads and impacts to receiving water courses in order to: maintain groundwater quality and flow and stream baseflow; protect water quality; minimize the disruption of pre-existing (natural) drainage patterns wherever possible; prevent increases in stream channel erosion; prevent any increase in flood risk; and protect aquatic species and their habitat.

Strategic Growth Areas
Within *settlement areas*, nodes, corridors and other areas that have been identified by municipalities or the Province to be the focus for accommodating *intensification* and higher-density mixed uses in a more *compact built form*. *Strategic growth areas* include *urban growth centres*, *major transit station areas*, *mobility hubs* and other major opportunities that may include infill,

redevelopment, *brownfield sites*, the expansion or conversion of existing buildings, or *greyfields*. Lands along major roads, arterials or other areas with existing or planned *frequent transit* service or *higher order transit* corridors may also be identified as *strategic growth areas*.

Strategic Settlement Employment Areas
Areas that have been identified by the Minister that are to be planned and protected for employment uses that require large lots of land and depend upon efficient movement of goods and access to Highway 400. These are not *settlement areas* or *prime employment areas*. *Major retail* and residential uses are not permitted.

Subwatershed Plan
A plan that reflects and refines the goals, objectives, targets and assessments of *watershed planning* at a broader scale; is tailored to subwatershed needs and local issues; considers existing and proposed development; identifies hydrologic features, areas and functions; and provides for protecting, improving or restoring the *quality and quantity of water* within a subwatershed. A *subwatershed plan* is based on pre-development monitoring and evaluation; is integrated with natural heritage protection; and identifies specific criteria, actions and targets for development, for water and wastewater servicing, for stormwater management and to support ecological needs.

Surface Water Features
Water-related features on the earth's surface, including headwaters, rivers, stream channels, inland lakes, seepage areas, recharge/discharge areas, springs, *wetlands*, and associated riparian lands that can be defined by their soil moisture, soil type, vegetation or topographic characteristics. (PPS, 2014)

Tallgrass Prairies
Land (not including land that is being used for agricultural purposes or no longer exhibits tallgrass prairie characteristics) that:

a) has vegetation dominated by non-woody plants, including tallgrass prairie species that are maintained by seasonal drought, periodic disturbances such as fire, or both;
b) has less than 25 per cent tree cover;
c) has mineral soils; and
d) has been further identified, by the Minister of Natural Resources and Forestry or by any other person, according to evaluation procedures established by the Ministry of Natural Resources and Forestry, as amended from time to time.

(Proposed Greenbelt Plan, 2016)

Total Developable Area
The total area of the property less the area occupied by *key natural heritage features* and *key hydrologic features* and any related *vegetation protection zone*. (Proposed Greenbelt Plan, 2016)

Transit Service Integration
The co-ordinated planning or operation of transit service between two or more agencies or services that contribute to the goal of seamless service for riders and could include considerations of service schedules, service routes, information, fare policy and fare payment.

Transit-supportive
Relating to development that makes transit viable and improves the quality of the experience of using transit. It often refers to compact, mixed-use development that has a high level of employment and residential densities. Approaches may be recommended in guidelines developed by the Province or based on municipal approaches that achieve the same objectives. (Based on PPS, 2014 and modified for this Plan)

Transportation Demand Management
A set of strategies that result in more efficient use of the *transportation system* by influencing travel behaviour by mode, time of day, frequency, trip length, regulation, route, or cost. (PPS, 2014)

Transportation System
A system consisting of facilities, corridors and rights-of-way for the movement of people and goods, and associated transportation facilities including transit stops and stations, sidewalks, cycle lanes, bus lanes, high occupancy vehicle lanes, rail facilities, parking facilities, park-and-ride lots, service centres, rest stops, vehicle inspection stations, inter-modal facilities, harbours, airports, marine facilities, ferries, canals and associated facilities such as storage and maintenance. (PPS, 2014)

Trip Generators
Destinations with high population densities or concentrated activities which generate a large number of trips (e.g., *urban growth centres* and other downtowns, *major office* and *office parks*, *major retail*, *employment areas*, community hubs and other *public service facilities* and other mixed-use areas)

Urban Growth Centres

Existing or emerging downtown areas shown in Schedule 4 and as further identified by the Minister on April 2, 2008.

Valleylands
A natural area that occurs in a valley or other landform depression that has water flowing through or standing for some period of the year. (PPS, 2014)

Vegetation Protection Zone
A vegetated buffer area surrounding a *key natural heritage feature* or *key hydrologic feature*.

Water Resource System
A system consisting of *ground water features* and areas and *surface water features* (including shoreline areas), and *hydrologic functions*, which provide the water resources necessary to sustain healthy aquatic and terrestrial ecosystems and human water consumption. The *water resource system* will comprise *key hydrologic features* and *key hydrologic areas*.

Watershed
An area that is drained by a river and its tributaries. (PPS, 2014)

Watershed Planning
Planning that provides a framework for the management of human activities, land, water, aquatic life and resources within a *watershed* and for the assessment of cumulative, cross-jurisdictional and cross-*watershed* impacts.

Watershed planning typically includes: a water budget and conservation plan; nutrient loading assessments; consideration of climate change impacts and severe weather events; land and water use management strategies; an environmental monitoring plan; requirements for the use of environmental management practices and programs; criteria for evaluating the protection of *quality and quantity of water*; the identification and protection of hydrologic features, areas and functions and the inter-relationships between or among them; and targets for the protection and restoration of riparian areas.

Watershed planning is undertaken at many scales, and considers cross-jurisdictional and cross-*watershed* impacts. The level of analysis and specificity generally increases for smaller geographic areas such as subwatersheds and tributaries.

Wetlands

Lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants. The four major types of *wetlands* are swamps, marshes, bogs and fens.

Periodically soaked or wet lands being used for agricultural purposes which no longer exhibit *wetland* characteristics are not considered to be *wetlands* for the purposes of this definition. (PPS, 2014)

Wildlife Habitat
Areas where plants, animals and other organisms live, and find adequate amounts of food, water, shelter and space needed to sustain their populations. Specific *wildlife habitats* of concern may include areas where species concentrate at a vulnerable point in their annual or life cycle; and areas which are important to migratory or non-migratory species. (PPS, 2014)

Woodlands
Treed areas that provide environmental and economic benefits to both the private landowner and the general public, such as erosion prevention, hydrological and nutrient cycling, provision of clean air and the long-term storage of carbon, provision of *wildlife habitat*, outdoor recreational opportunities, and the sustainable harvest of a wide range of *woodland* products. *Woodlands* include treed areas, woodlots or forested areas and vary in their level of significance at the local, regional and provincial levels. *Woodlands* may be delineated according to the Forestry Act definition or the Province's Ecological Land Classification system definition for "forest." (PPS, 2014)

Minimal changes are proposed for the schedules to the Growth Plan. Schedule 3 would be updated to remove the "2031A" forecasts. Schedule 4 would be updated to reflect local changes in the names for three "Urban Growth Centres". Schedules 5 and 6 would be updated to reflect current provincial commitments to transit and goods movement infrastructure.

Explanatory Text

Ontario

PLACES TO GROW

PROPOSED GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE, 2016

SCHEDULE 1

Greater Golden Horseshoe Growth Plan Area

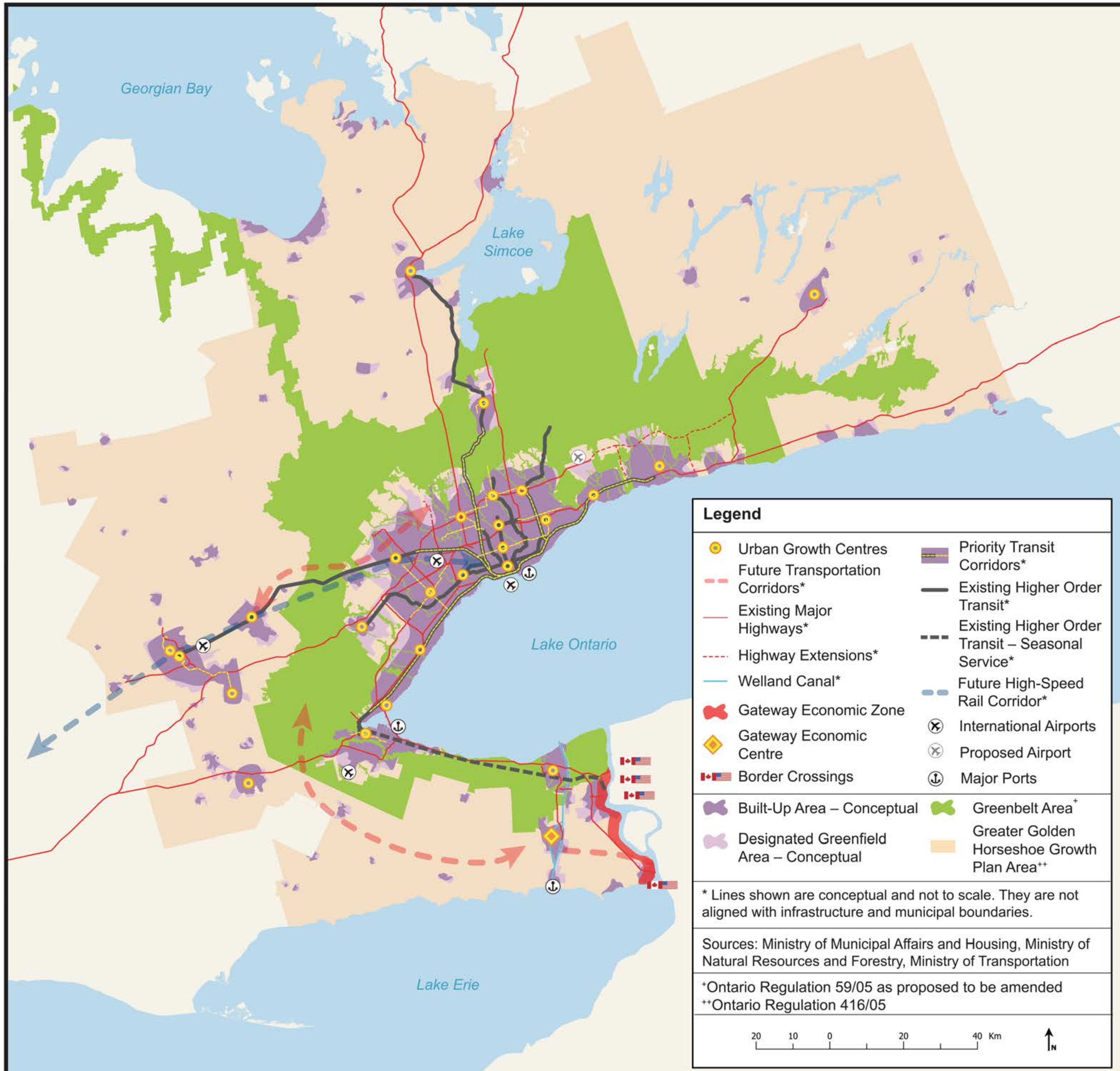
Note: The information displayed on this map is not to scale, does not accurately reflect approved land-use and planning boundaries, and may be out of date. For more information on precise boundaries, the appropriate municipality should be consulted. For more information on Greenbelt Area boundaries, the Greenbelt Plan 2016 should be consulted. The Province of Ontario assumes no responsibility or liability for any consequences of any use made of this map.

Ontario

PLACES TO GROW

PROPOSED GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE, 2016

SCHEDULE 2
Places to Grow Concept



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Distribution of Population and Employment for the Greater Golden Horseshoe to 2041 (figures in 000s)						
	POPULATION			**EMPLOYMENT**		
	2031	**2036**	**2041**	**2031**	**2036**	**2041**
Region of Durham	970	1,080	1,190	360	390	430
Region of York	1,590	1,700	1,790	790	840	900
City of Toronto	3,190	3,300	3,400	1,660	1,680	1,720
Region of Peel	1,770	1,870	1,970	880	920	970
Region of Halton	820	910	1,000	390	430	470
City of Hamilton	680	730	780	310	330	350
GTAH TOTAL*	9,010	9,590	10,130	4,380	4,580	4,820
County of Northumberland	100	105	110	36	37	39
County of Peterborough	70	73	76	20	21	24
City of Peterborough	103	109	115	52	54	58
City of Kawartha Lakes	100	101	107	29	30	32
County of Simcoe	See Schedule 7	456	497	See Schedule 7	141	152
City of Barrie		231	253		114	129
City of Orillia		44	46		22	23
County of Dufferin	80	81	85	29	31	32
County of Wellington	122	132	140	54	57	61
City of Guelph	177	184	191	94	97	101
Region of Waterloo	742	789	835	366	383	404
County of Brant	49	53	57	22	24	26
City of Brantford	139	152	163	67	72	79
County of Haldimand	57	60	64	22	24	25
Region of Niagara	543	577	610	235	248	265
OUTER RING TOTAL*	2,940	3,150	3,350	1,280	1,360	1,450
TOTAL GGH*	11,950	12,740	13,480	5,650	5,930	6,270

Note: Numbers rounded off to nearest 10,000 for GTAH municipalities, GTAH Total and Outer Ring Total, and to nearest 1,000 for outer ring municipalities.
** Total may not add up due to rounding.*

Ontario

PLACES TO GROW

PROPOSED GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE, 2016

SCHEDULE 3
Distribution of Population and Employment for the Greater Golden Horseshoe to 2041

Ontario

PLACES TO GROW

PROPOSED GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE, 2016

SCHEDULE 4
Urban Growth Centres

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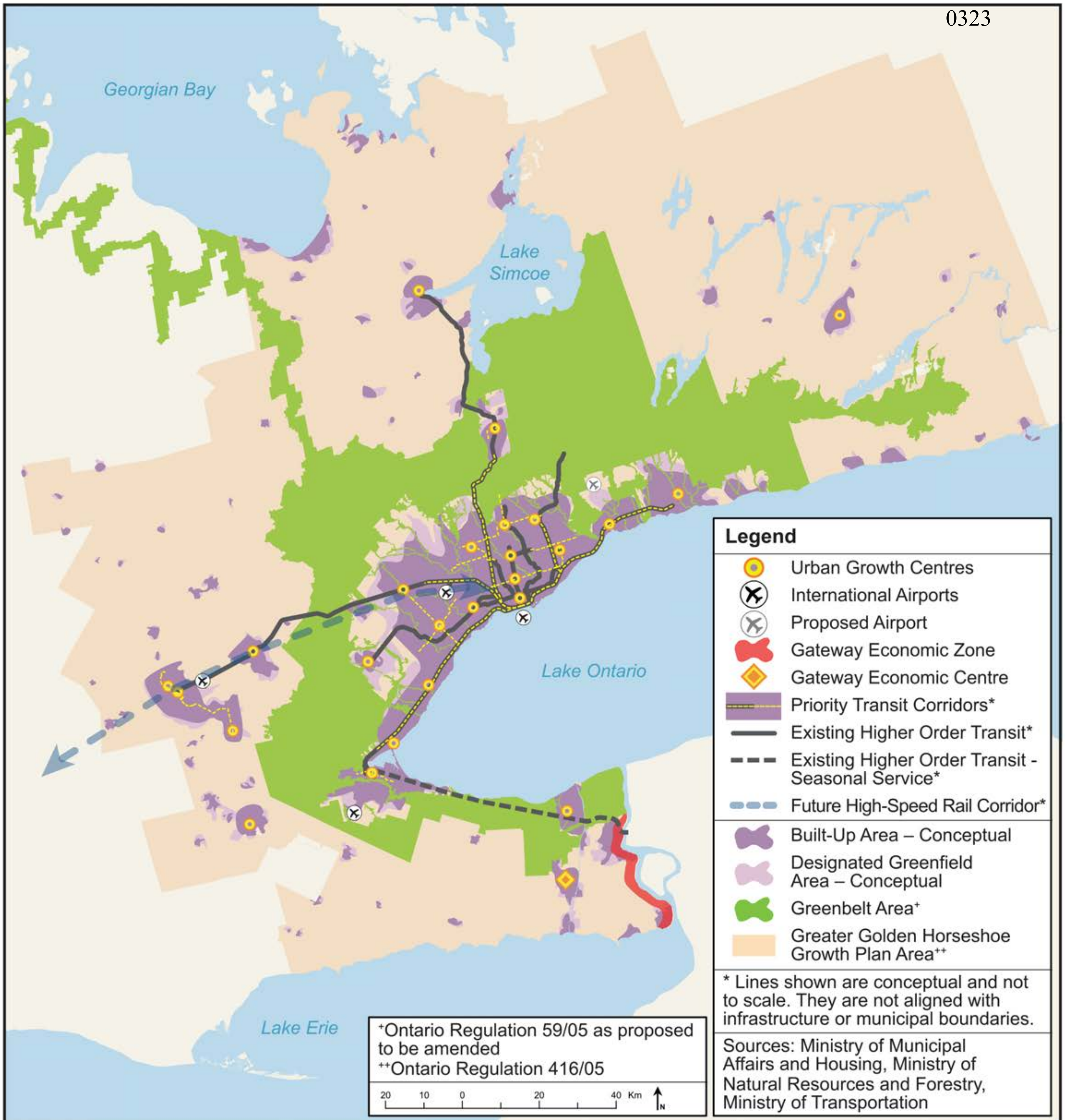

Ontario

PLACES TO GROW

PROPOSED GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE, 2016

SCHEDULE 5
Moving People – Transit

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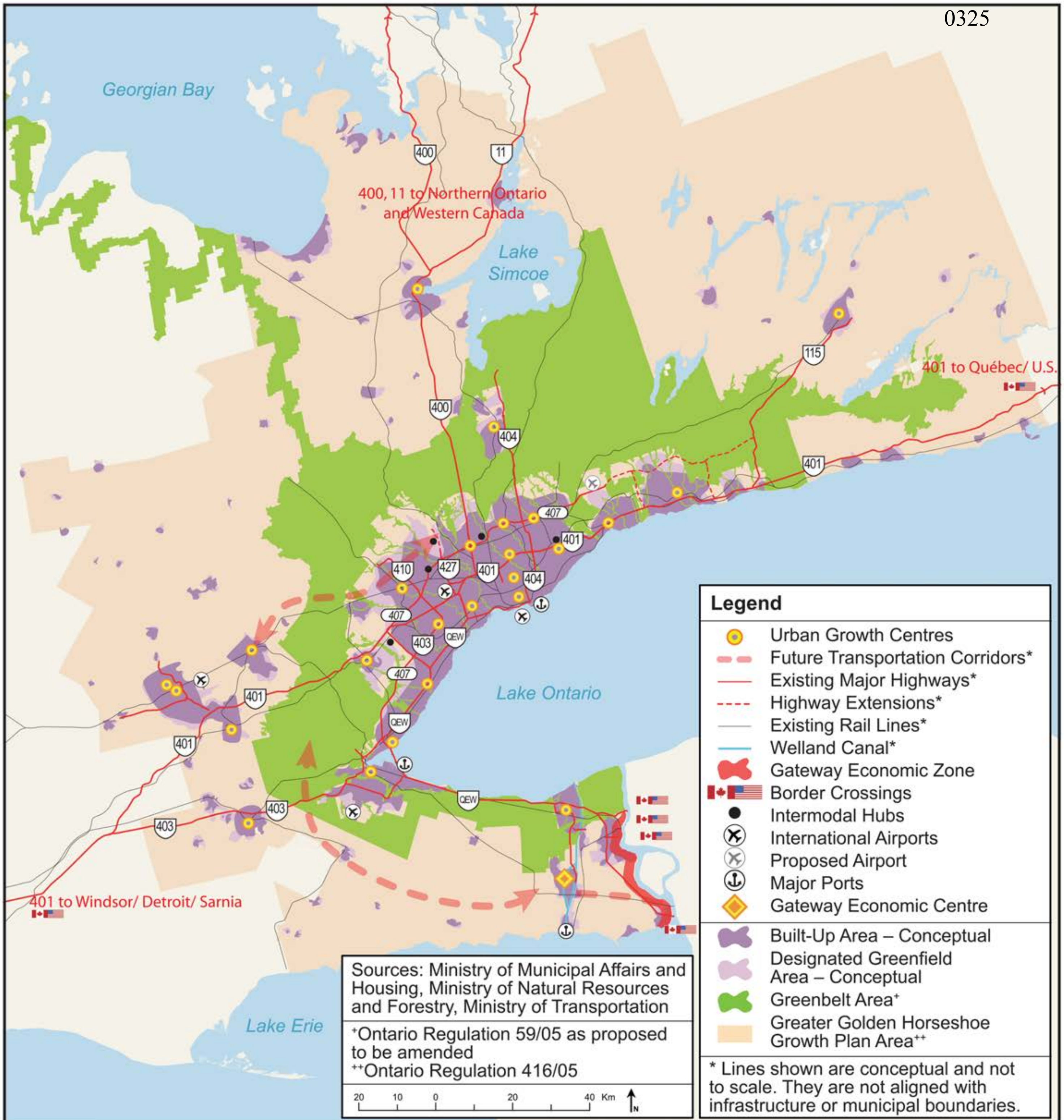


Ontario

PLACES TO GROW

PROPOSED GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE, 2016

SCHEDULE 6
Moving Goods

Note: The information displayed on this map is not to scale, does not accurately reflect approved land-use and planning boundaries, and may be out of date. For more information on precise boundaries, the appropriate municipality should be consulted. For more information on Greenbelt Area boundaries, the Greenbelt Plan 2016 should be consulted. The Province of Ontario assumes no responsibility or liability for any consequences of any use made of this map.

Distribution of Population and Employment for the City of Barrie, City of Orillia and County of Simcoe to 2031		
	POPULATION	**EMPLOYMENT**
City of Barrie	210,000	101,000
City of Orillia	41,000	21,000
Township of Adjala-Tosorontio	13,000	1,800
Town of Bradford West Gwillimbury	50,500	18,000
Township of Clearview	19,700	5,100
Town of Collingwood	33,400	13,500
Township of Essa	21,500	9,000
Town of Innisfil	56,000	13,100
Town of Midland	22,500	13,800
Town of New Tecumseth	56,000	26,500
Township of Oro-Medonte	27,000	6,000
Town of Penetanguishene	11,000	6,000
Township of Ramara	13,000	2,200
Township of Severn	17,000	4,400
Township of Springwater	24,000	5,600
Township of Tay	11,400	1,800
Township of Tiny	12,500	1,700
Town of Wasaga Beach	27,500	3,500
TOTAL SIMCOE SUB-AREA	667,000	254,000

Ontario

PLACES TO GROW

PROPOSED GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE, 2016

SCHEDULE 7
Distribution of Population and Employment for the City of Barrie, City of Orillia and County of Simcoe to 2031

Ontario

PLACES TO GROW

PROPOSED GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE, 2016

SCHEDULE 8

Simcoe Sub-area

Note: The information displayed on this map is not to scale, does not accurately reflect approved land-use and planning boundaries, and may be out of date. For more information on precise boundaries, the appropriate municipality should be consulted. For more information on Greenbelt Area boundaries, the Greenbelt Plan 2016 should be consulted. The Province of Ontario assumes no responsibility or liability for any consequences of any use made of this map.

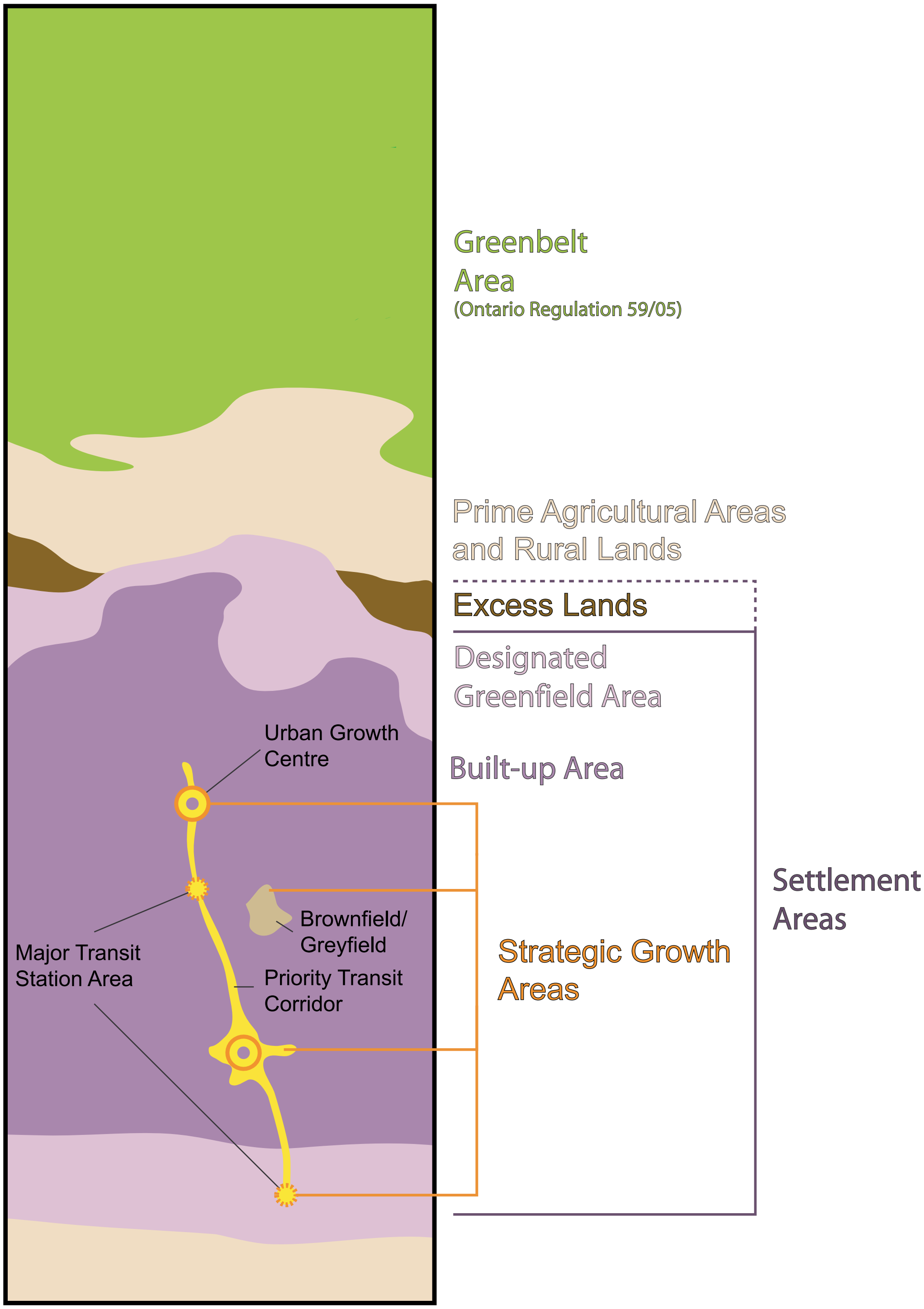
Ontario

PLACES TO GROW

PROPOSED GROWTH PLAN FOR THE GREATER GOLDEN HORSESHOE, 2016

APPENDIX 1
Context Map: Location of the Greater Golden Horseshoe within Ontario

The information displayed in the map above is not to scale. This appendix is included for information only and should not be read as a part of the Growth Plan for the Greater Golden Horseshoe.



Ontario

PLACES TO GROW
GROWTH PLAN FOR
THE GREATER GOLDEN HORSESHOE 2006

APPENDIX 2
Illustration Diagram: Growth Plan Land-use Terminology

The information displayed in the map above is not to scale. This appendix is included for information only and should not be read as a part of the Growth Plan for the Greater Golden Horseshoe.

Implementation

How to read this section

This implementation section would not form part of the text of the Growth Plan for the Greater Golden Horseshoe, 2016. The section sets out actions that are proposed to be taken as part of implementing the Growth Plan, 2016, if approved.

This section includes provincial actions that are proposed to be taken as part of implementing the Growth Plan, 2016, if approved. These include –

- A proposed timeframe, to be established by the Minister, for municipalities to bring official plans into conformity with the Growth Plan, 2016, if approved; and
- A proposed approach to minimizing impacts on planning matters that may be in process at the time that the Growth Plan, 2016, if approved, takes effect.

The Ministry of Municipal Affairs and Housing welcomes your feedback on these proposed actions.

Proposed Timeframe for Implementation

Under section 12 of the Places to Grow Act, 2005, the official plan of a municipality must be brought into conformity with a growth plan within three years of the growth plan coming into effect. Subsection 12(3) gives the Minister the ability to set an alternate date for a municipality to meet the conformity requirements.

In order to synchronize the timeframe for municipal implementation of the Growth Plan, 2016, if approved, with timeframes for implementation of the revised Greenbelt Plan and the revised Oak Ridges Moraine Conservation Plan, if approved, the Minister is proposing to extend the timeframe for Growth Plan conformity to a date that is five years after the Growth Plan, 2016, if approved, takes effect.

Proposed Effective Date and Transition

In accordance with subsection 14(1) of the Places to Grow Act, 2005, all decisions made under the Planning Act and Condominium Act, 1998 shall conform with a growth plan that applies to that growth plan area. Subsection 3(5) of the Planning Act provides that decisions in respect of planning matters shall conform with provincial plans that are in effect on the date of decision.

The effective date of the Growth Plan, 2016, if approved, will be the date specified by the Lieutenant Governor in Council in an approval under section 10 of the Places to Grow Act, 2005. Any matter commenced, but where a decision(s) remains to be made prior to the effective date of the Growth Plan, 2016, if approved, would be subject to the policies of the Growth Plan, 2016, if approved. The only proposed exceptions would relate to matters that were historically exempted from the application of the Growth Plan, 2006 by O.Reg. 311/06.

In order to facilitate implementation, it is proposed that the Growth Plan, 2016, if approved, may be released to the public for a limited period of time in advance of its effective date, as was done for PPS, 2014. It is proposed that the effective date for the Growth Plan, 2016, if approved, would be co-ordinated with the effective date for the Greenbelt Plan (2016), Oak Ridges Moraine Conservation Plan (2016) and Niagara Escarpment Plan (2016), if approved.

Further, it is proposed that the Minister will review the existing transition regulation for the Growth Plan, O. Reg. 311/06, and consider amending the provisions that apply to the Greater Golden Horseshoe Growth Plan Area to remove any provisions that are no longer needed or to clarify certain provisions, where necessary. Any changes to O. Reg. 311/06 would come into force on the same date that the Growth Plan, 2016, if approved, would take effect.

Seeking Feedback

The Ontario government is seeking feedback on the proposed changes to the plans.

Provide your feedback

We want to hear your comments and feedback on the proposed changes to the plans.

Please visit www.ontario.ca/landuseplanningreview to:

- Submit or upload your feedback and comments using the online e-form by September 30, 2016.
- Learn more about attending a Public Open House in your area.

Other ways to provide feedback

You also have the option to submit comments using one of the other methods listed below.

Environmental Bill of Rights Registry at www.ontario.ca/ebr

1. Proposed Growth Plan for the Greater Golden Horseshoe, 2016. Notice #012-7194
2. Proposed Greenbelt Plan (2016). Notice #012-7195
3. Proposed Oak Ridges Moraine Conservation Plan (2016). Notice #012-7197
4. Proposed Niagara Escarpment Plan (2016). Notice #012-7228
5. Proposed Amendment to the Greenbelt Area Boundary Regulation. Notice #012-7198

All comments received on proposed changes to the Niagara Escarpment Plan will also be shared with the Niagara Escarpment Commission. Comments can also be submitted directly to the Niagara Escarpment Commission at www.escarpment.org/planreview.

Regulatory Registry at www.ontariocanada.com/registry

1. Proposed Amendment to the Greenbelt Area Boundary Regulation. Notice #16-MAH017
2. Proposed Oak Ridges Moraine Conservation Plan (2016). Notice #16-MAH016

Comments may also be mailed to:

Land Use Planning Review
Ministry of Municipal Affairs and Housing
Ontario Growth Secretariat
777 Bay Street, Suite 425 (4^{th} floor)
Toronto, ON M5G 2E5

The deadline for providing feedback is September 30, 2016.

Notice Regarding Collection of Information

Any collection of personal information for the Co-ordinated Land Use Planning Review is in accordance with subsection 39(2) of the Freedom of Information and Protection of Privacy Act. It is collected under the authority of the legislation establishing the four plans for the purpose of obtaining input on revisions to the plans.

If you have questions about the collection, use, and disclosure of this information please contact:

Ministry of Municipal Affairs and Housing
Senior Information and Privacy Advisor
777 Bay Street
Toronto, Ontario, M5G 2E5
416-585-7094

Organizations and Businesses:
Comments or submissions made on behalf of an organization or business may be shared or disclosed. By submitting comments you are deemed to consent to the sharing of information contained in the comments and your business contact information. Business contact information is the name, title and contact information of anyone submitting comments in a business, professional or official capacity.

Individuals:
Personal contact information will only be used to contact you and will not be shared. Please be aware that any comments provided may be shared or disclosed once personal information is removed. Personal information includes your name, home address and personal e-mail address.

Ministry of Municipal Affairs and Housing

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NOTICE OF MEETING – AVIS DE RÉUNION

TO ***A***	**Canadian Nuclear Safety Commission** Dave Newland, Ross Richardson, Laura Andrews, Francis Martel **Ontario Power Generation** Ray Davies, Leslie Mitchell, Allan Webster **Emergency Management Ontario** Kathy Bleyer **Durham Region** Alex Georgieff Roger Saunders **Municipality of Clarington** Janice Szwarz Faye Langmaid	**Ontario Ministry of Municipal Affairs and Housing** Darryl Lyons, Philip Parker, Viki Eric, Ken Petersen **Ontario Ministry of Energy** Cheryl O'Donnell **Ontario Ministry of Environment** May Lyn Trudelle, Heather Watt, Kate Kirvan **Ontario Ministry of Infrastructure** Norma Forrest
SUBJECT ***OBJET***	**Teleconference - Next Steps on JRP Recommendation #43 – Land Use Policy - Engagement with Stakeholders** JRP Report: http://www.ceaa.gc.ca/052/document-eng.cfm?did=55381 Government of Canada Response: http://www.ceaa.gc.ca/052/document-html-eng.cfm?did=55542	
AGENDA OR REMARKS ***ORDRE DU JOUR OU REMARQUES***	1. Welcome & introductions 2. High level overview of what we've heard to date: - coordinated approach with multiple agencies required - key documents include the Provincial Policy Statement (PPS), Durham Region Official Plan, Clarington Official Plan, the Provincial Nuclear Emergency Response Plan (PNERP), and RD-346, Site Evaluation for New Nuclear Power Plants - clarification required on 3 km zone (e.g. where measured, technical basis) - clarification on JRP's use of the term "residential" (e.g. high or low density) - stakeholder workshop to discuss next steps 3. Planning for stakeholder workshop in spring/summer 2013 - proposed dates/location - workshop objectives - workshop agenda - option for external facilitator 4. Transfer of CNSC project officer role 5. Other matters of interest 6. Next steps 7. Meeting closeout	

<table>
<tr><td rowspan="3">LOCATION OF MEETING

ENDROIT DE LA RÉUNION</td><td colspan="2">Location/ Endroit: Teleconference (# 1-877-413-4782, ID # 4335794)</td></tr>
<tr><td colspan="2">Date: Tuesday, April 23, 2013</td></tr>
<tr><td>Time/Heure: 1:30 pm – 3:00 pm</td><td>Duration/Durée: 1.5 hours</td></tr>
<tr><td>ARRANGED BY
ORGANISÉ PAR</td><td>Name/Nom: R. Richardson</td><td>Tel: 943-0241</td></tr>
</table>

Canadian Nuclear Safety Commission / Commission canadienne de sûreté nucléaire

P.O. Box 1046 Station B 280 Slater Street Ottawa, Ontario Canada K1P 5S9	C.P. 1046 Succursale B 280, rue Slater Ottawa (Ontario) Canada K1P 5S9	***Meeting Minutes*** ***E-Docs #4125712*** ***File/Dossier:2.01***
SUBJECT ***OBJET***	**All Stakeholders Teleconference – Next Steps on Joint Review Panel Recommendation #43 - Land Use Policy**	
DATE **(TIME/*HEURE*)**	April 23, 2013 (1:30 pm – 3:00 pm)	
ATTENDEES ***PARTICIPANTS***	**Canadian Nuclear Safety Commission** Dave Newland, Ross Richardson, Laura Andrews, Francis Martel **Ontario Power Generation** Ray Davies **Emergency Management Ontario** Kathy Bleyer **Durham Region** Alex Georgieff Roger Saunders **Municipality of Clarington** Janice Szwarz Faye Langmaid	**Ontario Ministry of Municipal Affairs and Housing** Darryl Lyons, Philip Parker **Ontario Ministry of Energy** Sarah Paul **Ontario Ministry of Environment** Heather Watt **Ontario Ministry of Infrastructure** Norma Forrest
AGENDA	1. Welcome & introductions 2. High level overview of what we've heard to date: 3. Planning for stakeholder workshop in spring/summer 2013 4. Transfer of CNSC project officer role 5. Other matters of interest 6. Next steps 7. Meeting closeout	

DRAFT MINUTES

Actions highlighted in **bold blue text.**

2. High level overview of what we've heard

Ross Richardson (CSNC) presented key messages heard from stakeholders to date as follows:

- coordinated approach with multiple agencies required
- key documents include the Provincial Policy Statement (PPS), Durham Region Official Plan, Clarington Official Plan, the Provincial Nuclear Emergency Response Plan (PNERP), and RD-346, Site Evaluation for New Nuclear Power Plants
- clarification required on 3 km zone (e.g. where measured, technical basis)
- clarification on JRP's use of the term "residential" (e.g. high or low density)
- stakeholder workshop to discuss next steps was recommended by stakeholders

Further roundtable discussion highlights:

- MAH indicated the comment review period was closed for the Draft PPS but are still accepting comments as part of the PPS review. Approximately 600

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submissions were received following draft policy release in Sept 2012. These are still being reviewed. It is anticipated that the PPS review will be completed in 2013. MAH outlined that the PPS applies to all of Ontario and does not contain site specific policies. The draft 2012 policies that were released for consultation propose a new policy that requires planning authorities to consider land use compatibility between sensitive uses and major facilities, which can include energy generating facilities. Many of the policies of the PPS are supplemented by technical guidance materials that outline more direct parameters for achieving the policy outcomes (e.g. Ontario Ministry of Natural Resources - Natural Heritage Reference Manual).

- Region of Durham noted it supports specific consideration for NPP's in the final draft of the PPS, given distances and sensitivities. Region of Durham requires an actual number in relation to the specific distance for land use planning purposes. Various plans are at different stages of revision/review/approval (Official Plan approved Jan 2012, Greenbelt Plan expected 2014, Growth Plan coming up (population & employment targets out to 2036 and 2041).
- The Clarington review cycle is same as Durham Regions. Their Official Plan is currently in revision. This must conform with the Durham Regional Plan, Growth Plan and the 'Places to grow' legislation.
- Future Land Use discussions should also address the ability of senior levels of government to locate sensitive facilities such as prisons, etc. within the defined setback for nuclear power stations.
- The PNERP revision is just being initiated following Fukushima and targeting end 2014 for a revised planning basis. Protective zones are in scope of the review with potential for change. The 3km (planning zone for emergency protective measures) and 10 km zones are from the current version of the PNERP.
- The 3km zone is the area where more prompt response is needed, based on accident scenarios. The 3km zone is intended to be a precaution for stochastic health effects (i.e. priority area for evacuation or sheltering) but could go out to 10km. The 10km zone role is for sheltering, KI pills and evacuation. The zone out to 50km is focused on ingestion.
- The 'new science' will look at Fukushima, multi-unit, external factors (weather) and extended power outage effecting off-site response.
- The Region and EMO agree that the distance for zones should be based from the center point of the containment building (from plant).

3. Planning for stakeholder workshop in spring/summer 2013

Discussion focused on agreement that a facilitator would be engaged and further details would be forthcoming. Some discussion as to objectives of the workshop should be to encompass the scope of JRP recommendations # 44,45 and 59 as well. This information will be conveyed to the facilitator to plan the working session.

4. Transfer of CNSC Project Officer role

The Project Officer for the CNSC on Land Use Planning will be Laura Andrews effective April 24, 2013. Ross will continue to participate as much as his new role will allow. Please feel free to copy him on communications. Ross will participate in the workshop being planned for June 2013.

5. Other matters of interest

It was noted that the PNERP does not speak to land use planning, only to protective measures.

6. Next Steps

- The CNSC will engage a contractor and facility for the workshop targeted for end of June, 2013.
- All agencies will provide input by May 10, 2013 to CNSC on issues/concerns that they would like addressed at the workshop.

Briefing Note

Issue:

The OPG Board of Directors approved a recommendation by OPG management to extend the nominal life of the Pickering B units instead of refurbishing them at this time.

Summary:

On November 19, 2009, the OPG Board of Directors approved taking initiatives to extend the nominal life of the Pickering units (referred to as Continued Operations), and not to refurbish the Pickering B units at this time.

In providing this recommendation to the Board, OPG management assessed the technical, regulatory, financial, and schedule implications of the options.

OPG Decision Framework:

The recommendation by OPG management was based on analyses of several factors, namely:

- cost effectiveness
- technical feasibility based on plant condition
- regulatory impacts, and
- schedule

The outcome of the analyses of each of these factors is provided below:

Cost Effectiveness:

- Significant investments would be required to mitigate regulatory risks associated with extending the life of the units beyond 2016. The costs would result from the need to perform increased maintenance and inspections.

- The refurbished units retain a significant risk of less than optimal performance post refurbishment.

- Comparative analysis showed that operating costs for the units would be high relative to industry standards due to design complexity.

- The complexity of the plant results in more people being required to operate it when compared to the industry at large.
- The cost to refurbish the units would be approximately $10.7 billion, or $2 billion per unit plus a contingency.
- This compares to 2008 estimates for refurbishment of Bruce power units at $1.7 billion per unit, and Point LePreau at $1.1 billion.
- The cost of all electricity produced over the life of the refurbished units was estimated to be about 9.6 cents per kilowatt hour.
- By comparison, estimates for electricity costs produced by refurbished Darlington units show less than 8 cents per kilowatt hour.
- Cost benefit analysis showed that little safety improvement would have been derived as a result of investing 100 M dollars would result in little safety improvement.

Technical feasibility based on plant condition:

- The plant design, in addition to being complex, the units are small and include a large number of components relative to today's designs. Pickering B units are nominally 515 MW, compared to Darlington at 881 MW, or new build designs at approximately 1,000 MW or larger.
- There exists high potential for discovery of defects which could make refurbishment unfeasible.

Regulatory impacts:

- As an older design, the Pickering B units do not meet modern standards. For example, whereas modern plants may contain dual safety trains, the Pickering unit safety units are typically single trains. This has the potential to present regulatory challenges in the future. This would result in significant ongoing regulatory scrutiny.
- The CNSC requirement to review as built plant standards versus modern standards every ten years results in the potential need for significant plant upgrades in the future.
- The ability to continue to operate for 30 years in a targeted population growth area (as defined by the Province of Ontario) also carries the potential for significant regulatory sanction in response to public intervention.

Schedule impacts:

- Shutting the Pickering B units down for refurbishment at their end of nominal life would result in a significant impact on the overall availability of OPG's fleet to meet power demands at a time when a number of the Province's units would also be shut down for refurbishment.

- The time frame for the shut down of the Pickering units would overlap with the shut down of both the Darlington and Bruce units due to the need to procure steam new generators. Steam generator procurement requires a 5-6 year lead time.

Background:

- Pickering B units (5 – 8) were initially placed in service in 1983 – 1986 with a nominal life expectancy of 30 years based on pressure tube life.

- The current predicted nominal end of service life is 2014 – 2016 for the units

- OPG, in response to a government directive of 2006, began the assessment of the feasibility of refurbishing existing nuclear plants as well as the environmental assessment of the impacts of refurbishing Pickering B.

- The feasibility studies on Pickering B have progresses significantly allowing OPG management to develop an improved understanding of the regulatory requirements, environmental impacts, scope of the project and refurbishment costs.

- OPG management has explored the Continued Operation of the Pickering B units for an additional 4 years beyond their current nominal operating lives and is of the view that continued operation is possible with additional investments

- Realization of this option would be of significant benefit to Ontario's electricity system during the 2014 – 2020 period when significant refurbishments will be occurring across the fleet.

MEI Staff Position

- After discussing OPG's rationale and review of the decision making framework, MEI staff concurred with OPG on their decision to continue to operate the Pickering B units and not refurbish them at this time.

Prepared by: Cedric Jobe (5-6545)
Director, Nuclear Supply Branch
January 08, 2010

\
Approved by: Rick Jennings
ADM, Office of Energy Supply, Transmission and Distribution
January 08, 2010.

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OPG Decision Framework:

The recommendation by OPG management was based on analyses of several factors, namely:

- cost effectiveness
- technical feasibility based on plant condition
- regulatory impacts, and
- schedule

The outcome of the analyses of each of these factors is provided below:

Cost Effectiveness:

- Significant investments would be required to mitigate regulatory risks associated with extending the life of the units beyond 2016. The costs would result from the need to perform increased maintenance and inspections.

- The refurbished units retain a significant risk of less than optimal performance post refurbishment.

- In comparison, the cost to extend the life of 4 Pickering units to 2020 is approximately $1.3B, with an addition requirement of approximately $100M for increased inspection and maintenance between 2009 and 2013.

- Comparative analysis showed that operating costs for the units would be high relative to industry standards due to design complexity.

- The complexity of the plant results in more people being required to operate it when compared to the industry at large.

- The cost to refurbish the units would be approximately $10.7 billion, or $2 billion per unit plus a contingency.

- This compares to 2008 estimates for refurbishment of Bruce power units at $1.7 billion per unit, and Point LePreau at $1.1 billion.

- The cost of all electricity produced over the life of the refurbished units was estimated to be about 9.6 cents per kilowatt hour.

- By comparison, estimates for electricity costs produced by refurbished Darlington units show less than 8 cents per kilowatt hour.

Technical feasibility based on plant condition:

- The plant design itself makes refurbishment more complex. As older designs a greater number of components required to generate less power than in newer CANDU units. For example, whereas the Pickering units units are composed of 12 steam generators and 16 heat transport pumps, the Darlington units by comparison are composed of 4 steam generators and 4 heat transport pumps.

- The age and higher number of parts raises the potential for discovery of defects such as calandria tube defects which could make refurbishment unfeasible as a result of the resources required to refurbish them.

- The power output from the Pickering units is in the 500 Mw range, as compared to Darlington units which have an output in the range of 880 Mw. This fact significantly affects the cost of electricity generated from the respective plants.

Regulatory impacts:

- As an older design, the Pickering B units do not meet modern standards. For example, whereas modern plants may contain dual safety trains, the Pickering unit safety units are typically single trains. This has the potential to present regulatory challenges in the future. This would result in significant ongoing regulatory scrutiny.

- The CNSC requirement to review as built plant standards versus modern standards every ten years results in the potential need for significant plant upgrades in the future.

- The ability to continue to operate for 30 years in a targeted population growth area (as defined by the Province of Ontario) also carries the potential for significant regulatory sanction in response to public intervention.

Schedule impacts:

- Shutting the Pickering B units down for refurbishment at their end of nominal life would result in a significant impact on the overall availability of OPG's fleet to meet power demands at a time when a number of the Province's units would also be shut down for refurbishment.

- The time frame for the shut down of the Pickering units would overlap with the shut down of both the Darlington and Bruce units due to the need to procure new steam generators. Steam generator procurement requires a 5-6 year lead time.

Background:

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- The feasibility studies on Pickering B have progressed significantly allowing OPG management to develop an improved understanding of the regulatory requirements, environmental impacts, scope of the project and refurbishment costs.

- OPG management has explored the Continued Operation of the Pickering B units for an additional 4 years beyond their current planned operating lives and is of the view that continued operation is possible with additional investments

- Realization of this option would be of significant benefit to Ontario's electricity system during the 2014 – 2020 period when significant refurbishments will be occurring across the fleet.

MEI Staff Position

- After discussing OPG's rationale and review of the decision making framework, MEI staff concurred with OPG on their decision to continue to operate the Pickering B units and not refurbish them at this time.

January 11, 2010

Prepared by: Cedric Jobe (5-6545)
Director, Nuclear Supply Branch

Approved by: Rick Jennings
ADM, Office of Energy Supply, Transmission & Distribution

ONTARIOPOWER GENERATION

Report

Internal Use Only	
Document Number: NK30-SR-01320-00001	
Sheet Number: N/A	Revision: R003

Title: **PICKERING B SAFETY REPORT - PART 1**

Pickering B Safety Report - Part 1

NK30-SR-01320-00001-R003
2009-09-15

Order Number: N/A
Other Reference Number: N/A

Internal Use Only

Revised by: M. Ferrarelli 14 OCT 2009
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Engineering/Applied Science Trainee
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Pickering B

Reviewed by: K. Woods 2009 Oct 14
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Section Manager
Plant Design Engineering
Pickering B

Approved by: B. Morrill 14-OCT-2009
Brent Morrill — Date
Senior Manager
Plant Design Engineering
Pickering B

Table of Contents

List of Tables and Figures

Revision Summary

Revision Number	Date	Comments
R003	2009-09-15	Pickering B Safety Report has been re-templated to align with the format of the 2009 Pickering A Safety Report. Section 1: <u>Modifications:</u> Table 1-1 – The table has been modified to reflect that units 2 and 3 at Pickering A have been placed in safe storage as of 2005. Figure 1-4 – The site layout drawing has been updated to the version issued in 2009. <u>Corrections:</u> Secton 1.5 – References 1-4, 1-5, and 1-6 of revision 002 have been removed. Section 2: <u>Modifications:</u> Section 2.1.4 – The population of Ontario has been updated according to statistics from the 2006 National Census. The corresponding reference, R-86, has also been updated. Section 2.5.2.6 – Results from a feasibility study of an advance warning system of algae influx are provided. An algae net has been installed to reduce algae influx into the station. Table 2-1 – Values for area, population, and population density have been updated. Table 2-27 – Values have been updated to reflect data taken between 2001 and 2005.

2.2 Land Use

As part of the Greater Toronto Area, Durham Region is experiencing rapid population growth. The associated increase in the number of households, particularly single or detached housing units in the region, creates a continuous demand for land to build new dwellings and community facilities. In addition, economic growth also creates a parallel demand for industrial, commercial and transportation land uses. All these human activities continue to grow on limited supply of productive agricultural land. From 1981 to 1986, for example, the Toronto urban-centred region absorbed 100 km^2 of prime agricultural land (Canada, 1991); additional several hundred km^2 of land will be urbanized in the next two decades.

The Pickering site is close to residential, industrial, agricultural, recreational, municipal service and transportation lands. Existing residential as well as other land uses in vicinity of the site are illustrated in Figure 2-6. This figure is taken from the Regional Municipality of Durham official plan and is used to demonstrate existing land use designations [R-82].

2.2.1 Agriculture

Agricultural data presented in this report were derived from the most current (2001) Statistics Canada agricultural census of Ontario [R-68].

An inventory of site-specific agricultural data, which are pertinent to the food chain pathway radiological analysis, has been compiled for areas within 100 km (62 mi) of the Pickering site. Table 2-3 to Table 2-6 show the summary results by distance and by sectors from the generating station. The inventory includes estimates of two major human food categories: Vegetable and Livestock. The source of information for these tables were Agricultural Census 2001, however, the data were reformatted for specific radii and wind directions.

The first major category is further divided into three groups based on agricultural transport characteristics. These include: Vegetables, Fruits, and Crops.

The second major category includes livestock food items of beef, pork, mutton, and poultry. These foodstuffs are of concern as a result of animals consuming contaminated vegetation.

2.2.2 Industry

The area, bounded by Highway 401 on the North, Duffin Creek on the East, the Pickering site on the South and Sandy Beach Road (the eastern limit of residential development in Bay Ridges and Fairport) on the West, has been designated for industrial development. To date many industries have located here, particularly around Brock Road. These are mostly light manufacturing enterprises but also include repair shops, warehouses and laboratories. The trend towards light industrial growth is expected to continue in the area.

Durham Region is one of the fastest growing areas in Canada [R-89]. The main sectors are Advanced Manufacturing/Automotive, Energy and Agri-Business [R-89]. Each of these sectors is comprised of the following: the Advanced Manufacturing/Automotive sector includes Parts, Logistics, Automation and Auto Assembly; the Energy sector includes Generation, New Technologies, Research, Alternative, and Conservation; and the Agri-Business sector includes Nurseries, Bio-Diesel and Agri-tech [R-89].

According to the 2005 City of Pickering Community Profile, more than 31,000 people are currently working at businesses which are located in Pickering [R-90]. The main industries in Pickering are Energy, Electronics, Telecommunications and Wireless Technology, Pharmaceuticals, Logistics, International Call Centres, Advanced Manufacturing and Warehousing, Environmental Technologies and Engineering, and Automotive Related Products [R-90]. The energy sector alone accounts for almost 20% of the labour force in Pickering [R-91].

There are also plans to develop Pickering into an energy sector cluster through the development of the Durham Strategic Energy Alliance (DSEA) [R-91].

The top five industries in the Town of Ajax are: Manufacturing, Retail Trade, Heath Care & Social Assistance, Accommodation & Food Services, and Educational Services [R-92]. Manufacturing alone accounts for 28% of the town's labour force, with transportation equipment, chemicals, fabricated metal, paper, and machinery as the main manufacturing sectors [R-92]. In the Town of Whitby, the main industries are Steel, Furniture, Pharmaceutical, Plastics, Packaging, Telecommunications, Paper, Automotive, Publishing, Electronics, Tool Manufacturing, Defence Technology, Consumer Products, Recycling and Environmental Management, Engineering, Warehousing, Fabricated Metals, and Food Processing [R-93].

2.2.3 Fishing

2.2.3.1 Fisheries Resources

There are over 60 species of fish in the waters from Etobicoke Creek (western Metropolitan Toronto) to Duffin Creek, according to the Ministry of Natural Resources surveys. This represents almost 50 per cent of the fish species found in Ontario. In the immediate vicinity of Pickering NGS A brown bulkhead, alewife, white perch, shad, smelt, white sucker and yellow perch are most common. The major spawning areas near the station are the Rouge River, Frenchman's Bay and Duffin Creek.

2.2.3.2 Commercial Fishing

Table 2-7 shows the commercial catches in Lake Ontario (Quota Zone 1-8) from 1993 to 1997 and 2001. The commercial catches for 2005 are listed in

The location of recreation areas within 24 km (15 mi) of Pickering NGS A is illustrated by Figure 2-9. More specific information concerning the larger areas is provided in Table 2-10. A number of small municipal parks are not included due to the scale used. However, there are a number of sports fields and playgrounds in Pickering, some of which include softball/baseball diamonds, play units, basketball courts, soccer fields, tennis courts, among other facilities [R-99].

As shown in Table 2-10, Petticoat Creek, about 4 km west of the Pickering NGS site, is the largest recreational area in the Town of Pickering. The 68-hectare conservation area has been designated under the Metropolitan Toronto Region Conservation Authority Greenspace Plan as a major recreation area. It is open from spring to fall with facilities of artificial swimming lake, group camping, nature trails, a picnic area, and beach. Greenwood Conservation area is also located in Pickering.

Figure 2-10 illustrates recreation areas within 3.2 km of Pickering NGS. This map has been reproduced from a detailed map [83] produced by the city of Pickering, Planning & Development Department, Information & Support Services. There are a number of locations for water related recreational activities. Marinas and public parks are located on Frenchman's Bay. Its proposed development envisages expansion of the water-oriented uses including commercial marinas and public boat launching facilities. The head of the bay will be retained as a marsh area. Other waterfront areas in Pickering which are of recreational interest include Petticoat Creek Conservation Area, Rotary Frenchman's Bay West Park, Millenium Square, and Beachfront Park. Rouge Park, one of the largest urban area parks in North America [R-99], is located West of Pickering.

A small municipal park at the foot of Liverpool Road, just west of Pickering NGS boundary, is part of Ontario Power Generation's park lands. In this area, there are fitness trails and cricket pitch facilities. Bay Ridges Kinsmen Park is also part of Ontario Power Generation's park lands, but it is leased to the Town of Pickering for park purposes. This area has been developed with tennis courts, ball diamonds, and soccer fields.

About 3 km east of Pickering NGS is Duffin Creek where a golf and curling club is presently located. The planning concept for this area includes a boat launch, an informal beach, playground, and wildlife and fisheries habit enhancement projects.

2.2.4 Transportation

The Pickering site is serviced by a considerable transportation network of railways and provincial and municipal roads. The station has ready access to provincial Highway 2 and Highway 401 both running East West. Both the Canadian National and Canadian Pacific main rail lines pass within 10 km (6 mi) to the North. The GO Transit network operates on the Canadian National tracks near Highway 401.

The Brock Road interchange is the main access point to the site from Highway 401. The distance from the interchange to the site is 1.6 km.(1 mi) To accommodate the increasing amount of traffic generated by the new industries along Brock Road and still provide good access to the station, the roadway has been upgraded to a four-lane arterial road. Access to the site is also possible by municipal roads connecting with the Pickering and Ajax interchanges on Highway 401 and Highway 2.

There are eight airports that handle the majority of the Greater Toronto Area's (GTA) aviation requirements: Brampton Airport, Burlington Air Park, Hamilton Airport, Oshawa Airport, Buttonville Airport, Toronto City Centre Airport, Markham Airport and Toronto Pearson [R-100]. A map of the main airports in the GTA, including the location for the proposed Pickering Airport is found in Figure 2-11.

Hamilton Airport handles aviation requirements in the western regions of the GTA while Toronto Buttonville Municipal Airport and Oshawa Municipal Airport handle the aviation requirements to the East [R-100]. Since the prospect of expansion at Toronto Pearson Airport is limited, a proposal for an airport at Pickering is under consideration [R-100]. The proposed Pickering Airport would then handle the aviation requirement in the eastern regions of the GTA, potentially replacing Toronto Buttonville Municipal Airport, Oshawa Municipal Airport, Markham Airport and Toronto City Centre Airport [R-100].

The proposed Pickering Airport would be located on the 7,530 hectares of the Pickering Lands [R-100]. The approximate boundaries of the proposed airport include: Highway 48 in Markham in the West, Webb Road in Uxbridge in the North, Sideline 16 in Pickering in the East and Highway 7 in the South. Detailed information about the proposed Pickering Airport can be found in [R-100].

In addition to the above mentioned airports, there are other airports and airstrips located near Pickering. Table 2-12 shows the airports and airstrips within an approximated 100-km radius of Pickering that have runways greater than 100 ft wide.

2.3 Geology

This region of Southern Ontario is underlain by a thick sequence of relatively undeformed Paleozoic sedimentary rock formations that consist of soft, thinly-bedded shale's and hard, medium to massive-bedded limestone's, shaly limestone's, dolomites and sandstones. These formations dip gently to the South and Southwest at gradients of from about 4 to 8.7 m/km (1 in 250 to 1 in 120). The sedimentary rocks lie unconformably on the Precambrian basement which consists of mainly granitic and gneissic rocks.

2.3.1 Regional Geology

The bedrock comprises flat-lying, Paleozoic shales and limestones of Ordovician age. These sedimentary rocks are approximately 212 m (695 ft) thick and overlie Precambrian granitic rocks [2].

Joints are a predominant structural feature in Southern Ontario within the Paleozoic formations. The joints are often well developed and close spaced within the near

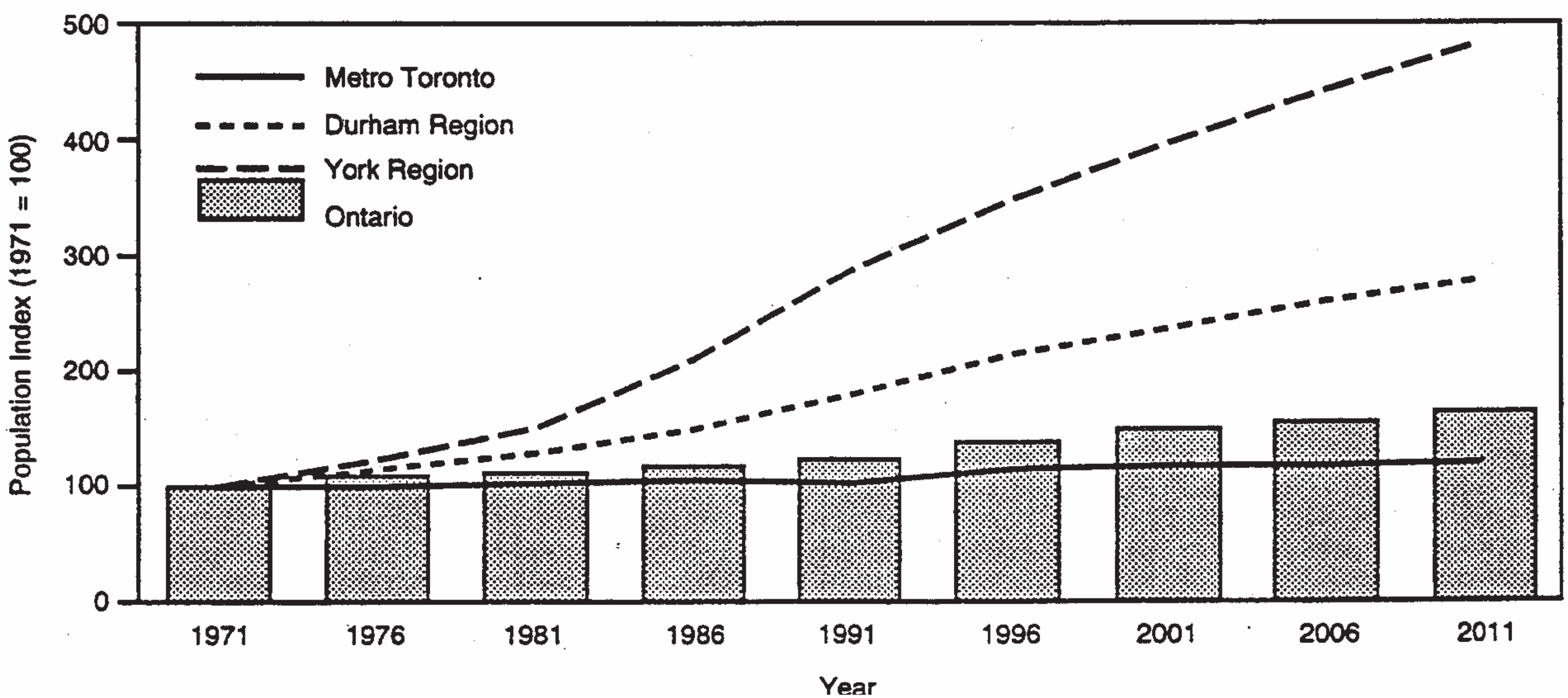

Figure 2-3: Historical Population Trends of Ontario and Municipalities around Pickering NGS (Approximate Values)

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Durham Region Risk-Specific Plan

Durham Nuclear Emergency Response Plan (DNERP)

Foreword

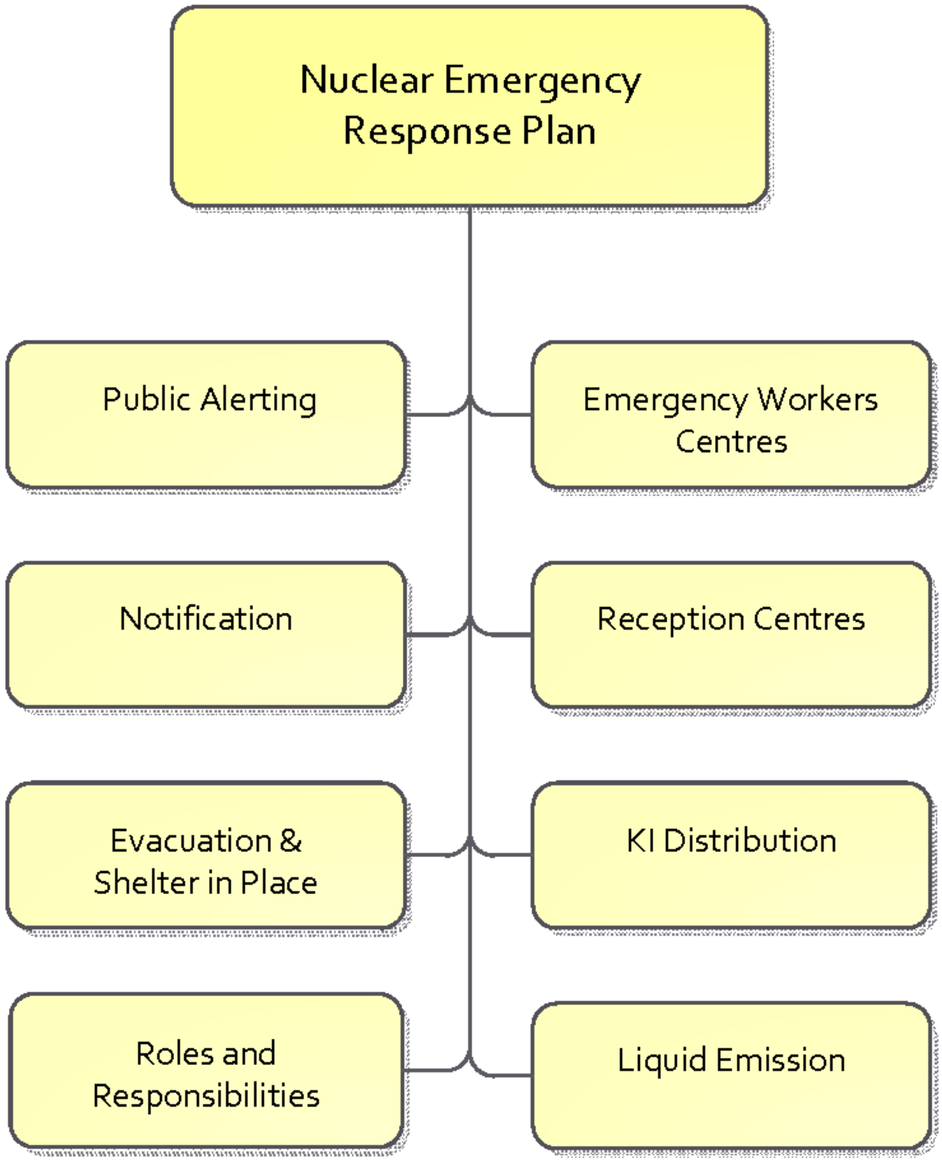
The Durham Nuclear Emergency Response Plan (DNERP) conforms to the Provincial Nuclear Emergency Response Plan, pursuant to Section 8 of the Emergency Management and Civil Protection Act, R.S.O. 1990, E.9.

The Durham Nuclear Emergency Response Plan is a risk-specific plan under the Durham Region Emergency Master Plan and details offsite response actions to be taken in the event of a nuclear emergency at the Darlington or Pickering Nuclear Generating Station.

This plan is issued under the authority of Regional By-Law 37-2015. Comments or suggestions relating to this plan should be directed to:

Durham Emergency Management Office (DEMO)
The Regional Municipality of Durham
Box 623, 605 Rossland Road East
Whitby, ON L1N 6A3

Figure 1 - Diagram of Nuclear Emergency Response Plan Structure



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Overview of Durham Region Nuclear Plan Structure

The nuclear plans structure, which is illustrated in the diagram on the opposite page, consists of the following:

Durham Nuclear Emergency Response Plan (DNERP): The DNERP is the risk-specific plan for nuclear emergencies. It is based on the Durham Emergency Master Plan and the Provincial Nuclear Emergency Response Plan (PNERP) and prescribes the overall principles, policies, concepts, organizational structures and responsibilities for preparing for, and responding to, a nuclear emergency in Durham Region

Nuclear Support Functions: provide details on procedures in support of the DNERP and are issued separately:

- Roles & Responsibilities
- Public Alerting
- Notification
- Evacuation & Shelter-In-Place
- Reception Centres
- Emergency Worker Centres
- Potassium Iodide (KI) Distribution
- Liquid Emission – specific to radioactive leak only

Area Municipal Nuclear Emergency Response Plans: Plans of the municipalities in the Primary Zone will be consistent with the DNERP and will prescribe how the local municipality will plan for and respond to a nuclear emergency.

Implementing/Operating Procedures: Based on the above plans, Regional Departments, the Durham Regional Police Service and District School Boards should have developed implementing procedures that detail the methods by which assigned roles and tasks will be completed.

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Section 1.0 General

1.1 Background

For this plan, a nuclear emergency occurs when there is an actual or potential hazard to public health, property or the environment from ionizing radiation whose source is a major nuclear installation within or immediately adjacent to Ontario. Such a hazard will usually be caused by an accident, malfunction, or loss of control involving radioactive material.

Pursuant to Section 8 of the *Emergency Management and Civil Protection Act (EMCPA)*, the Province shall formulate an emergency plan for nuclear facility emergencies. Under the Provincial Nuclear Emergency Response Plan - Master Plan dated January 2009 (PNERP); Durham Region has been designated with off-site nuclear emergency planning and preparedness responsibilities for the Darlington and Pickering Nuclear Generating Stations. Durham Region must have a nuclear emergency response plan that conforms to the Provincial plan.

1.2 Aim

The aim of the Durham Nuclear Emergency Response Plan (DNERP) is to protect the health, safety and welfare of the citizens of Durham Region in the event of a nuclear emergency at the Darlington or Pickering Nuclear Generating Station by establishing an effective system of emergency management to prepare for, respond to and recover from a nuclear emergency event.

1.3 Scope

The DNERP sets out the offsite emergency response actions to be taken in Durham Region in response to a nuclear emergency at the Darlington or Pickering Nuclear Generating Station.

The DNERP outlines specific functional responsibilities to Regional departments, the Durham Regional Police Service (DRPS), local municipalities, school boards, host municipalities and other agencies and is consistent with the Provincial plan.

1.4 Legal Basis and Requirement

Pursuant to Section 8 of the *EMCPA*, the Lieutenant Governor in Council shall formulate an emergency plan for nuclear facility emergencies. The Province is primarily responsible for the off-site effects and response to a nuclear emergency. In a nuclear emergency, therefore, the Province will take the leading role in managing the off-site response. The Province, through the Provincial Emergency Operations Centre (PEOC), may issue operational directives or emergency orders.

Once a provincial declaration of emergency has been made, the Province has the power to make emergency orders and may delegate these powers to a Minister or to the Commissioner of Emergency Management.

Pursuant to Sections 3 and 8 of the *EMCPA,* the DNERP conforms to the Provincial Nuclear Emergency Response Plan (PNERP) - Master Plan (January 2009), as well as the PNERP implementing plans for the Darlington and the Pickering Nuclear Generating Stations (November 2009).

The Municipalities of Ajax, Clarington, Oshawa, Pickering and Whitby, identified Regional Departments, the Durham Regional Police Service, the Durham Region Emergency Medical Services, Durham Regional Transit, the Durham District School Board, the Durham Catholic District School Board, the Kawartha Pine Ridge District School Board and the Peterborough, Victoria, Northumberland and Clarington Catholic District School Board, should prepare nuclear emergency plans and implementing procedures to conform with the DNERP.

1.5 Declaration of Emergency and Plan Activation

The Regional Chair and Mayors of local municipalities, or designated alternates, may declare an emergency in their respective jurisdictions in response to an emergency event under Section 4 of the *EMCPA*.

In response to an emergency at the Pickering or Darlington Nuclear Generating Stations, the Regional Chair should consider such a declaration whenever the Provincial and Durham Region nuclear emergency plans have been partially activated and shall make such a declaration whenever the DNERP is fully activated.

Upon declaring a Regional emergency, the Regional Chair shall inform the Solicitor General of Ontario, Regional Council and local municipalities, and issue a news release. The head of council of an area municipality affected by the nuclear accident should also consider declaring a municipal emergency.

The Regional Chief Administrative Officer, designated alternate or the Director of Emergency Management for Durham Region may activate this Plan where such action is considered necessary, until the Regional Control

Group assembles or before the official declaration of the emergency by the Regional Chair, pursuant to Section 9 of the *EMCPA*.

1.6 Liability for Action

Pursuant to Section 9 of the *EMCPA*, employees of the Region and other boards and services with responsibilities under this plan are hereby authorized to take action to implement this Plan where such action is considered necessary, even though an emergency has not yet been formally declared.

Pursuant to Section 11 of the *EMCPA*, members of Council and Regional and local municipal employees are protected from personal liability for any act done in good faith in the implementation or the intended implementation of this emergency plan.

1.7 Administration of DNERP

The DNERP is a risk-specific support plan to the Durham Region Emergency Master Plan. The DNERP is coordinated with appropriate stakeholders and issued under the authority of the Chief Administrative Officer in accordance with Regional By-Law 37-2015. The Director of Emergency Management is authorized to create and amend any Regional risk-specific or support plan.

Authorized support functions that detail implementing procedures to the DNERP are shown on page iii.

Durham Region By-Law 36-2015 established the Durham Emergency Management Program Committee (DEMPC) to provide the Region with a higher level coordinating body to facilitate inter-departmental and municipal level cooperation regarding emergency management policy. The DEMPC is chaired by the Regional CAO The PNERP requires that each designated municipality under the plan form a Nuclear Emergency Management Coordinating Committee. The DEMPC will consider nuclear emergency planning and preparedness as part of its mandate and thus will meet the obligations of the Provincial plan.

Section 2.0 Nuclear Emergency Planning Basis

2.1 Radiation Hazard

While the probability is low, a nuclear reactor accident could result in radiation exposure and radioactive contamination of people (external and internal) and/or the environment.

Radiation exposure pathways are as follows:

- external contamination of skin and clothing from airborne radioactive material,
- direct exposure to radiation from radionuclides in the plume of gases or particles released,
- internal contamination by inhalation of airborne radioactive particles, and
- internal contamination by ingestion of contaminated foodstuffs or water.

The primary health effect of chronic low doses of radiation could be the induction of various types of cancers, typically with a latency period of 4 to 20 years.

2.2 Planning Objective

The purpose of nuclear offsite emergency planning is to consider all of the principal exposure pathways and prevent or minimize the radiation dose which the public could potentially receive. The aim is to ensure, to the extent possible, that no person offsite will be exposed to intolerable levels of radiation as a result of an accident.

2.3 Planning Basis – Basic Offsite Effect

Formal risk analysis of nuclear reactor accidents indicates that there is generally an inverse relationship between the probability of occurrence of an accident and the severity of its likely consequences.

If an accident were to occur at either Nuclear Generating Stations (NGS), the most probable result would be that the effects would be confined within the station boundary.

The Provincial plan has selected a “basic offsite effect” to serve as the basis for nuclear emergency management. The basic offsite effect is characterized by one or more of the following:

- a warning period would usually exist before the offsite effects occur,
- the main hazard would be from external exposure to and inhalation of radionuclides,
- radiation doses would be low (it is assumed that the individual dose to the most exposed person at the station boundary will not exceed 250 mSv (25 rem),
- environmental contamination would be limited to very low levels,
- low level radioactive emissions could continue for some time (days or weeks), and
- The impact would not extend beyond 10 km around the nuclear station.

An example of an accident resulting in a basic offsite effect is a loss of coolant accident, with the following typical progression:

- after an initial “puff” release of radioactivity from the reactor building, a “box-up” would occur whereby all pathways to the environment are sealed,
- ducts connecting the reactor building to the vacuum building would open, drawing all radioactive material from the damaged reactor fuel into the vacuum building,
- during a retention period in the vacuum building, some of the radioactivity would decay,
- given suitable meteorological conditions, the contained radioactivity would be vented through filters in a direction away from populated areas, and
- once the pressure in the vacuum building nears normal atmospheric pressure venting could be intermittent or continuous and could last for weeks. The level of radioactivity being released would progressively decline with time.

2.4 Planning Basis – More Severe Offsite Effect

Notwithstanding the above, an accident could occur that results in more severe offsite effects. The probability of such an accident is assessed to be very low. A more severe accident would be defined by one or more of the following:

- the time between the accident and any release of radioactivity may be generally limited,
- radiation doses could be high (greater than 250 mSv) for the most exposed person at the station boundary,

- radioiodines and particulates could form a component of the radioactive emission,
- environmental contamination could be quantitatively significant in extent and duration, and
- the area affected could be larger than for the basic offsite effect.

2.5 Emergency Planning Zones and Response Sectors

For planning purposes, the area around a nuclear station is divided into the following zones:

<u>Contiguous Zone</u> The area immediately surrounding the nuclear station out to a radius of 3 kilometres. If required, priority evacuations will be undertaken within this area.

<u>Primary Zone</u> The area around the nuclear station out to a radius of 10 kilometres, which includes the Contiguous Zone. Detailed planning and preparedness will be carried out in this zone for measures against exposure to a radioactive emission.

<u>Secondary Zone</u> The area around a nuclear station out to a radius of 50 kilometres within which it is necessary to plan for ingestion control measures based on the monitoring of the food chain for contamination.

To assist with planning, each Primary Zone is divided into Response Sectors which are be delineated by clearly recognizable boundaries. The Secondary Zone is divided into sub-zones.

Response sectors of the Primary Zones are divided into three rings of response sectors around the nuclear station: an inner ring (the 3 km Contiguous Zone), a middle ring and an outer ring.

2.6 Darlington NGS - Emergency Planning Zones

The <u>Primary Zone for the Darlington NGS</u> is shown in Figure 2. The boundaries are described in Table 1. The Primary Zone is divided into 16 Response Sectors which are located in the following rings around the Darlington NGS:

- Contiguous ZoneSector
    - D1 and Lake Sector D14.
- Middle Ring Sectors
    - D2, D3, D4, D5, and Lake Sector D15.
- Outer Ring Sectors

- D6A, D6B, D7, D8A, D8B, D9, D10, D11, D12, D13, and Lake Sector D16.

Estimates of the population by sector are shown in Table 2.

The Secondary Zone for the Darlington NGS encompasses parts of Durham Region, the City of Toronto, York Region, the City of Kawartha Lakes, Northumberland County and Peterborough County within a 50 kilometre radius of the Darlington NGS. The Secondary Zone with its sub-zones is shown in Figure 3.

Figure 2 - Darlington Primary Zone Map

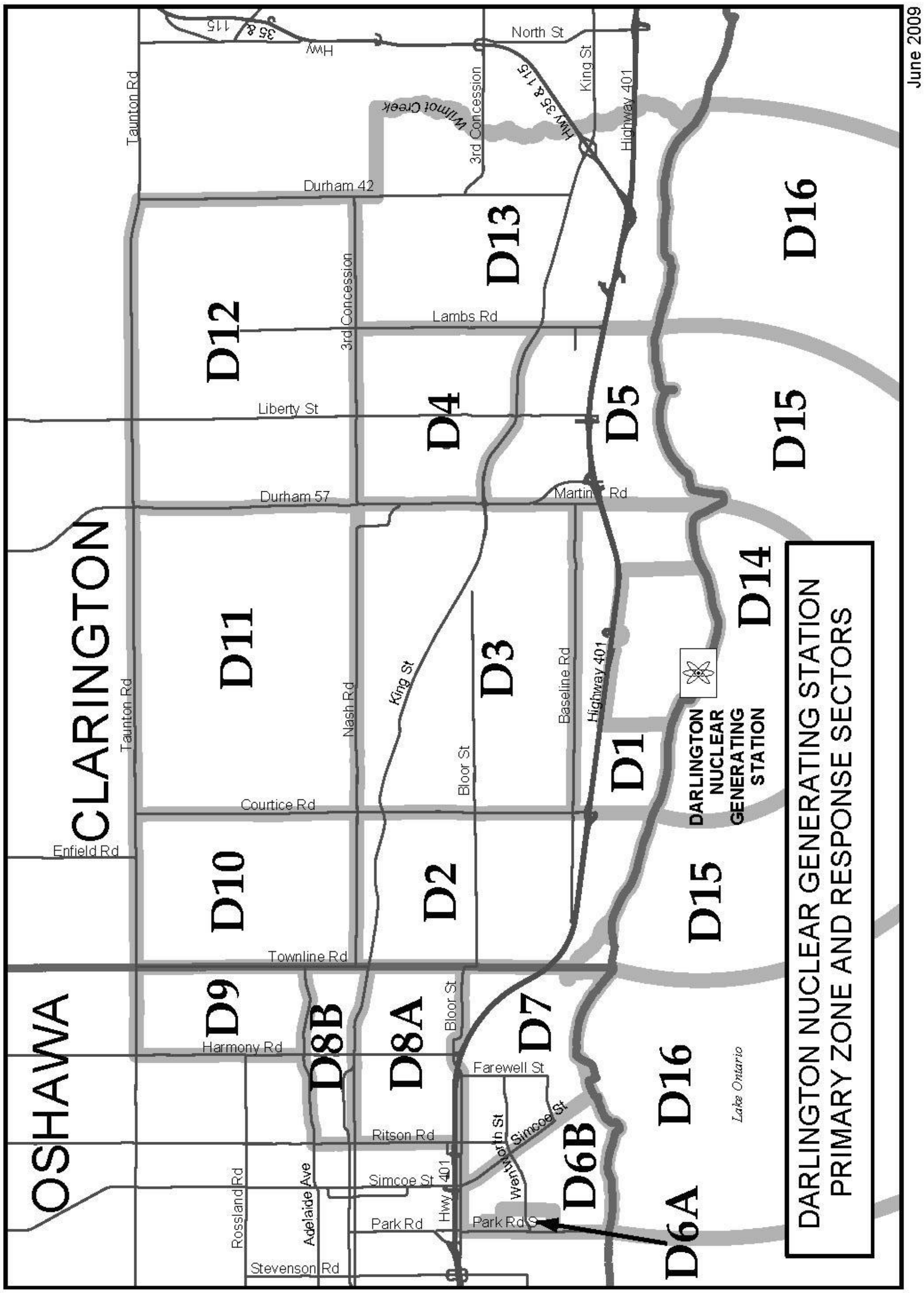


Table 1 - Darlington Primary Zone Response Sector Boundaries

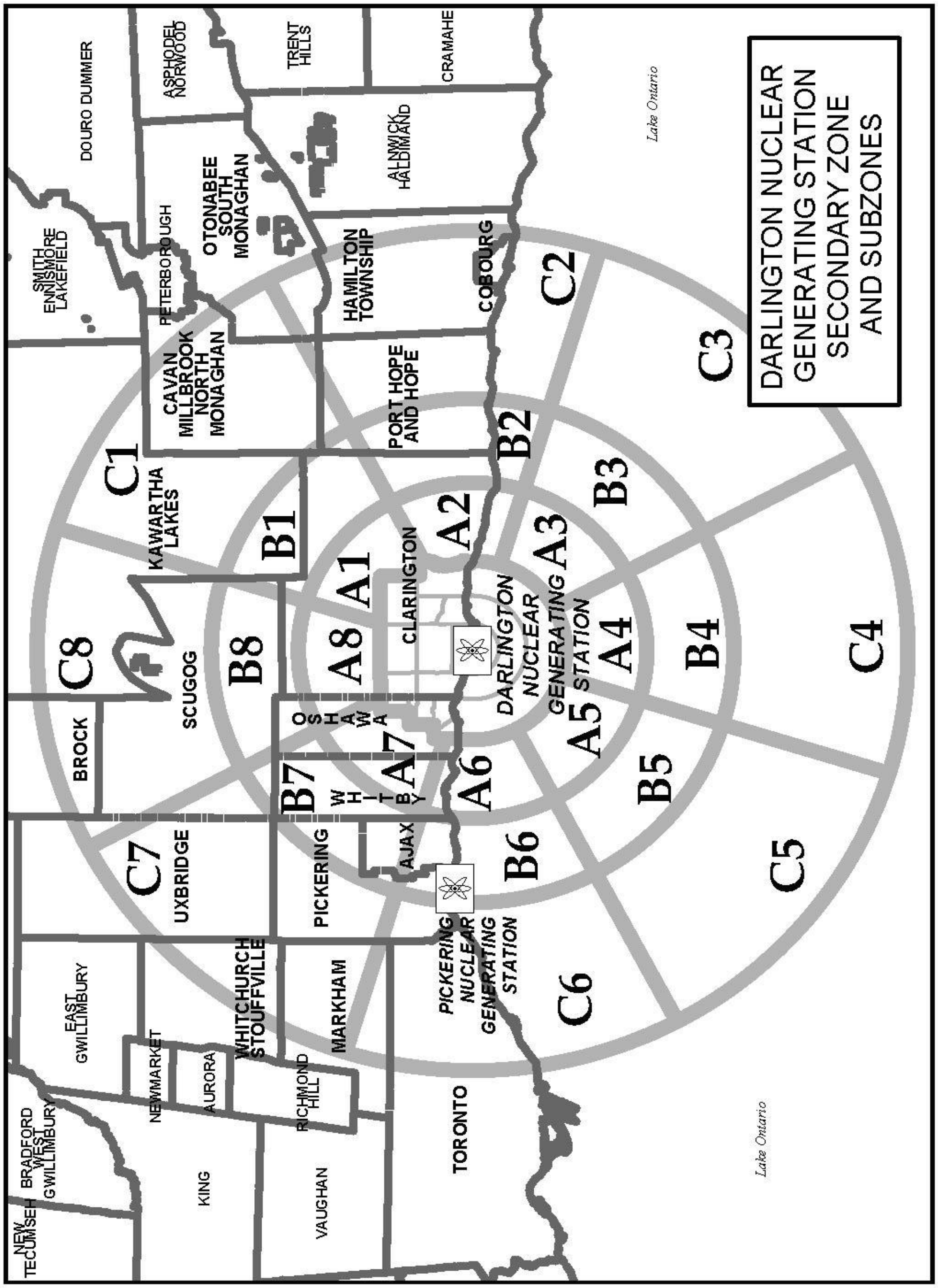
Sector	Sector Boundary (North; East; South; West)
D1	Baseline Road; Martin Road; Lake Ontario; Courtice Road
D2	Nash Road; Courtice Road/RR 34; Lake Ontario; Townline Road/RR 55
D3	Nash Road; Martin Road/RR 57; Baseline Road; Courtice Road/RR 34
D4	Concession Rd #3; Lamb's Road; Highway 2; Martin Road/RR 57
D5	Highway 2; Lambs Road; Lake Ontario; Martin Road/RR 57
D6A	General Motors Parking Lot
D6B	Bloor Street/RR 22; Simcoe Street/RR 2; Lake Ontario; Park Road/RR 54
D7	Bloor Street/RR 22; Townline Road/RR 55; Lake Ontario; Simcoe St/RR 2
D8A	King St: Townline Rd/RR 55;Bloor St/RR 22; Ritson Rd/RR 16
D8B	Adelaide Ave/RR 58; Townline Road/RR 55; King St; Ritson Road/RR 16
D9	Taunton Rd/RR 4; Townline Rd/RR 55; Adelaide Ave/RR 58; Harmony Rd/RR 33
D10	Taunton Road/RR 4; Courtice Road/RR 34; Nash Road; Townline Road/RR 55
D11	Taunton Road/RR 4; Martin Road/RR 57; Nash Road; Courtice Road/RR 34
D12	Taunton Rd/RR 4; Darlington-Clarke Townline/RR 42; Concession #3; Martin Road/RR 57
D13	Concession Rd #3 and #4; Wilmot Creek; Lake Ontario; Lambs Road
D14 - D 16	Lake Ontario Sectors

Table 2 - Population* Estimate for Darlington Sectors

Sector	Population (Maximum)
D1	85
D2	17,757
D3	8,173
D4	21,376
D5	8,729
D6A	General Motors Parking Lot
D6B	13,776
D7	4,469
D8	23,228
D9	12,808
D10	7,718
D11	1,263
D12	767
D13	2,195
DNGS	1,400
TOTAL	123,744

*2011 census data.

Figure 3 - Darlington Secondary Zone Map



2.7 Pickering NGS - Emergency Planning Zones

The Primary Zone for the Pickering NGS is shown in Figure 4. The boundaries are described in Table 3. The Primary Zone is divided into 25 Response Sectors which are located in the following rings around the Pickering NGS:

- Contiguous Zone Sectors
  - P1, P2 and Lake Sector P23.
- Middle Ring Sectors
  - P3 to P14 and Lake Sector P24.
- Outer Ring Sectors
  - P15 to P22 and Lake Sector P25.

Estimates of the population by sector are shown in Table 4.

The Secondary Zone for the Pickering NGS encompasses parts of Durham Region, the City of Toronto, York Region, Peel Region and the City of Kawartha Lakes within a 50 kilometre radius of the Pickering NGS. The Secondary Zone is shown in Figure 5.

Note that Sectors P3, P15, P16, P17, P18 and P19 fall outside the Regional boundary and are the responsibility of the City of Toronto, as are Lake Sector P25 and the western portion of Lake Sector P24.

Figure 4 - Pickering Primary Zone Map

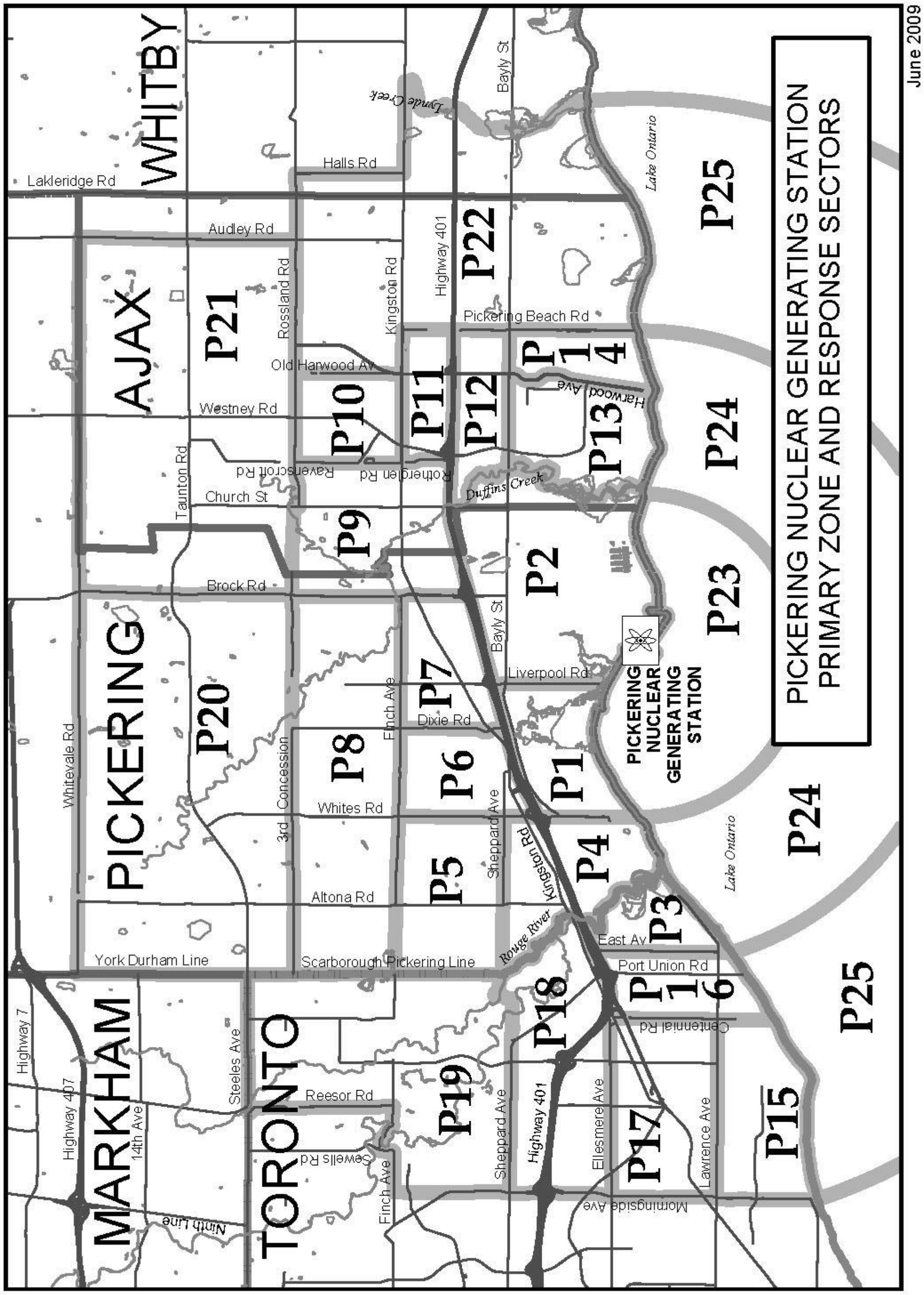


Table 3 - Pickering Response Sector Boundary Description

SECTOR	SECTOR BOUNDARY (north; east; south; west)
P1	Highway 401; Liverpool Road; Lake Ontario; Whites Road/RR38
P2	Highway 401; Duffin's Creek; Lake Ontario; Liverpool Road
P3	Highway 401; Rouge River; Lake Ontario; East Avenue
P4	Sheppard Avenue; Whites Road/RR 38; Lake Ontario; Rouge River
P5	Finch Avenue/RR 37; Whites Road/RR 38; Sheppard Avenue; Scarborough-Pickering Townline Road/RR 30
P6	Finch Avenue/RR 37; Dixie Road; Highway 401; Whites Road/RR 38
P7	Finch Avenue/RR 37; Brock Road/RR 1; Highway 401; Dixie Road
P8	3rd Concession (Rossland); Brock Road/RR 1; Finch Avenue/RR 37; Scarborough-Pickering Townline/RR 30
P9	3rd Concession (Rossland); Ravenscroft/Rotherglen Roads; Highway 401; Brock Road/RR 1
P10	3rd Concession (Rossland); Harwood Avenue; Kingston Road/Highway 2; Rotherglen/Ravenscroft Roads

SECTOR	SECTOR BOUNDARY (north; east; south; west)
P11	Kingston Road/Highway 2; Pickering Beach Road; Highway 401; Rotherglen Road
P12	Highway 401; Pickering Beach Road; Bayly Street/RR 22; Duffin's Creek
P13	Bayly Street/RR 22; Harwood Avenue/RR 44; Lake Ontario; Duffin's Creek
P14	Bayly Street/RR 22; Pickering Beach Road; Lake Ontario; Harwood Avenue/RR 44
P15	Lawrence Avenue; Centennial Road; Lake Ontario; Morningside Avenue
P16	Highway 401; East Avenue; Lake Ontario; Centennial Road
P17	Ellesmere Road; Centennial Road; Lawrence Avenue; Morningside Avenue
P18	Sheppard Avenue; Little Rouge River; Ellesmere Avenue; Morningside Avenue
P19	Old Finch and Steeles Avenue; Scarborough-Pickering Townline/RR 30; Sheppard Avenue; Morningside Avenue
P20	Whitevale Road; Brock Road/RR 1; 3rd Concession (Rossland); Markham-Pickering Townline/RR 30
P21	Whitevale Road; Lake Ridge Road/RR 23; 3rd Concession (Rossland); Brock Road/ RR 1

SECTOR	SECTOR BOUNDARY (north; east; south; west)
P22	3rd Concession (Rossland); Hall's Road and Lynde Creek; Lake Ontario; Pickering Beach Road and Harwood Avenue

Table 4 - Population* Estimate for Pickering Sectors

SECTOR	POPULATION (maximum)
P1	9,126
P2	5,012
P3	8,892 (City of Toronto)
P4	8,516
P5	18,036
P6	11,702
P7	16,398
P8	16,652
P9	19,152
P10	16,780
P11	9,351
P12	3,911
P13	9,667
P14	9,926
P15	10,898 (City of Toronto)
P16	7,224 (City of Toronto)
P17	14,604 (City of Toronto)

SECTOR	POPULATION (maximum)
P18	19,407 (City of Toronto)
P19	9,451 (City of Toronto)
P20	339
P21	28,886
P22	22,071
PNGS	4,500
Region of Durham TOTAL	210,025
TOTAL PZ (incl. Toronto)	280,591

* 2011 census data.

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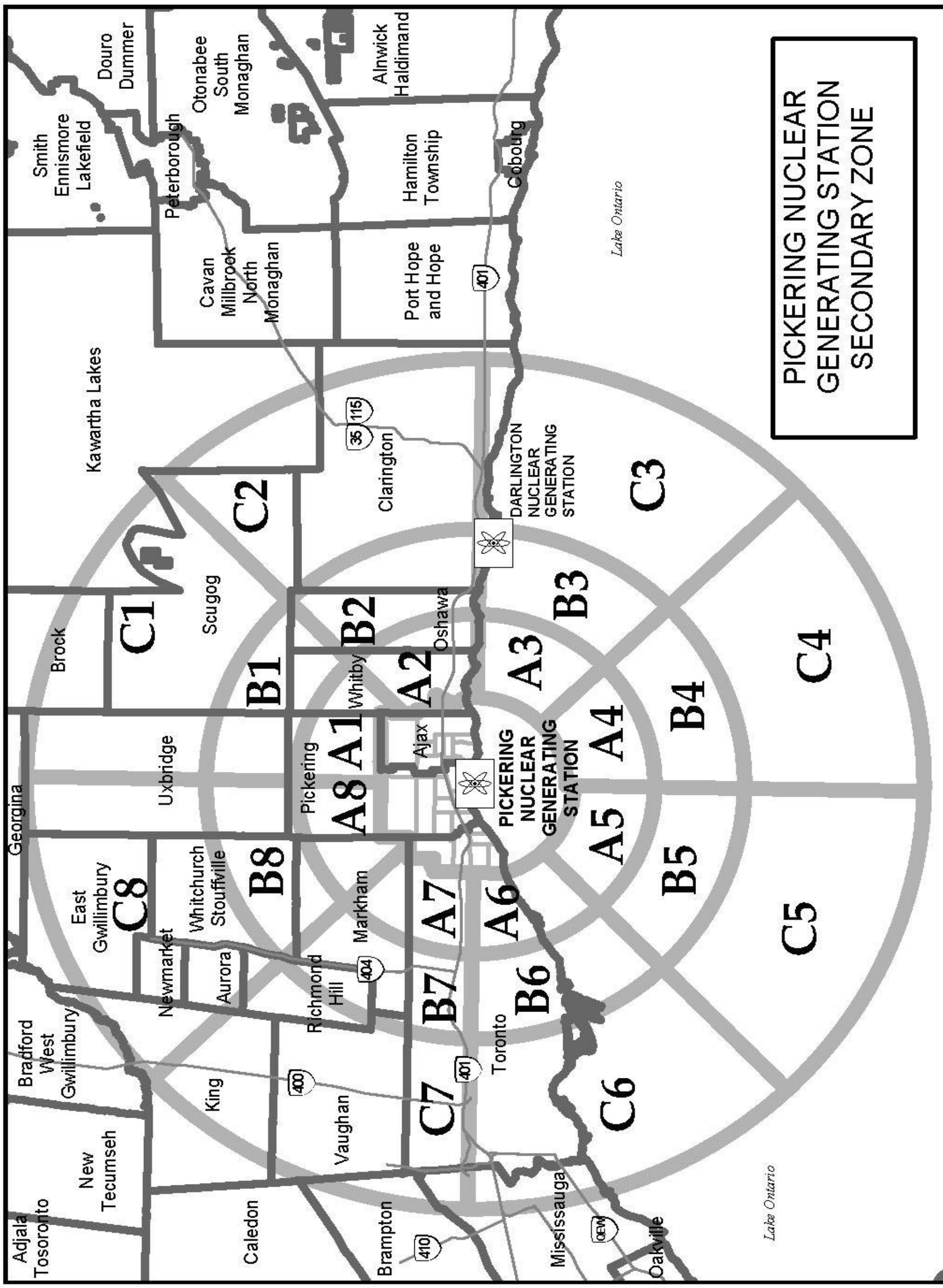
Figure 5 - Pickering Secondary Zone Map



2.8 Containment Hold-Up Time Estimates

The timing of any release of radioactivity following an accident at a nuclear station depends on the characteristics of the accident as well as the containment system. The containment design for Darlington and Pickering NGS involves the use of a vacuum building to control any release of radioactive contaminants.

Over time, the vacuum will become depleted which will require a controlled, filtered discharge to the atmosphere. The normal procedure would be to vent through the filtered air discharge system shortly before the vacuum building reaches atmospheric pressure. For planning purposes the hold-up times for containment at the nuclear stations are as follows:

- Darlington NGS:
  - 7 days
- Pickering NGS:
  - 2 days

2.9 Protective and Precautionary Measures

There are specific protective measures available to the Province to minimize the radiation hazard during a nuclear emergency. They can be grouped in the following categories:

- Exposure Control Measures – designed to avoid or limit exposure to the source of radiation and surface deposits from it. These measures include: entry control, thyroid blocking (use of KI pills), sheltering indoors, evacuation and decontamination.
- Ingestion Control Measures – protect the food chain from radioactive contamination. Measures include preventing the consumption of contaminated food or water.
- Precautionary Measures – these facilitate the application of protective measures and include: closing of recreation areas, schools and workplaces, entry control to affected areas, banning consumption of exposed food items and placing farm animals inside.

2.10 Evacuation Time Estimates

Ontario Power Generation has commissioned a U.S. company to conduct traffic engineering evacuation time estimates for the Primary Zones around the Darlington and Pickering stations.

A 2015 study for Darlington used 2011 census data and took into account the roadway infrastructure network, mobilization time required by evacuees to make preparations, voluntary evacuation of people when not ordered to do so, school population, special events, ridesharing, weather, time-of-day, time-of-week, time-of-year, traffic management studies by Durham Regional Police, as well as shadow evacuations of people who live beyond the 10 km zones. 364 unique cases were modelled, based on 36 different evacuation regions and 14 separate scenarios, resulting in a worst-case evacuation time estimate of 4 hours and 55 minutes for the Darlington Primary Zone.

A 2016 study for Pickering, using the same methodology described above, resulted in a worst-case evacuation time estimate of 8 hours 40 minutes for the Pickering Primary Zone.

2.11 Concept of Operations – Nuclear Emergency

Operations to deal with a nuclear emergency will be conducted in two phases: the Response Phase and the Recovery Phase.

The Response Phase involves immediate action to deal with the possible effects of radiation. This phase begins with the first warning that a significant problem exists with the potential for a radiation release and ends when the radiation threat has ended. This phase could last for weeks. This phase will involve operations to implement exposure control to avoid or limit exposure to radiation and ingestion control to minimize contamination of the food chain and prevent consumption of contaminated food.

The Recovery Phase involves longer term action to restore conditions to normal. This phase will continue to involve ingestion control measures and on-going monitoring of the environment.

Section 3.0 Nuclear Emergency Response Organization

3.1 Province

Overall Direction. Response organizations for a nuclear emergency are the same as for any emergency. However, in a nuclear emergency, the Province of Ontario will provide overall direction to the management of the response. Overall coordination will be provided through the Provincial Emergency Operations Centre (PEOC).

Contingency. The PEOC shall normally coordinate the emergency management and response in Durham Region through the Regional Emergency Operations Centre (REOC). However, if there are communication problems, the PEOC may issue directions directly to any element of the emergency response organization.

Provincial Emergency Operations Centre (PEOC). The PEOC is organized using the Incident Management System (IMS) and includes the following sections: Command, Operations, Planning, Logistics, Finance and Administration, and Science. The Scientific Section is responsible for providing scientific advice on projected offsite effects, coordinating radiation monitoring efforts and performing technical assessments of the developing situation.

Provincial Emergency Information. The Provincial Emergency Information Section will be activated for a nuclear emergency. The Province will issue news releases and other information products, coordinate news conferences, monitor media and the public's perception of and reaction to the situation, and provide key messages and information to activated call centres. The Province will coordinate the development and release of information with the Region's Emergency Information Centre at the REOC to ensure consistent messaging at all levels.

Joint Traffic Control Centre (JTCC). A JTCC will be established by the Ontario Provincial Police to implement the Joint Traffic Control Plan. The JTCC is responsible for the management of evacuations as well as the traffic impact beyond it. The JTCC includes representatives from the OPP, Durham Region Police, York Region Police, Toronto Police and Ministry of Transportation.

Liaison. The PEOC will normally provide a liaison officer to the Regional Emergency Operations Centre during a nuclear emergency.

3.2 Ontario Power Generation (OPG)

Corporate Emergency Operations Facility (CEOF). OPG will establish their CEOF in the event of a nuclear emergency. The CEOF is an off-site facility common to the nuclear sites that coordinates and manages the overall OPG Nuclear response to a nuclear emergency. The CEOF supports the nuclear station with technical and financial resources and operates under the auspices of the Chief Nuclear Officer (CNO). The CEOF will liaise directly with the PEOC and not Durham Region.

Site Management Centre (SMC). The affected nuclear generating station will establish an SMC for an emergency. The SMC is the on-site facility where station management augmentation and technical staff assemble. Overall site emergency response is managed from the SMC, including the support to and oversight of the Main Control Room and EOC.

Liaison. The affected nuclear generating station will provide a liaison officer to the REOC. The liaison officer will coordinate OPG support to the Region and provide situational updates related to the emergency.

3.3 Regional Municipality of Durham

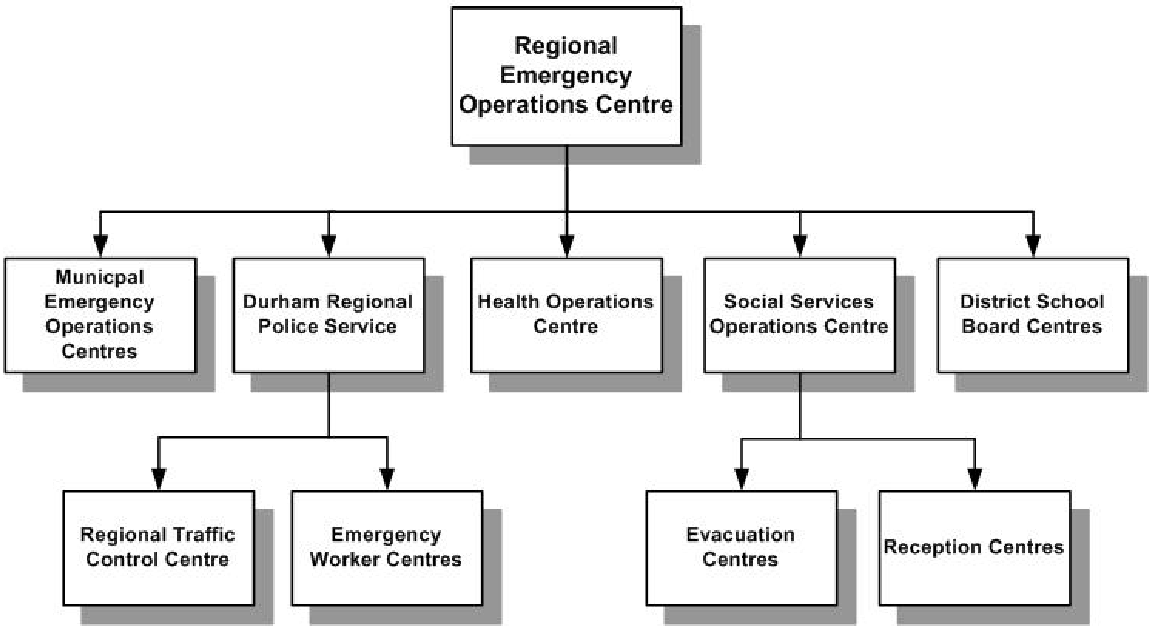
General. The Regional Chair will manage nuclear emergency response activities in Durham Region through the Regional Control Group (RCG) working out of the Regional Emergency Operations Centre (REOC). The Regional emergency response organization which consists of all the entities that report directly to the REOC (see Figure 6) will be responsible for the implementation of the DNERP.

Regional Emergency Operations Centre (REOC). The REOC coordinates emergency operations within Durham Region, monitors operations conducted by other agencies and coordinates Regional resources in support of other agencies. It is responsible for implementing Provincial directives during a nuclear emergency.

The REOC is organized utilizing the Incident Management System (IMS). The Command Section is supported by the Regional Control Group (RCG), established under By-law 36-2015, which is composed of Department Heads, Chief of Police and other senior Regional staff under the management of the Chief Administrative Officer.

Figure 6 - Region Nuclear Emergency Response Organization

REGIONAL EMERGENCY RESPONSE ORGANIZATION



Departmental Operations Centres. For a nuclear emergency, the Health Department will establish its Health Operations Centre (HOC) and the Social Services Department will establish the Social Services Operations Centre (SSOC). These centres will coordinate Departmental response activities, coordinated through the REOC.

Regional Traffic Management Centre (TMC). The TMC will be set up by DRPS and supported by the Regional Works Department to implement traffic control measures required by the Joint Traffic Control Centre in Toronto. The TMC maintains direct contact with the JTCC but is under command of the Chief of Police at the REOC.

Reception Centres (RC). If required and so ordered by the Province, Reception Centres will be set up during nuclear emergencies to monitor and decontaminate people and to provide emergency reception services. OPG staff will operate the monitoring and decontamination units while Social Services will coordinate the reception of evacuees including registration and inquiry, allocation to evacuation centres, first aid and other personal support

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services. In Durham Region, Reception Centres are planned to be established at the following locations:

- Durham College, Oshawa
- Legends Centre, Oshawa

Additional fixed Reception Centres will be established by Host Municipalities designated in the Provincial plan (see 3.5 below).

Evacuation Centres (EC). Evacuation Centres may be set up by Durham Region Social Services to provide emergency short term shelter for people who evacuate but have no other place to stay. According to the PNERP, for a nuclear emergency, the majority of short-term shelter requirements for evacuees will be provided by host municipalities. Further, the PNERP estimates that 10 - 20% of the total number of evacuees may require short-term accommodation are provided for them.

Emergency Worker Centres (EWC). EWCs will be set up in the event of a nuclear emergency to protect emergency workers and provide monitoring and decontamination. When ordered by the Province, all workers (including police, fire, EMS, transit, utilities, Provincial and Federal survey teams, etc.) will be required to report to an EWC before entry into the Primary Zone. The DRPS will have operational control of the two EWCs in Durham Region and OPG staff will provide monitoring and decontamination services for workers entering and exiting the zone. The City of Toronto is responsible for one EWC.

Table 6 - Emergency Worker Centre Location and Responsibility

Emergency at:	EWC	Responsibility
Pickering NGS	Centennial College Scarborough Iroquois Park, Whitby	City of Toronto Durham Region
Darlington NGS	Orono Arena, Clarington Iroquois Park, Whitby	Durham Region Durham Region

3.4 Local Municipalities

MEOC. The Municipalities of Ajax, Clarington, Oshawa, Pickering and Whitby will open their Municipal Emergency Operations Centres to coordinate the implementation of protective measures in their respective communities and to support the overall Regional response to the emergency.

3.5 Designated/Host Municipalities

The Provincial plan designates municipalities to act as a Host Municipality in the event of a nuclear emergency. Host municipalities will have plans for the reception and accommodation of evacuees and for the coordination of monitoring and decontamination arrangements. Host municipalities and planned Reception Centre locations are shown below:

Table 7 – Designated/Host Municipality and Reception Centre

Emergency at	Host Municipality	Reception Centre
Pickering NGS	Region of Durham	Legends Centre
	Region of Durham	Durham College
	City of Peterborough	Sir Sanford Fleming
	City of Toronto	York University
Darlington NGS	Region of Durham	Legends Centre
	Region of Durham	Durham College
	City of Peterborough	Sir Sanford Fleming
	City of Toronto	York University

Section 4.0 Operational Concepts

4.1 Control of Operations

In a nuclear emergency where the Provincial plan has been activated, the Province will lead the offsite response through the Provincial Emergency Operations Centre (PEOC). The Province may issue operational directives and emergency orders under the Emergency Management and Civil Protection Act (EMCPA).

Whenever the Province contemplates issuing operational directives or an emergency order for a protective action within Durham Region, the Province will consult with the Region through the Regional Emergency Operations Centre (REOC).

The Province will communicate response directives from the PEOC to the REOC. However, if communication problems exist, the PEOC may communicate directly to other entities of the Durham Region emergency management structure such as local municipalities.

4.2 Declaration of Emergency

Pursuant to Section 4 (1) of the EMCPA, the Regional Chair can declare that an emergency exists in the Region. The Regional Control Group will advise the Chair to make such a declaration when the DNERP is fully activated. The Solicitor General of Ontario will be notified immediately following the declaration of an emergency.

4.3 Public Alerting

The Provincial Nuclear Emergency Response Plan details the public alerting requirements that Durham Region must implement for the Primary Zones around the Darlington and Pickering Nuclear Generating Stations. OPG is required to provide the resources and assistance for the establishment and maintenance of the alerting system.

The public alerting requirement for the Contiguous (3 km) Zone is as follows:

Provide within 15 minutes of initiation of the alerting system:

- warning to practically 100% of the people in that zone,
- whether they be indoors or outdoors, and
- irrespective of the time of day or year.

The term “practically 100%” means that the signal can be heard by nearly everyone in the 3 km zone unless exceptional circumstances (e.g. hearing impairment, loud machinery operations) provide an impediment.

The public alerting requirement for the remainder of the Primary Zone (3 - 10 km) is as follows:

Provide, within 15 minutes of initiation of the alerting system:

- warning on an area-wide basis, and
- to the population in all of the response sectors within the 3 - 10 km zone.

The term “area wide basis” means that the alert signal will cover the 3 - 10 km area but does not presume that 100% of the people in that area will necessarily hear the alerting signal.

In the case of a nuclear emergency with an on-going or imminent emission of radioactivity the Region is authorized to immediately initiate the public alerting system. The PEOC will issue the appropriate Emergency Bulletin prior to initiating the siren alerts in order to ensure there is relevant information for the public to receive, once directed inside by the sirens.

4.4 Public Direction – Emergency Bulletins

The aim of public direction is to provide to the affected population, direction and guidance regarding protective measures they should undertake.

Public direction will be implemented through the release of Emergency Bulletins through the broadcast and social media. It is the responsibility of the PEOC to issue Emergency Bulletins. The Region will be consulted on and notified of the release of any bulletins.

4.5 Emergency Information

The aim of emergency information is to provide to the public and to the media, timely and accurate information on the emergency, the measures being taken to deal with it and action to be taken by the public.

Each jurisdiction (Province, OPG, Region, local municipalities) is responsible for providing emergency information related to their respective operations. Every effort will be made to ensure that the information being developed and issued is coordinated and consistent with overall Provincial messaging, particularly with respect to protective actions and status information.

In Durham Region the Director, Corporate Communications will act as the Emergency Information Officer (EIO) in the event of a nuclear emergency. The EIO will receive direction from the Regional Control Group and oversee the emergency communications structure including Emergency Information Centre, Public Inquiry Centre and Media Centre. Details of emergency information can be found in The Durham Region Master Plan, Communications Emergency Support Function.

4.6 Protective Action Decision Making

The Scientific Section of the Provincial PEOC will produce technical assessments for input into the protective action decision making process. The technical assessment will include details of the accident and its prognosis, repressurization time for the vacuum building, venting data and projections and evacuation distance requirements.

The implementation of protective measures will be based on technical assessments and operational and public safety considerations. Where a protective measure is warranted, the PEOC will consult with the Region if time permits, and then issue an operational directive or, once an emergency is declared, an order for that protective measure to be carried out. The PEOC will also issue the emergency bulletins to the public.

In order to provide guidance on the need to take certain protective measures, the Province has developed Protective Action Levels (PALs) based on projected dose levels. PALs are expressed as a range because the decision on implementing a protective measure will be based on operational and public safety considerations as well as technical factors. Table 9 below lists the protective action levels for exposure control measures:

Table 8 - Protective Action Levels (PALs)

Protective Measure	Lower Level		Upper Level	
	Effective Dose	Thyroid Dose	Effective Dose	Thyroid Dose
Sheltering	1 mSv (0.1 rem)	10 mSv (1 rem)	10 mSv (1 rem)	100 mSv (10 rem)
Evacuation	10 mSv (1 rem)	100 mSv (10 rem)	100 mSv (10 rem)	1 Sv (100 rem)
Thyroid Blocking	0	100 mSv (10 rem)	0	1 Sv (100 rem)

4.7 Sheltering

Sheltering is a protective measure that uses the shielding properties of buildings to reduce the radiation dose to people inside.

Sheltering may be utilized as a protective measure if there is insufficient time to safely evacuate an area or if the dose projected for an area is so low that evacuation is not required.

In general, all sectors adjacent to those being evacuated will be ordered to shelter. If possible, the operational directive to shelter will be issued by the PEOC at least 4 hours prior to the expected commencement of an emission.

For sheltering, an Emergency Bulletin from the PEOC will direct that people go or remain inside. All doors and windows and fireplace dampers should be closed, and air conditioners and furnaces turned off. If possible, go to a basement or a ground floor room with no windows.

4.8 Evacuation

All routes will be utilized to evacuate the Primary Zone. There are no designated routes out.

"Shadow" evacuations may occur spontaneously in areas close to the Primary Zone and therefore contribute to road congestion. Shadow evacuation is when people living outside the area at risk choose to leave which may impede evacuees from an area that is at risk.

Families will want to reunite and evacuate together, if possible. The ability for families to unite will depend on the entry control measures put in place due to the severity of the accident and the timing of an emission.

It is assessed that the majority of evacuees will make their own arrangements for alternate accommodation. Host municipalities will be designated to assist Durham Region with the reception and care of evacuees. Durham Region Transit will support the evacuation operations out of the PZ in concert with DRPS, for those people without vehicles.

Emergency plans of those school boards with schools in the PZ should detail the arrangements for the transportation of students and staff to pre-arranged temporary “holding” schools. If directed, evacuated students and staff may be required to go first to a monitoring and decontamination unit. Evacuated students are the responsibility of their respective Board until collected from the holding school by their parents/guardians.

Emergency plans for hospitals, long term care facilities and other institutions will include provisions for the transfer of patients/residents to appropriate facilities outside the PZ.

It is expected that the majority of evacuees will make their own arrangements for food and lodging. Designated host communities will make arrangements for evacuees without resources.

4.9 Thyroid Blocking

In the event of a serious accident at a nuclear station, radioactive material may escape, including radioactive iodine. If radioiodines are inhaled, they are absorbed by the thyroid gland. Thyroid blocking is the prevention or reduction of radioiodine absorption by the thyroid gland through the ingestion of a stable iodine compound, potassium iodide (KI), thereby ‘blocking’ further uptake of radioiodine.

OPG is required to procure adequate quantities of Potassium Iodide (KI) pills for the 10 km zone populations around the Darlington and Pickering NGS, pre-distribute KI to all homes and businesses within 10km, and make available to anyone within 50km who may wish to possess it.

Durham Region Health Department has a plan to facilitate the availability of KI for Primary Zone institutions such as schools, child care centres, and Health care facilities for emergency centres.

The order to taken KI will be made by the Chief Medical Officer of Health for the Province.

Procedures in Durham Region for the administration of KI and the approved dose are contained in Potassium Iodide (KI) Distribution Nuclear Support Function.

4.10 Monitoring and Decontamination

In the event of a delayed emission, evacuees will likely not require monitoring or decontamination. In the event of an on-going emission, evacuees may be exposed to varying levels of contamination. Contamination would be in the form of loose particulate on people. Internal contamination may be present in some individuals.

Monitoring and decontamination of the public, if required, will be accomplished by the establishment of Monitoring and Decontamination Units (MDU) by OPG. Currently, there are plans to establish MDUs at the 5 fixed Reception Centres listed in Section 3 above. OPG also has 2 mobile MDUs which can be deployed to additional pre-designated locations as required.

If it is estimated that evacuees will clear the affected area before an emission occurs, they will not be directed to a MDUs for monitoring and decontamination. Evacuees from sectors not affected by the emission will be directed to go to a destination of their choosing.

If evacuees cannot clear the affected area before an emission, they may be directed to proceed for monitoring and decontamination. The first priority is for the public to leave the affected area as quickly as possible. If MDUs are not yet set up, evacuees will be advised to go to a destination of their choice, shower and bag their clothes. MDUs will be set up and direction from the PEOC on decontamination or reassurance monitoring will be provided once the initial evacuations have been completed.

Details of personal decontamination procedures will be provided through Emergency Bulletins from the PEOC as will the locations of MDUs when they are operational.

4.11 Radiation Health Response

If there is a reasonable possibility of significant radiation exposure, the Ministry of Health and Long-Term Care (MOHLTC) will implement the Provincial Radiation Health Response Plan. This includes monitoring for internal contamination, maintaining a database of potentially affected people, counselling and conducting a public health information program.

4.12 Environmental Radiation Monitoring

Hybrid teams comprised of members from Federal, Provincial, OPG and possibly private sector organizations will be assembled to jointly carry out environmental radiation monitoring.

The PEOC has overall responsibility for the organization and coordination of radiation monitoring resources. Environmental radiation monitoring teams will be directed to gather information about contamination, including plume and depositions, air and ground concentrations and exposure rates. Data that is gathered will be collated and coordinated through the PEOC.

4.13 Emergency Worker Safety

The Ministry of Labour will oversee the system of emergency worker safety during a nuclear emergency. Emergency workers will only be allowed to enter affected response sectors in order to provide or maintain essential services. All emergency workers will report to an Emergency Worker Centre (EWC) prior to entry into a potentially contaminated zone. An exception to this is DRPS officers who are trained and are equipped with personal monitoring equipment who may be required to enter a sector before an EWC is functioning.

Two Emergency Worker Centres (EWCs) will be established for the affected nuclear station primary zone under management of the DRPS. At these centres, emergency workers will be provided with personal monitoring devices and be briefed by OPG staff on the precautions they should observe and the maximum limit on their stay in the sector. After completing their assigned tasks the emergency workers will again report to the EWC for monitoring and debriefing, and decontamination if required.

In the event of an emergency, the PEOC will assign a safety status and colour code to all response sectors in the 10 km Primary Zone around the affected NGS based on the projected dose rate. The colour codes used are as follows:

- GREEN

    - ≤ Normal background level
- ORANGE
    - Background to 5 mSv (0.5 rem) per hour
- RED
    - 5 mSv (0.5 rem) per hour

Precautionary measures will be implemented as ordered by the PEOC and based on the colour code. A summary of precautionary measures follows:

- GREEN
    - No precautions necessary. No limit on stay.
    - Pregnant workers may enter these sectors.
- ORANGE
    - Emergency workers shall carry personal monitoring devices.
    - Dosimeters are to be checked every hour.
    - Workers shall exit the sector if the reading reaches 40 mSv (4 rem) or other limit set by the EWC.
    - If duties permit, emergency workers shall remain under shelter or inside a vehicle. If working outside, emergency workers should wear an outer garment such as a plastic raincoat.
    - The maximum time in a sector shall be limited to four hours, or the time prescribed by the EWC.
- RED:
    - Emergency workers will be accompanied by a qualified escort provided by OPG.
    - Dosimeters are to be checked every 30 minutes.
    - Time in the Sector shall be limited to one hour or the time prescribed by the EWC or the qualified escort.
    - If duties permit, emergency workers shall remain under shelter or inside a vehicle. If working outside, emergency workers should wear an outer garment such as a plastic raincoat.
    - Emergency workers shall exit a sector if the dosimeter reading reaches 40 mSv (4rem) or other limit set by the EWC.

See the Nuclear Emergency Support Function - Emergency Worker Centre, and DRPS for detailed procedures on the setup and operation of Emergency Worker Centres by the Region.

4.14 Traffic Control

The Ministry of Transportation (MTO) will oversee the overall development and maintenance of Joint Traffic Control Plan. During an emergency, the

Joint Traffic Control Centre (JTCC) shall be responsible for implementing the joint traffic control plan. The JTCC is located in the City of Toronto and includes staff from MTO and police services from Durham Region, Toronto, York Region and the OPP.

Traffic monitoring and control measures will be implemented in the Region though the Regional Traffic Control Centre (see Section 3.3.5).

Traffic control plans are designed to be implemented in three incremental stages:

- Stage 1. Implemented automatically when the DNERP is activated. At this stage traffic will be monitored on all major routes out of the Primary Zone. The aim at this stage is to ensure that traffic keeps flowing as smoothly as possible.
- Stage 2. Shall be ordered by the PEOC when it appears likely that evacuations may become necessary, or if spontaneous evacuations begin. Highway 401 will be closed to through traffic and a diversion route around the affected Primary Zone will be put into place. Entry into the Primary Zone will be controlled.
- Stage 3. Shall be ordered by the PEOC when particular response sectors are to be evacuated. Additional traffic control resources may be deployed to ensure that the evacuee traffic moves as safely and quickly as possible out of the Primary Zone and beyond.
- Lake Sectors. Whenever it is likely that a radioactive emission will take place, the PEOC will issue operational directives to clear boat traffic from Lake Sectors of the affected nuclear station and entry control will be imposed by the Canadian Coast Guard and assisted by the DRPS and Toronto Police marine units.

4.15 Radioactive Liquid Emission

A radioactive liquid emission in Durham Region is an accidental release into Lake Ontario of water containing tritium at levels above normal, with the potential to affect drinking water supplies.

The emergency response to a tritium release is dealt with differently than an atmospheric emission and is not part of the DNERP. The response to a liquid emission in Durham Region is detailed in Liquid Emission (LERP), Nuclear Support Function.

Section 5.0 Notification and Initial Response

5.1 General

Initial notification is the report made by a nuclear generating station (NGS) to the Province and the Region that an event has occurred which requires immediate disclosure under the PNERP.

Initial offsite response is the action taken by the Province and Region which is appropriate for the initial notification.

5.2 Initial Notification

The affected NGS shall make a notification to the PEOC and to the DRPS Communications Centre within 15 minutes of the requirement for notification being recognized. The NGS cannot terminate or cancel an initial notification once it has been made.

Details of the Durham Region notification are set out in the Nuclear Support Function – Notification. The Support Function outlines how key regional, municipal and other emergency response personnel will be contacted and what level of monitoring or response will be adopted, as directed by the Province.

5.3 Initial Offsite Response

Within 15 minutes of the receipt of the initial notification from the NGS, the PEOC will decide on the initial response level to be adopted by the Region and the Province and provide this direction to the DEMO Duty Officer through established protocols.

The DEMO Duty Officer will immediately phone the DRPS Communications Centre Supervisor with the Regional Response Notification message and the specific agencies to be contacted. The Regional message will be based on the response level determined by the PEOC.

5.4 Notification Categories

There are four categories for initial notification which relate to the severity of event at the NGS. The notification categories are:

- Reportable Event. Any event affecting the NGS which would be of concern to offsite authorities including any event that could reduce the nuclear station capability to deal with an emergency onsite.
- Abnormal Incident. An abnormal occurrence at the NGS which may have a significant cause or may lead to more serious consequences.

Examples include a minor break in the physical integrity of the heat transport system and activation of the emergency cooling system or containment system.

- Onsite Emergency. A serious malfunction which results or may result in an atmospheric emission of radioactive material or is likely to result in an emission at a later time of more than 12 hours.
- General Emergency. An on-going atmospheric emission of radioactive material, or one likely within 12 hours, as a result of a more severe accident.

5.5 Activation of Nuclear Emergency Response Plans

The PEOC will determine the initial offsite response to all NGS nuclear emergency notifications. The offsite response level will be communicated by the DEMO Duty Officer to all appropriate municipalities, departments and organizations. The PEOC will order one of the following levels of activation as an initial action:

- Routine Monitoring. DEMO staff and appropriate municipal and departmental emergency coordinators will monitor the situation and review emergency preparedness arrangements from their normal workplaces.
- Enhanced Monitoring. DEMO staff and appropriate municipal and departmental emergency coordinators will increase the level of staffing to monitor the developing situation. Organizations may be required to monitor the situation from their respective operations centres with minimum staffing, 24 hour a day.
- Partial Activation. Protective measures are not immediately required but may become necessary if the situation deteriorates. All emergency response personnel are placed on standby, operations centres at all levels are fully staffed to monitor or assess the situation and other emergency centres (Reception Centres, EWCs) are readied to become fully operational.
- Full Activation. It is expected that protective measures will be necessary to deal with the emergency. All operations and appropriate emergency centres are fully staffed, 24/7. All emergency response staff with designated roles will report to their place of duty.

5.6 Region Initial Notification Action Summary

An overview of the initial notification process is illustrated in Figure 7. The initial notification from the NGS must be made within 15 minutes of the requirement being recognized and must include the appropriate notification category. The NGS will contact the PEOC and the DRPS Communications Centre Supervisor by phone and email, with fax as backup.

The DRPS Communications Centre Supervisor will immediately contact the DEMO Duty Officer. Within 15 minutes, the PEOC will contact the DEMO Duty Officer to advise on the initial offsite response. The DEMO Duty Officer will provide the notification of Regional response to the DRPS Communications Centre Supervisor for onward notification of local municipalities and other organizations. The DEMO Duty Officer will contact members of the Regional Control Group.

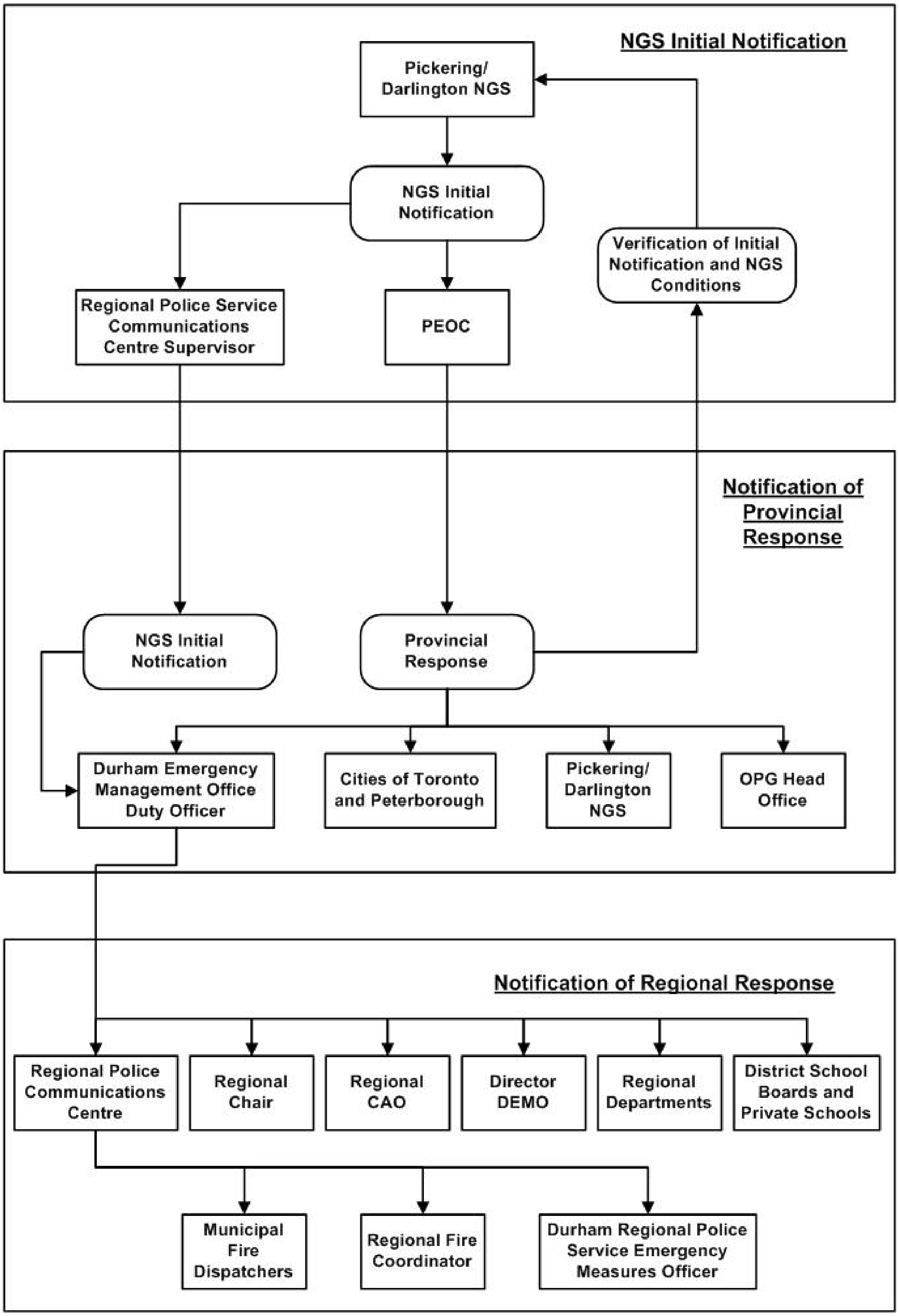
All persons receiving a Regional notification message shall continue the notification process as outlined in their respective organization's procedures.

5.7 Public Alerting System Activation

The PEOC will order the activation of the public alerting system, depending on the initial notification level and will issue a corresponding Emergency Bulletin prior to sounding the alerts.

If the initial notification from the NGS is a General Emergency, with an emission on-going or imminent, the DRPS Communications Centre Supervisor is authorized to immediately activate the public alerting system.

Figure 7 - Overview of Initial Notification Process



5.8 Summary of Region Initial Response Actions

Based on the notification category and initial response level in the Provincial notification message, the Region's default response actions are shown in Table 10 below:

Table 9 - Summary of Region Initial Response Actions

Notification Category	Initial Provincial Response Actions	Initial Durham Region Response Actions
Reportable Event	*Routine Monitoring* PEOC to issue notification of Provincial response to DEMO Duty Officer. PEOC to monitor situation and coordinate the issue of news releases, if required.	*Routine Monitoring* Regional response notification limited to the DRPS Communications Centre, Regional Chair, C.A.O. and the affected PZ municipalities. DEMO staff to monitor situation from normal workplace and maintain regular contact with PEOC Duty Officer.
Abnormal Incident	*Enhanced Monitoring* PEOC to issue notification of Provincial response to DEMO Duty Officer. PEOC to monitor situation, assemble a duty team and if required coordinate the issue of news releases.	*Enhanced Monitoring* Regional response notification to DRPS Communications Centre, Regional Chair, C.A.O., DRPS Emergency Coordinator and municipalities in affected PZ. If ordered by the PEOC, DEMO and the PZ municipal emergency staff to monitor situation from REOC/MEOC(s). DEMO staff to confirm communications arrangements with PEOC and other operations centres and review Regional preparedness arrangements.
Onsite Emergency **(No emission**	*Partial Activation* PEOC to issue notification of Provincial response to	*Partial Activation* Regional response notification to DRPS Communications Centre, Regional Chair, C.A.O., DRPS

Notification Category	Initial Provincial Response Actions	Initial Durham Region Response Actions
occurring)	DEMO Duty Officer. PEOC will adopt partial activation, PEOC to be fully staffed. PEOC to consider issuing an Emergency Bulletin or news release. Ministry EOCs and JTCC to be established and appropriately staffed.	Emergency Coordinator, Regional Departments and all municipalities. All Regional Departments, Regional Police and municipal support staff with nuclear emergency responsibilities placed on standby. REOC and affected PZ MEOC(s) to be set up with respective control group staff. Key staff report or liaise with Regional emergency centres, as required. The other PZ municipalities will adopt “enhanced monitoring.” Stage 1 of Region Traffic Control Plan implemented. REOC/MEOC(s) to monitor media and respond to public enquiries. News release may be issued.
Onsite Emergency **(Emission on-going or expected within 12 hours)**	*Full Activation* PEOC to issue notification of Provincial response to DEMO Duty Officer. Direct the activation of the public alerting system. Issue Emergency Bulletin and news release. Issue operational directives for: Sheltering in the 3 km zone Suspension of all traffic	*Full Activation* Regional response notification to entire Regional Emergency Response Organization. Activate the public alerting system. Recall all designated Regional employees. Set up and fully staff all required EOCs, reception, evacuee and emergency worker centres in the Region. Fully activate DNERP and formally declare a Regional Emergency. Implement traffic control and entry

Notification Category	Initial Provincial Response Actions	Initial Durham Region Response Actions
	through the 3 km zone. Clearance of the lake sectors. JTCC and ministry EOCs fully activated.	measures directed by JTCC. Implement directives issued by PEOC. Ensure all PEOC directives are passed to local municipalities.
General Emergency **(Emission on-going or expected within 12 hours)**	*Full Activation* PEOC to issue notification of Provincial response to DEMO Duty Officer. Confirm the activation of the public alerting system. Issue Emergency Bulletin and new release. Issue operational directives for: Suspension of road, rail and air through the 3 km zone. Evacuation of the 3 km zone and Lake sectors. If emission is on-going or evacuations not completed prior to emission, issue directives for: Evacuees to report for radiation monitoring at a Reception Centre or to self-decontaminate once out of the PZ. The ingestion of KI in the 3 km zone. Sheltering in the remainder	*Full Activation* • Regional response notification to entire Regional Emergency Response Organization. • Activate the public alerting system. • Recall all designated Regional employees • Set up and fully staff all required EOCs, reception, evacuee and emergency worker centres in the Region. • Fully activate DNERP and formally declare a Regional Emergency. • Implement traffic control and entry measures directed by JTCC. • Implement directives issued by PEOC. • Ensure all PEOC directives are passed to local municipalities.

Notification Category	Initial Provincial Response Actions	Initial Durham Region Response Actions
	of the PZ. PEOC to adopt full activation. JTCC and Ministry EOCs fully activated.	

Section 6.0 Operational Response

6.1 Monitoring

The operational response for a Reportable Event or Abnormal Incident initial notification is monitoring. For a Reportable Event, the response is Routine Monitoring. The DEMO Duty Officer will monitor the situation from the normal place of work or home. Similarly, local municipal emergency management coordinators will monitor from their normal place of work or home.

For an Abnormal Incident, the response is Enhanced Monitoring and DEMO staff may monitor the situation from the REOC if directed to do so by the PEOC. Similarly, local municipality emergency coordinators will monitor from their MEOCs.

6.2 Partial Activation (Delayed Emission)

Delayed Emission. The most probable scenario for an accident at a NGS is a delayed emission, with the holdup of any radioactive material in the containment system.

Sequence. The general sequence of actions for a Delayed Emission with Partial Activation is as follows:

- notification of the Regional emergency management organization and set up and full staffing of the REOC and MEOCs,
- technical assessments of the accident and its projected effects by the PEOC Scientific Section. The assessment will include an evaluation of the accident and its prognosis, the operation of the NGS vacuum building, venting times, evacuation distances and recommended protective measures,
- decisions by the PEOC on any precautionary and protective measures and directives to the Region, and
- the issuing of Emergency Bulletins by the PEOC.

Technical Assessment. The technical assessment will produce a projection of the maximum distance from the NGS at which the lower Protective Action Level (PAL) for evacuation, sheltering and KI is likely to be reached during an emission. Once discussion with the REOC and decisions on protective actions are made, emergency directives and Emergency Bulletins will be issued to provide direction to the public.

The PEOC will upgrade to Full Activation response if it is determined that an emission is expected in 36 hours or less.

Precautionary Measures. The PEOC will consider, and discuss with the REOC, the implementation of precautionary measures. The application of precautionary measures will be conveyed to the public by Emergency Bulletins issued by the PEOC. The REOC and MEOCs must be prepared to assist with the implementation of these measures including:

- closing beaches and recreation areas,
- closing workplaces and schools,
- entry control,
- suspension of admissions of non-critical patients to hospitals,
- banning consumption of local water, milk, meat and produce.

Venting For Delayed Emission. Any radioactive material released from damaged fuel would be held up in the vacuum building for a minimum of 2 days at Pickering NGS and for 7 days at Darlington NGS. This will create the opportunity to vent the material in a controlled manner. The PEOC will consult with the REOC as well as other organizations before decisions are taken regarding venting and the protective measures that should be implemented before venting is carried out.

6.3 Full Activation (Imminent/On-going Emission)

The PEOC will order Full Activation under the following circumstances:

- on receipt of a General or Onsite Emergency notification from the NGS,
- after a Partial Activation, at a later stage of an emergency, if the situation deteriorates, and
- if an emission will occur in 36 hours or less.

Sequence. If the PEOC receives an initial notification from the NGS that an emission is on-going or imminent and there is insufficient time for the Scientific Section to assemble, the PEOC will take the following action:

- initiate a Full Activation response,
- issue an Emergency Bulletin to the broadcast media.
- direct public alerting to be initiated
- issue operational directives for sheltering and evacuation

For an Onsite Emergency, the default action is sheltering of the 3 km Contiguous Zone. For a General Emergency, the default will be to evacuate the 3km Contiguous Zone and shelter in the remainder of the 10km Primary Zone. As soon as the Scientific Section is assembled it will undertake a rapid technical assessment to determine what further protective measures are required and to what sectors of the 10km Primary Zone they are to be applied.

Evacuation and Personal Decontamination. If evacuations are being undertaken during an emission, the first priority is to leave the affected area as soon as possible. If Mobile Decontamination Units are not available because of time constraints, evacuees will be directed to go to a destination of their choice and decontaminate them (shower and put on fresh clothes). Details for decontamination will be provided in Emergency Bulletins issued by the PEOC.

KI and Sheltering. The decision to issue an operational directive for thyroid blocking by use of KI will be made by Chief Medical Officer of Health for Ontario and MOHLTC in coordination with the PEOC. If sheltering in some sectors is determined to be required, an Emergency Bulletin will be issued at least 4 hours in advance of the commencement of any emission.

Emergency Worker Safety. For a nuclear emergency with an on-going emission, the default sector safety status (including Lake Sectors) will be as follows:

- Onsite Emergency
    - CZ Sectors- Orange
    - All other Sectors - Green
- General Emergency
    - CZ Sectors- Red Middle
    - Ring Sectors-Orange
    - All other Sectors- Green

As soon as relevant data is available, the PEOC will reassign safety status to all of the sectors. Emergency workers who need to enter a sector that has been assigned a safety status other than Green will first report to an EWC where they will be provided with personal monitoring devices by OPG staff and be briefed on precautions they should follow. An exception to this is DRPS officers who are trained and are equipped with personal monitoring equipment who may be required to enter a sector before an EWC is functioning.

<u>Public Direction</u>. Directions to the public on the protective measures they should take to ensure their safety during the emergency will be issued only by the PEOC. The PEOC will provide public direction by use of Emergency Bulletins issued to media. Release of these bulletins will be coordinated with the REOC.

<u>Emergency Information</u>. When the offsite response is Routine or Enhanced Monitoring, the Director of the Communications Branch of the Ministry of Community Safety & Correctional Services, will prepare media releases on the situation. When the offsite response is Partial or Full Activation, the Provincial Emergency Information Section (PEIS) will be established. For Durham Region, the Director of Corporate Communications will be responsible to prepare media releases on behalf of the Region and activate the Emergency Information Centre when the REOC is activated.

6.4 Transition to the Recovery Phase

The PEOC will end the Response Phase of the emergency and move to the Recovery Phase at any time after both of the following conditions have been met:

- the nuclear reactor that had the accident is in a guaranteed shutdown state, and
- no further emissions at significant levels are anticipated i.e. they do not adversely affect public safety and do not warrant any exposure control measures.

Nuclear Emergency Facilities List

Regional Emergency Operations Centre (REOC)

Durham Region Headquarters
605 Rossland Road East, Whitby

Regional Traffic Control Centre

101 Consumers Drive, Whitby

Ajax Municipal Emergency Operations Centre

Ajax Fire Headquarters
900 Salem Road North, Ajax

Clarington Municipal Emergency Operations Centre

Clarington Fire Department
3333 Highway 2, Newcastle

Pickering Municipal Emergency Operations Centre

Claremont Community Centre
Old Brock Road, Claremont

Municipal Office
One the Esplanade, Pickering

Oshawa Municipal Emergency Operations Centre

Oshawa Fire Station #5
1550 Harmony Road North, Oshawa

Northview Community Centre
150 Beatrice Street East, Oshawa

Whitby Municipal Emergency Operations Centre

Fire Department Headquarters
111 McKinney Drive, Whitby

Reception Centres in Durham Region

Legends Centre
1661 Harmony Road North, Oshawa

Durham College
2000 Simcoe Street North, Oshawa

Reception Centres in City of Toronto

York University
4700 Keele Street, North York

Reception Centre in City of Peterborough

Sir Sanford Fleming College
Brealey Drive, Peterborough

Emergency Worker Centres

Iroquois Park
Victoria Street and Henry Street, Whitby

Orono Arena
Station Street at Rowe Street, Orono

Centennial College
Progress Court at Markham Road, Scarborough

Glossary

Absorbed Dose

The amount of energy absorbed in the body, or in an organ or tissue of the body, due to exposure to ionizing radiation, divided by the respective mass of the body, organ or tissue. Expressed in terms of sieverts (or rem).

Acute Radiation Syndrome

An acute illness caused by irradiation of the entire body (or most of the body) by a high dose of penetrating radiation in a very short period of time.

Alerting

Informing the population, by means of an appropriate signal, that a nuclear emergency has occurred or is about to occur.

Collective (Equivalent) Dose

An expression for the total radiation dose incurred by a population, defined as the product of the average radiation dose to a group of exposed persons and the number of persons in the group. Generally expressed in terms of person-sievert (or person-rem).

Committed (Equivalent) Dose

The radiation dose that will be received over a period of 50 years (for adults) or 70 years (for children) after a person takes in a quantity of radioactive material (by ingestion, absorption or inhalation). The dose is expressed in terms of sievert (or rem).

Containment (System)

A series of physical barriers that exist between radioactive material contained in a nuclear installation and the environment. Containment usually refers only to the reactor and vacuum buildings, and integral systems such as dousing.

Contamination

The unwanted presence of radioactive material in water or air, or on the surfaces of structures, areas, objects or people.

Contiguous Zone (CZ)

The zone immediately surrounding a nuclear installation. An increased level of emergency planning and preparedness is undertaken within this area because of its proximity to the potential hazard. The actual Contiguous

Zone for each designated nuclear installation is specified in the relevant Implementing plans of the Provincial Nuclear Emergency Response Plan.

Critical Group

A particular group among the relevant population which, by virtue of age, sex or dietary habits, is expected to receive the highest dose from a stated radiation source or exposure pathway.

Decontamination

Reduction or removal of radioactive contamination in or on materials, persons or the environment.

Derived Emission Limits

Limits for radioactive emissions to air and water from a nuclear facility which ensure that, under normal operating conditions, Canadian Nuclear Safety Commission dose limits for members of the public are not exceeded by persons exposed to those emissions.

Designated Municipality

A municipality in the vicinity of a nuclear facility which has been designated under the *Emergency Management and Civil Protection Act*, as one that shall have a nuclear emergency plan (*for list see* **Annex A**).

Dose

A measure of the radiation received or “absorbed” by a target. The quantities termed absorbed dose, organ dose, equivalent dose, effective dose, committed equivalent dose or committed effective dose are used, depending on the context. The modifying terms are often omitted when they are not necessary for defining the quantity of interest.

Dose Projection

The calculation of projected dose (*see* **Projected Dose**).

Dose Rate

The amount of radiation dose which an individual would receive in a unit of time. In the context of this Plan, the measurement units are multiples or submultiples of the sievert (or rem) per hour.

Dosimeter

An instrument for measuring and registering total accumulated exposure to ionizing radiation.

Effective (Equivalent) Dose

The sum of the weighted equivalent doses received by the organs and tissues of the body, where the weighted equivalent dose is the equivalent dose to an organ or tissue of the body multiplied by the appropriate weighting factor laid down in the Atomic Energy Control Regulations promulgated by the Atomic Energy Control Board (Canadian Nuclear Safety Commission). Expressed in terms of sievert (or rem).

Emergency Bulletin (EB)

Directions to the public on appropriate protective and other measures to be taken during a nuclear or radiological emergency, which are issued by the province and broadcast through the media.

Emergency Workers

A person who assists in connection with an emergency that has been declared by the Lieutenant Governor in Council or the Premier, under 5.7.0.1 of the EMPCA or by the head of council of a municipality under section 4 of the EMCPA. This may include persons who are required to remain in, or to enter, offsite areas affected or likely to be affected by radiation from an accident, and for whom special safety arrangements are required. Examples of emergency workers include police, firefighters, ambulance and personnel from the Canadian Armed Forces, and other essential services. They shall not include radiation workers or ingestion monitoring field staff.

Emergency Worker Centre (EWC)

A facility set up to monitor and control radiation exposure to emergency workers.

Emission

In the context of this plan, emission refers to the release of radioactive material to the environment from a nuclear facility in the form of either an airborne or a liquid emission.

Entry Control

The prevention of non-essential persons from entering a potentially dangerous area.

Equivalent Dose

The absorbed dose multiplied by a weighting factor for the type of radiation giving the dose. Weighting factors for use in Canada are prescribed by the

Atomic Energy Control Board (Canadian Nuclear Safety Commission). This term is also sometimes called *weighted dose*. Expressed in terms of Sievert (or rem).

Evacuation

The process of leaving a potentially dangerous area.

Exposure

The act or condition of being subject to irradiation. Exposure can be either external exposure (irradiation by sources outside the body) or internal exposure (irradiation by sources inside the body).

Exposure Control

Emergency operations aimed at reducing or avoiding exposure to a plume or puff of radioactive material. Measures to deal with surface contamination and re-suspension might also be included.

Exposure Pathways

The routes by which radioactive material can reach or irradiate humans.

External Notification

The notification of organizations and agencies (not directly part of the emergency management organization) which may be affected by a nuclear emergency, or which may be required to assist in responding to it.

Field Monitoring:

The assessment of the magnitude, type and extent of radiation in the environment during an emergency by such means as field surveys and field sampling.

Food Control:

Measures taken to prevent the consumption of contaminated foodstuffs and control of including the supply of uncontaminated foodstuffs. Where appropriate, such control may include food storage to permit radionuclide decay, diversion of food to non-human, non-food chain use or disposal of unusable stocks.

Guaranteed Shutdown State

A reactor is considered to be in this state when there is sufficient negative reactivity to ensure sub-criticality in the event of any process failure, and approved administrative safeguards are in place to prevent net removal of negative reactivity.

Hostile Action:

Any deliberate action or threat of action, which could cause a nuclear emergency.

Host Municipality

The municipality assigned responsibility in the Provincial Nuclear Emergency Response Plan for the reception and care of people evacuated from their homes in a nuclear emergency.

Imminent Emission

A radioactive emission that will occur in 12 hours or less.

Ingestion Control

Emergency response operations in which the main aim is to avoid or reduce the risk from ingestion of contaminated food and water.

Initial Notification

The notification made by a nuclear facility to Provincial and/or municipal authorities upon the occurrence of an event or condition which has implications for public safety, or could be of concern to these authorities. The criteria and channels for making such notification are usually prescribed in emergency plans.

Internal Notification

The notification by an organization to its personnel who are required to respond to an emergency.

Land Control

Control on the use of contaminated land for growing food products or animal feed.

Livestock Control

Quarantine of livestock in the affected area to prevent movement to other areas. Slaughter of such animals for food may be banned.

Milk Control

Preventing the consumption of locally produced milk in the area affected by a nuclear emergency, and its export outside the area until it has been monitored. Collection of contaminated milk, its diversion to other uses, or its destruction, may also be involved.

Notification

Conveying to a person or an organization, by means of a message, warning of the occurrence or imminence of a nuclear emergency, usually includes some indication of the measures being taken or to be taken to respond to it.

Nuclear Emergency

An emergency caused by an actual or potential hazard to public health and property or the environment from ionizing radiation or from a nuclear facility.

Nuclear Establishment

A facility that uses, produces, processes, stores or disposes of a nuclear substance, but does not include a nuclear installation. It includes, where applicable, any land, building, structures or equipment located at or forming part of the facility, and, depending on the context, the management and staff of the facility.

Nuclear Facility

A generic term covering both nuclear establishments and nuclear installations.

Nuclear Installation

A facility or a vehicle (operating in any media) containing a nuclear fission or fusion reactor (including critical and sub-critical assemblies). It includes, where applicable, any land, buildings, structures or equipment located at or forming part of the facility, and, depending on the context, the management and staff of the facility.

Nuclear Substance

As defined in the (Federal) Nuclear Safety and Control Act.

Offsite

Offsite refers to the area outside the boundary (fence) of a nuclear facility.

Onsite

Onsite refers to the area inside the boundary (fence) of a nuclear facility.

Operational Directives

Direction given by the emergency response organization to implement operational measures.

Operational Measures

Measures undertaken by the emergency response organization to deal with the emergency, including measures to enable or facilitate protective action for the public, e.g., public alerting, public direction, activation of plans, traffic control, emergency information, etc.

Operator

Holder of a subsisting licence issued pursuant to the Nuclear Safety and Control Act for the operation of a nuclear installation.

Pasture Control

Removing milk- and meat-producing animals from pasture and from access to open water sources, and supplying them with uncontaminated feed and water.

Personal Monitoring

The use of radiation monitoring devices to assess whether persons, and their belongings, including vehicles, are contaminated or not, and, if contaminated, the type and level of contamination.

Plume

A cloud of airborne radioactive material that is transported in the direction of the prevailing wind from a nuclear facility. A plume results from a continuing release of radioactive gases or particles.

Precautionary Measures

Measures which will facilitate the application and effectiveness of protective measures.

Primary Zone (PZ)

The zone around a nuclear installation within which planning and preparedness is carried out for measures against exposure to a radioactive plume. (The Primary Zone includes the Contiguous Zone). The Primary Zone for the Darlington and Pickering Nuclear Generating Stations is 10 km.

Produce and Crop Control

Restrictions on the harvesting or processing of potentially or actually contaminated crops, vegetables and fruits. Measures include: embargoing export outside the affected area; storage to allow radionuclide decay; diversion to non-food chain use; destruction and disposal of contaminated produce.

Projected Dose

The highest committed effective equivalent dose or committed equivalent dose to a specified organ or tissue, likely to be received through all applicable exposure pathways by the most exposed member of the critical group in the area for which the projection is being made.

Protective Action Levels (PALs)

Projected dose levels which provide technical guidance on the need to take certain protective measures.

Protective Measures

Measures designed to protect against exposure to radiation during a nuclear emergency.

Puff

A plume of short duration. The distinction between a puff and a plume is a matter of time. The upper limit on the duration of a puff is half an hour.

Radiation

In the context of this Plan, radiation means ionizing radiation (i.e. radiation with the potential to harm human tissue or cells produced by a nuclear substance or a nuclear facility.

Radiological Emergency

Emergency caused by an actual or environmental hazard from ionizing radiation emitted by a source other than a nuclear installation.

Radiological Device (RDs)

Could be lost or stolen radioactive sources which may be in locations resulting in radiation exposure and/or contamination of the public, contamination of a site and/or contamination of food and water supplies.

Radionuclide (or radioactive isotope or radioisotope)

A naturally occurring or artificially created isotope of a chemical element having an unstable nucleus that decays, emitting alpha, beta and/or gamma rays until stability is reached.

Response Sectors

The Primary Zone is subdivided into Response Sectors to facilitate the planning and implementation of protective measures.

Restoration

Operations to restore conditions to normal after a nuclear emergency.

Secondary Zone

The zone around a nuclear installation within which it is necessary to plan and prepare measures against exposure from the ingestion of radioactive material. (The Secondary Zone includes both the Primary and Contiguous Zones). The Secondary Zone for the Darlington and Pickering Nuclear Generating Station is 50 km.

Selective Evacuation

The evacuation of a specified group of people, such as seriously ill patients in hospitals, bedridden residents of nursing homes, or disabled residents.

Sheltering

A protective measure which uses the shielding properties of buildings and their potential for ventilation control to reduce the radiation dose to people inside.

Source Term

A generic term applied to the radioactive material released from a nuclear facility. It includes the quantity and type of material released as well as the timing and rate of its release. It could apply to an emission that was currently occurring, or one which had ended, or one which could take place in the future.

Special Group

A group for which special constraints arise in the application of a protective measure, such as intensive care patients in hospitals and institutions, bedridden patients in nursing homes, handicapped persons and prison inmates.

Support Municipality

Pursuant to section 7.0.2 (4) of the EMPCA, the LGIC may, by order, specify a municipality to act in a support capacity to provide assistance to designated municipalities.

Thyroid Blocking

The reduction or prevention of the absorption of radioiodine by the thyroid gland, which is accomplished by the intake of a stable iodine compound (such as potassium iodide) by people exposed or likely to be exposed to radioiodine.

Venting

The release to the atmosphere of radioactive material from the containment of a nuclear facility through systems designed for this purpose.

Vulnerable Group

A group which, because it is more vulnerable to radiation, may require protective measures not considered necessary for the general population, such as pregnant women and, in some cases, children.

Water Control

Measures taken to avoid the contamination of drinking water supplies and sources, and to prevent or reduce the consumption of contaminated water.

Weighted Dose

Expressed in terms of sievert (or rem).

Report

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PICKERING NGS DEVELOPMENT OF EVACUATION TIME ESTIMATES

Pickering NGS Development Of Evacuation Time Estimates

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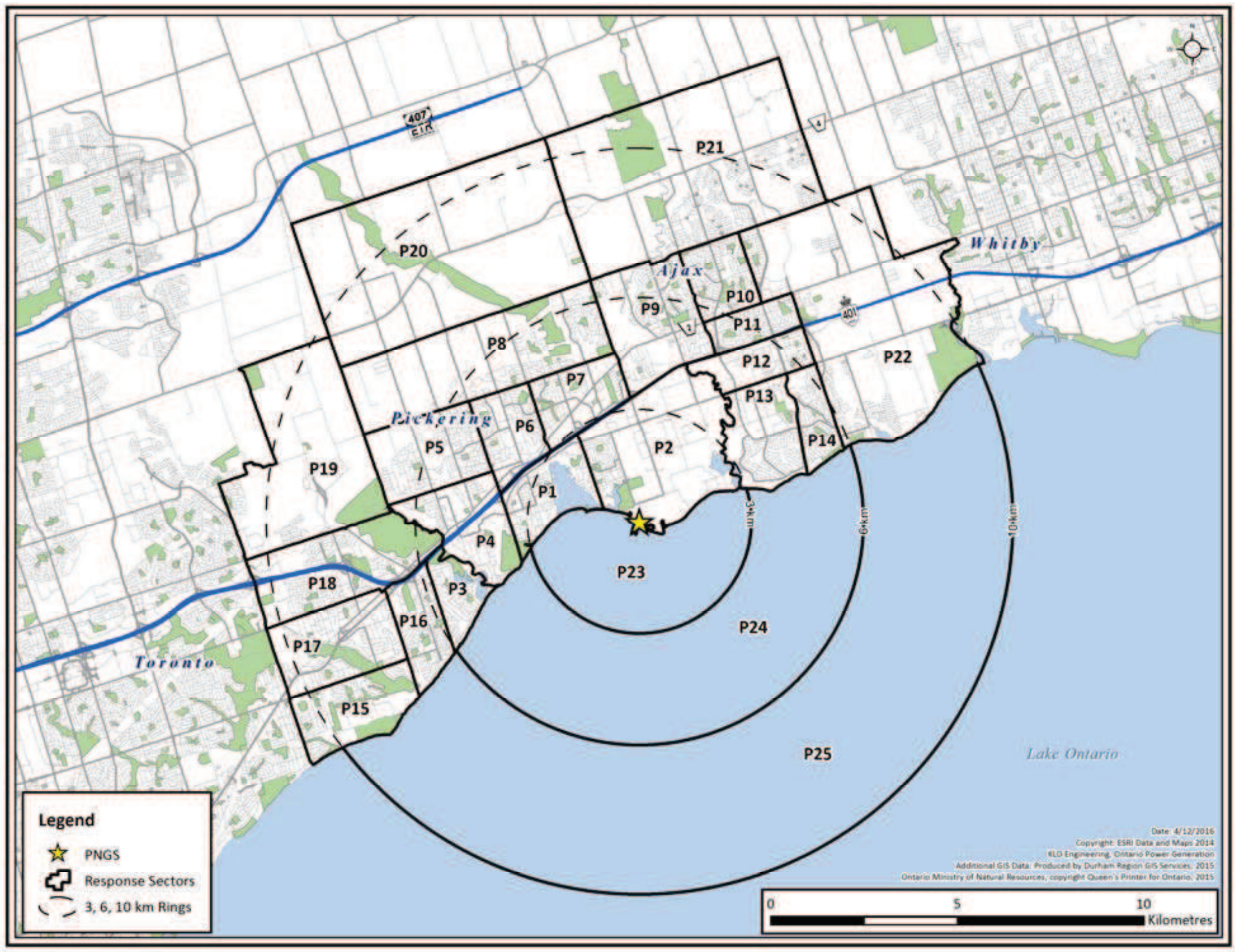
PICKERING NUCLEAR GENERATING STATION

Development of Evacuation Time Estimates



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EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Pickering Nuclear Generating Station (PNGS) located in the Municipality of Pickering in Durham Region, Ontario. This study provides Ontario Power Generation (OPG), the Province, and the Region with the estimated times to evacuate the Primary Zone (PZ) and various subsets of the PZ.

A traffic/evacuation simulation model (Dynamic Evacuation Simulation Model, or DYNEV-II) is used to compute ETE using the procedure shown in Figure ES-1. The supply input to DYNEV-II is in the form of a link-node analysis network – a computerized replica of the roadway system within the study area (a circle centred at PNGS with a radius of 15 km). The link-node analysis network is calibrated to include roadway characteristics such as free speed (speed that drivers are comfortable traveling at in the lack of traffic congestion), number of lanes, type of traffic control (signal, stop sign, manned), etc that were collected during a field survey in 2015. Resident population from 2011 Statistics Canada data, employee and transient data provided by Durham Region and the City of Toronto, and phone calls to individual facilities are used to estimate the evacuation vehicle demand. All estimates of evacuation demand, except for the 2011 Statistics Canada data, were obtained in 2015. The supply and demand are input to DYNEV-II. The two main outputs of the DYNEV-II model are ETE for general population (evacuees with personal vehicles) and route-specific evacuation speeds, which are used to compute the ETE for special facilities (schools, medical facilities, correctional facilities, etc.) and the transit-dependent population. The ETE values presented in Section 7 of this report were developed based on 2011 Statistics Canada data. Table M-9 and Table M-10 present the 90^{th} and 100^{th} percentile ETE, respectively, for 2015. All input data for Table M-9 and Table M-10, including permanent residents, transients, employees, special facilities, and roadway network, were obtained in, or extrapolated to, 2015.

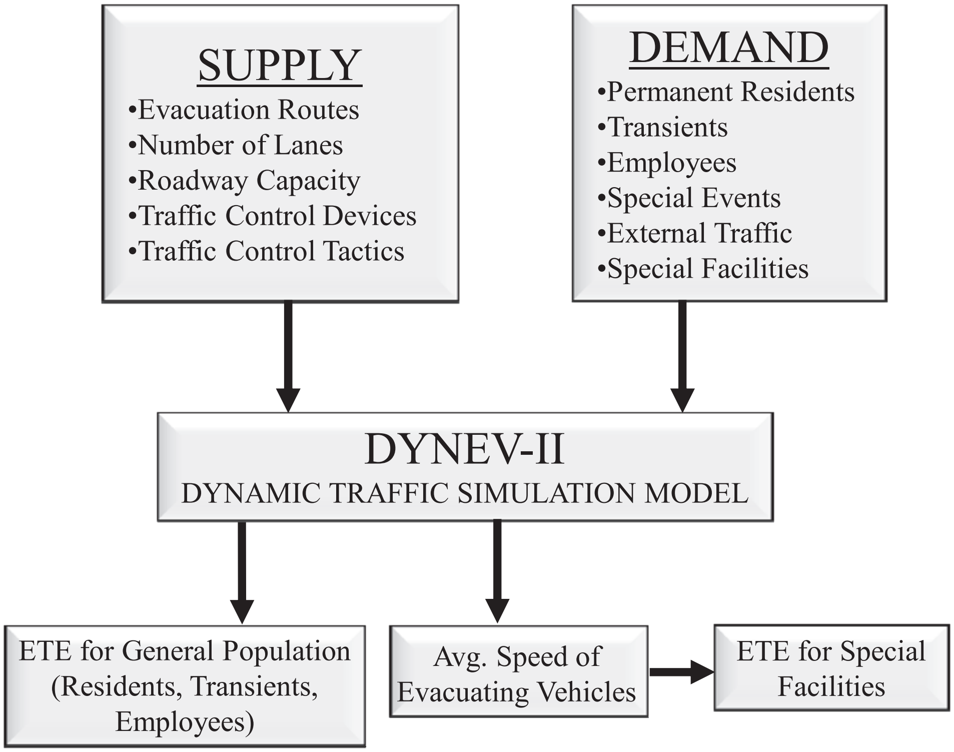


Figure ES-1. ETE Methodology

The general population ETE are presented in Tables 7-1 and 7-2. These data are the times needed to clear the indicated regions of 90 and 100 percent of the population occupying these regions, respectively. For definitions of scenarios (demand changes due to temporal variations) and regions (area to be evacuated varies with wind direction and speed), see Section 6 and Appendix H, respectively. These computed ETE include consideration of mobilization time and of estimated voluntary evacuations from other regions within the PZ and from the Shadow Region (area extending from the PZ boundary to 15 km radially from the plant).

Critical findings of the study include:

- The ETE computed for this study are longer than the ETE computed in the previous study (2008). This increase in ETE is the result of a 14 percent increase in residential population and the additional vehicles from transients, special facilities, schools, day camps, college populations and the correctional facility, which the previous study did not account for.
- General population ETE were computed for 420 unique cases – a combination of 30 unique Evacuation Regions and 14 unique Evacuation Scenarios. Table 7-1 and Table 7-2 document the ETE for the 90th and 100th percentiles. These ETE range from 2:00 (hr:min) to 6:10 at the 90th percentile.
- Inspection of Table 7-1 and Table 7-2 indicates that the ETE for the 100th percentile are significantly longer than those for the 90th percentile, ranging from 5:45 to 8:40. This is

the result of congestion within the PZ. See Section 7.3.

- Inspection of Table 7-3 and Table 7-4 indicates that a staged evacuation protective action strategy benefits evacuees from within the contiguous zone, yet adversely impacts many evacuees located beyond the contiguous zone. See Section 7.6 for additional discussion.
- Comparison of Scenarios 3 (summer, weekend, midday) and 13 (summer, weekend, midday) indicates that the special event (a large event at the Toronto Zoo) has little to no impact on the 90th or 100th percentile ETE. See Section 7.5 for additional discussion.
- Comparison of Scenarios 1 and 14 in Table 7-1 indicates that events such as adverse weather or traffic accidents which close a lane on Hwy 401 Express westbound, from the interchange of Brock Road to the interchange with McCowan Road, can increase ETE by up to 25 minutes and 20 minutes for the 90th and 100th percentile ETE, respectively. See Section 7.5 for additional discussion.
- The majority of the PZ is congested during a full PZ evacuation. All congestion within the PZ clears by 6 hours and 55 minutes after the Advisory to Evacuate for a winter, midweek, midday, good weather scenario (Scenario 6). All congestion within the study area clears by 7 hours and 50 minutes. See Section 7.3 and Figures 7-3 through 7-11 for additional discussion.
- Separate ETE were computed for schools, medical facilities, the correctional facility and transit-dependent persons. The average single-wave ETE for these facilities are comparable to the general population ETE. See Section 8 for additional discussion.
- Section 8 indicates that based on discussions with local school bus providers, when evacuating schools, local school bus providers will make multiple trips to Temporary Holding Centres (THC) if needed. Durham Region Transit (DRT), Toronto Transit Commission (TTC) and Go Transit vehicles will be used to evacuate the transit dependent population only. Several of the medical facilities have their own transportation resources or have plans with DRT. There are some medical facilities that may require transportation assistance. The correctional facility currently has a van that remains on site and will be utilized during an evacuation. See Section 8.4.
- There are two existing Traffic Control Points (TCPs) with proposed modifications based on the results of this study. EVA07 at the intersection of Bayly Street/Regional Road 22 and Harwood Avenue; and, EVA50 at the intersection of Twyn Rivers Dr/Sheppard Avenue and Altona Road. See Section 9 and Appendix G.
- The general population ETE at the 90th and 100th percentiles are insensitive to changes in the base trip generation time of 5 hours and 45 minutes due to the traffic congestion within the PZ. See Table M-1.
- The general population ETE is affected by the voluntary evacuation of vehicles in the Shadow Region (quadrupling the shadow evacuation percentage from 20% to 80% increases 90th percentile ETE by 20 minutes and 100th percentile ETE by 35 minutes). Full evacuation (100%) of the Shadow Region increases the 90th and 100th percentile ETE by 20 minutes and 45 minutes, respectively. See Table M-2.
- Projected ETE values for 2015 and 2025 are provided as a sensitivity study in Appendix M. See Section M.3 for future results.

- A full closure of Hwy 401 has a significant impact on the 90th and 100th percentile ETE with increases of as much as 35 minutes and 1 hour and 10 minutes, respectively. See Section M.4.
- Prolonging the time to establish access control by 2 hours has a significant impact (increases of up to 40 minutes) on the 90th percentile ETE only. See Section M.5.

Table 7-1. Time to Clear the Indicated Area of *90* Percent of the Affected Population

	Summer		Summer		Summer	Winter			Winter			Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Special Event	Roadway Impact
Evacuate Contiguous Zone, Middle Ring and Full Primary Zone														
R01	2:15	2:35	2:15	2:30	2:00	2:15	2:30	2:50	2:10	2:25	2:45	2:00	2:15	2:15
R02	3:15	3:25	3:05	3:15	3:00	3:15	3:25	3:50	3:05	3:15	3:40	3:00	3:05	3:15
R03	4:25	4:45	4:10	4:35	4:00	4:25	4:45	5:20	4:15	4:25	5:05	4:00	4:15	4:25
Evacuate Contiguous Zone and Downwind to Primary Zone Boundary														
R04	4:25	4:50	4:20	4:40	4:10	4:30	4:55	5:25	4:20	4:40	5:10	4:10	4:20	4:35
R05	4:25	4:50	4:20	4:40	4:10	4:40	4:45	5:25	4:15	4:35	5:05	4:10	4:20	4:25
R06	4:20	4:50	4:15	4:35	4:10	4:25	4:45	5:20	4:15	4:30	5:00	4:05	4:15	4:20
R07	3:30	3:45	3:15	3:30	2:55	3:30	3:40	4:05	3:05	3:25	3:45	2:50	3:15	3:30
R08	3:10	3:25	3:05	3:15	2:40	3:15	3:30	3:50	3:00	3:15	3:35	2:40	3:05	3:15
R09	2:15	2:35	2:15	2:30	2:00	2:15	2:30	2:50	2:10	2:25	2:45	2:00	2:15	2:15
R10	2:30	2:45	2:20	2:35	2:15	2:30	2:45	3:05	2:20	2:35	2:55	2:15	2:20	2:30
R11	2:55	3:10	2:45	3:00	2:25	3:00	3:20	3:40	2:45	3:05	3:25	2:25	2:45	2:55
R12	3:05	3:20	2:55	3:10	2:40	3:05	3:25	3:45	2:55	3:10	3:35	2:40	3:00	3:05
R13	3:20	3:30	3:10	3:30	3:00	3:20	3:35	4:05	3:10	3:35	3:55	3:00	3:20	3:20
R14	3:20	3:35	3:10	3:30	3:15	3:20	3:45	4:15	3:10	3:25	4:00	3:15	3:20	3:20
R15	3:15	3:20	3:00	3:10	3:25	3:15	3:20	3:45	3:00	3:10	3:45	3:20	3:10	3:15
R16	3:35	3:40	3:20	3:35	3:25	3:35	3:45	4:05	3:20	3:30	3:50	3:30	3:20	3:35
Staged Evacuation - Evacuate Contiguous Zone and Downwind to Primary Zone Boundary														
R17	5:20	5:45	5:10	5:20	5:05	5:05	5:30	6:05	5:00	5:15	5:50	5:05	5:15	5:20
R18	5:00	5:35	5:10	5:15	5:05	5:05	5:40	6:05	5:15	5:15	6:10	5:05	5:10	5:25
R19	5:20	5:20	5:10	5:15	5:10	5:00	5:25	5:55	4:55	5:15	5:45	5:10	5:10	5:20
R20	4:05	4:15	3:50	4:10	4:00	4:00	4:15	4:40	3:55	4:00	4:40	4:00	3:55	4:05
R21	3:40	3:50	3:30	3:45	3:40	3:35	3:50	4:20	3:30	3:45	4:15	3:40	3:35	3:40
R22	2:15	2:35	2:15	2:30	2:00	2:15	2:30	2:50	2:10	2:25	2:45	2:00	2:15	2:15
R23	3:05	3:15	3:00	3:05	3:20	3:05	3:15	3:40	3:00	3:10	3:40	3:20	3:00	3:05
R24	3:25	3:40	3:25	3:30	3:35	3:30	3:40	4:15	3:20	3:30	4:10	3:35	3:25	3:25
R25	3:45	3:55	3:40	3:45	3:55	3:40	4:00	4:30	3:40	3:45	4:25	3:50	3:40	3:45
R26	4:05	4:15	4:05	4:10	4:10	4:05	4:15	4:55	4:05	4:10	4:45	4:10	4:05	4:05
R27	4:10	4:15	3:55	4:10	4:15	4:10	4:10	4:50	4:00	4:10	4:50	4:15	4:00	4:10
R28	3:55	4:05	3:55	4:05	4:25	4:00	4:05	4:50	3:55	4:00	4:40	4:10	3:55	4:00
R29	4:25	4:30	4:15	4:20	4:35	4:15	4:25	5:05	4:15	4:20	5:00	4:30	4:15	4:25
R30	5:00	5:15	5:00	5:10	4:55	5:00	5:15	5:55	5:00	5:05	5:55	4:50	5:05	5:05

Table 7-2. Time to Clear the Indicated Area of *100* Percent of the Affected Population

	Summer		Summer		Summer	Winter			Winter			Winter	Summer	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Region	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Special Event	Roadway Impact
Evacuate Contiguous Zone, Middle Ring and Full Primary Zone														
R01	5:50	5:50	5:45	5:45	5:45	5:50	5:50	5:50	5:45	5:45	5:45	5:45	5:45	5:50
R02	5:50	5:50	5:50	5:50	5:50	5:50	5:50	5:55	5:50	5:50	5:50	5:50	5:50	5:50
R03	6:45	7:40	6:50	7:20	6:15	6:55	7:40	8:40	6:40	7:15	7:55	6:15	6:55	6:45
Evacuate Contiguous Zone and Downwind to Primary Zone Boundary														
R04	6:40	7:10	6:25	7:10	6:10	6:50	7:40	8:15	6:35	7:15	7:50	6:10	6:30	6:45
R05	6:35	7:10	6:25	7:05	6:10	6:50	7:10	8:15	6:20	6:55	7:45	6:10	6:25	6:35
R06	6:15	7:10	6:15	6:45	6:05	6:20	7:00	7:55	6:15	6:45	7:20	5:55	6:20	6:25
R07	5:55	5:55	5:55	5:55	5:55	5:55	5:55	6:10	5:55	5:55	5:55	5:55	5:55	5:55
R08	5:55	5:55	5:55	5:55	5:55	5:55	5:55	6:00	5:55	5:55	5:55	5:55	5:55	5:55
R09	5:50	5:50	5:45	5:45	5:45	5:50	5:50	5:50	5:45	5:45	5:45	5:45	5:45	5:50
R10	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55
R11	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55
R12	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55
R13	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55
R14	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55
R15	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55
R16	5:55	5:55	5:55	5:55	5:55	5:55	5:55	6:20	5:55	5:55	6:15	5:55	5:55	5:55
Staged Evacuation - Evacuate Contiguous Zone and Downwind to Primary Zone Boundary														
R17	7:00	7:30	7:05	7:20	6:55	6:55	7:40	8:15	6:55	7:15	7:50	6:55	7:10	7:15
R18	7:00	7:30	7:05	7:20	6:55	6:55	7:40	8:15	6:55	7:15	7:50	6:55	7:10	7:15
R19	7:00	7:30	7:05	7:20	6:55	6:55	7:30	8:15	6:55	7:15	7:45	6:55	7:10	7:15
R20	5:55	6:15	5:55	6:05	5:55	5:55	6:10	7:00	5:55	5:55	6:55	5:55	5:55	5:55
R21	5:55	6:00	5:55	5:55	5:55	5:55	5:55	6:50	5:55	5:55	6:30	5:55	5:55	5:55
R22	5:50	5:50	5:45	5:45	5:45	5:50	5:50	5:50	5:45	5:45	5:45	5:45	5:45	5:50
R23	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55	5:55
R24	5:55	5:55	5:55	5:55	5:55	5:55	5:55	6:25	5:55	5:55	6:25	5:55	5:55	5:55
R25	5:55	6:00	5:55	5:55	5:55	5:55	5:55	6:34	5:55	5:55	6:25	5:55	5:55	5:55
R26	5:55	6:00	5:55	5:55	5:55	5:55	5:55	6:40	5:55	5:55	6:30	5:55	5:55	5:55
R27	5:55	6:00	5:55	5:55	5:55	5:55	5:55	6:40	5:55	5:55	6:30	5:55	5:55	5:55
R28	5:55	6:00	5:55	5:55	5:55	5:55	5:55	6:40	5:55	5:55	6:30	5:55	5:55	5:55
R29	5:55	6:20	6:00	6:15	5:55	6:00	6:20	7:05	6:05	6:25	7:05	5:55	6:05	6:00
R30	7:15	7:45	7:35	7:40	7:00	7:25	7:55	8:40	7:25	7:40	8:35	6:50	7:35	7:35

Amendment 26

to the City of Pickering Official Plan

Approved by the Ontario Municipal Board on March 4, 2015
OMB Case no. PL140854

Amendment 26 to the Pickering Official Plan

Purpose:

The purpose of this Amendment is to add new policies and change existing policies to the Pickering Official Plan to create a framework for the redevelopment and intensification of the City Centre and to identify required infrastructure improvements and transportation connections within and from the City Centre in support of anticipated population and employment growth. Other policy changes include minor revisions reflecting Regional terminology and housekeeping matters. This Amendment is consistent with the Growth Plan for the Greater Golden Horseshoe, Regional Official Plan Amendment No. 128 and the City's Sustainable Place- making Vision.

Location:

This amendment applies to all lands bounded by Pine Creek to the west, Diana Princess of Wales Park and the hydro corridor to the east, Bayly Street to the south and the rear lot lines of all parcels fronting the north side of Kingston Road (inclusive of 1848, 1852 & 1854 Liverpool Road and 1298 Kingston Road), as well as lands for three new road connections extending beyond the City Centre providing connections to Brock Road to the east, Kingston Road at Walnut Lane to the west, and Bayly Street to Kingston Road to the north. The subject lands are approximately 134 hectares in extent and within the City of Pickering.

Basis:

The Growth Plan has designated Pickering's City Centre as an Urban Growth Centre and stipulates that it will be planned to achieve, by 2031 or earlier, a minimum gross density of 200 residents and jobs combined per hectare. The City Centre has also been designated as an Anchor Mobility Hub in Metrolinx's Big Move with the Pickering GO Station being a major transit station and its surroundings having development potential for compact employment and higher density residential uses.

The approval of Regional Official Plan Amendment No.128 provided the policy foundation for the City to retain consultants to prepare its planning and urban design study for the redevelopment and intensification of the City Centre. Following an extensive consultation program involving stakeholders and the public, a report entitled "Downtown Pickering, A Vision for Intensification and Framework for Investment" was endorsed in principle by City Council on July 8, 2013. Staff was authorized to implement the vision and framework by initiating this Official Plan Amendment.

These new policies will also complement and augment the corporate vision of "Sustainable Place-making" by promoting land uses and built form that are transit oriented, environmentally friendly and supportive of mixed use development and walkability.

Actual Amendment:

The City of Pickering Official Plan is hereby amended by:

(New text shown as underlined text, deleted text shown as strikeout text, retained text shown as unchanged text)

1.0 Amending *Schedule I - Land Use Structure* for the lands subject to the amendment by:

- Replacing the "Downtown Core" designation with a new "City Centre" designation;
- Replacing the "Mixed Corridors" designation with a "Natural Areas" designation in recognition of the Krosno Creek corridor located west of Sandy Beach Road, north of Bayly Street;
- Replacing the remaining "Mixed Corridors" designation with new "City Centre" and "Natural Areas" designations for the lands located east of Liverpool Road and west of the hydro corridor, north of Bayly Street;
- Replacing the "Prestige Employment" designation with a new "City Centre" designation for the lands located east of Sandy Beach Road and west of the Hydro corridor, north of Bayly Street;
- Replacing the "Natural Areas" designation with a new "City Centre" designation for the lands located on the north-west corner of Liverpool Road and Highway 401, east of Pine Creek; and
- Replacing "Downtown Core" with "City Centre" in the Land Use Structure legend;

as illustrated on Schedule A attached to this Amendment.

2.0 Amending *Schedule II – Transportation System* for the roads subject to the amendment by:

- Adding a "Future Collector Road", south of Highway 401, from Brock Road to Bayly Street;
- Adding a "Future Type C Arterial Road" from Liverpool Road to Kingston Road opposite Walnut Lane; and

- Adding a "Future Type C Arterial Road" and "Overpass" from Bayly Street crossing over Highway 401 to Kingston Road;

as illustrated on Schedule B attached to this Amendment.

3.0 Amending the text of the Official Plan by:

3.1 Deleting all references in policies to the term "Downtown Core" and replacing it with "City Centre";

3.2 Revising section 2.10, South Pickering Urban Area Population Target, in Chapter Two – The Planning Framework, by adding a new sub-section (c) as follows:

"(c) despite sections 2.10 (a) and (b), adopts a population target for the City Centre of 13,500 people for the year 2031;"

3.3 Revising section 2.11, South Pickering Urban Area Employment Target, in Chapter Two – The Planning Framework, by adding a new sub-section (b) identifying an employment target for the City Centre and revising sub-section (c) (i) so that it reads as follows:

"(a) ...; ~~and~~
(b) despite section 2.11(a) adopts an employment target for the City Centre of 13,500 jobs for the year 2031; and,
(~~b~~c) shall endeavour to accommodate urban employment in the South Pickering Urban Area as follows,
(i) primarily in Mixed Use Areas~~,~~ and Employment Areas ~~and Regional Nodes~~ as designated on Schedule I to this Plan; and
(ii) as home occupations in Urban Residential Areas."

3.4 Revising Table 1, South Pickering Urban Area Population Targets 1996-2016, in Chapter Two – The Planning Framework, by adding a note below the table that reads as follows:

"Note: The year increments and the population targets for South Pickering Urban Area will be adjusted from 2016 to 2031 and updated through the completion of the City's Growth Plan conformity amendment."

3.5 Revising section 3.2, Land Use Objectives, in Chapter Three – Land Use, by revising subsections (c) and (d) to read as follows:

"(c) promote the ~~downtown~~ City Centre ~~core~~ as the City's main focus for business, employment, entertainment, shopping, major community and cultural uses, major indoor recreational facilities, ~~and~~ higher density residential accommodation~~;~~, and as an Anchor Mobility Hub for integrated transit service including GO transit, regional rapid transit and local bus service;

(d) while maintaining the character of stable residential neighbourhoods, increase the variety and intensity of land uses and activities in the urban area, particularly on lands designated Mixed Use Areas, ~~Regional Nodes~~ and Employment Areas;"

3.6 Revising Table 2, Land Use Categories and Subcategories, in Chapter Three – Land Use, to read as follows:

(Excerpt from Table 2)

TABLE 2		
LAND USE CATEGORY	**CRITERIA FOR DETERMINING SUBCATEGORIES**	**LAND USE SUBCATEGORIES**
Mixed Use Areas	**The location, scale and relative number of people served by the Mixed Use Area**	**Local Nodes** **Community Nodes** **Mixed Corridors** **Specialty Retailing Node** **~~Downtown~~ ~~Core~~ City Centre**
~~Regional Nodes~~	**~~The intended focus and mix of uses and activities in the node~~**	**~~Regional Node 1~~**

3.7 Revising Table 4, Relationship Between Regional Official Plan and Pickering Official Plan – Mixed Use Areas, in Chapter Three – Land Use under the sub-heading: Mixed Use Areas" so that it reads as follows:

TABLE 4

Regional Plan Categorization	Pickering Plan Designation
~~Main Central Area~~Urban Growth Centres	~~Downtown~~ ~~Core~~ City Centre
~~Community Central Areas~~ Community Centres	Community Nodes
~~Local Central Area~~ Neighbourhood Centres	Local Nodes
~~Section 8.2.2 (intensive mixed uses along arterial roads)~~ Corridors	Mixed Corridors
	Specialty Retailing Node

3.8 Revising section 3.6(e), Mixed Use Areas, in Chapter Three – Land Use, so that it reads as follows:

"(e) despite section 3.6(c)(ii) and Table 6, may permit net residential densities and floorspace indices *below the minimums* set out in the Table, if it can be demonstrated to the City's satisfaction that the design, site layout, blocking, and/or phasing of the project can be intensified over time to achieve at least the minimum levels of intensity set out in the Table;"

3.9 Revising the last row in Table 5, Mixed Use Areas: Permissible Uses By Subcategory, in Chapter Three – Land Use, so that it reads as follows:

(Excerpt from Table 5)

TABLE 5	
Mixed Use Areas Subcategory	**Permissible Uses** **(Restrictions and limitations on the uses permissible, arising from other policies of this Plan, will be detailed in zoning by-laws.)**
~~Downtown Core~~ City Centre	~~All uses permissible in Local Nodes and Community Nodes, at the greatest scale and intensity in the City, serving City-wide and regional levels;~~ ~~Special purpose commercial uses.~~ High density residential; Retailing of goods and services; Offices and restaurants; Hotels; Convention Centres; Community, cultural and recreational uses.

3.10 Revising Table 6, Mixed Use Areas: Densities and Floor areas By Subcategories, in Chapter Three – Land Use, so that it reads as follows:

(Excerpt from Table 6)

TABLE 6			
Mixed Use Areas Subcategory	**Maximum and Minimum Net Residential Density (in dwellings per hectare)**	**Maximum Gross Leasable Floorspace for the Retailing of Goods and Services (in square metres)**	**Maximum Floorspace Index (total building floorspace divided by total lot area)**
~~Downtown Core~~ City Centre	over 80 and up to and including ~~180~~ 570	up to and including 300,000	~~up to and including 3.0 FSI~~ over 0.75 and up to and including 5.75

3.11 Revoking section 3.7 and Table 7: Regional Nodes: Permissible Uses by Subcategory, in Chapter Three – Land Use, entirely.

3.12 Revising section 4.6, Transit, in Chapter Four – Transportation, so that it reads as follows:

"4.6 City Council shall,

(a) provide and/or co-operate with others in providing an adequately high level of local transit service to the ~~Downtown Core~~ City Centre, Mixed Use Areas, Employment Areas, ~~Regional Nodes,~~ and other important public destinations, to meet existing and anticipated demand;

(b) ...;

(c) ...;

(d) when warranted, support the introduction of transit priority lanes, wherever possible using existing lanes and/or existing rights-of-way (rather than adding new lanes or widening road rights-of-way for this purpose), giving priority to,

(i)...;

(ii)...;

(iii) other planned or potential transit routes within the City Centre;

(e) ...; ~~and~~

(f) in conjunction with section 11.10 of this Plan, support the planning and development of the Anchor Mobility Hub and City Centre to become a place where regional rapid transit services connect, where other modes of transportation merge, and where employment and residential development are concentrated to form an attractive and intensive transit gateway into the City; and

(g) prioritize transit stops and key transit transfer points as priority areas for bicycle parking, wide sidewalks, paths, weather-protected seating and other similar facilities to promote an integrated and connected active transportation network."

3.13 Revising section 4.9, Priority Pedestrian/Cyclist Connections, in Chapter Four – Transportation, by deleting sub-section (b) and re-numbering the subsequent sub-section so that it reads as follows:

"4.9 City Council shall consider the following as priority connections, and shall endeavour to ensure their early implementation,

(a) a continuous Pickering Waterfront Trail adjacent, wherever feasible, to Lake Ontario, as part of the Lake Ontario Waterfront Trail system;
~~(b) a bridge for pedestrians and cyclists over Highway 401 linking the Downtown Core and the GO Transit Station~~; and
~~(c)~~(b) a continuous bikeway across Pickering along the south side of the proposed Highway 407/Transitway."

3.14 Revising section 4.14, Provincial Assistance, in Chapter Four – Transportation, by deleting sub-section (a)(i) and replacing it with alternate wording, and revising subsection (b) so that it reads as follows:

"4.14 City Council shall request assistance from the Province of Ontario as follows,
(a) to assist financially and otherwise in constructing,
(i) ~~a bridge overpass for pedestrians and cyclists to link the Downtown Core with the GO Transit Station~~ a multi-modal bridge over Highway 401 within the Hydro Corridor between Bayly Street and Pickering Parkway;
(ii) ...;
(iii) ...; and
(b) to assist, financially and otherwise, in constructing an additional pedestrian/cyclist bridge over Highway 401 to support the Anchor Mobility Hub;"

3.15 Revising section 5.5, Co-operation with Others, in Chapter Five – Economic Development, by amending sub-sections (d) and (e) and adding a new sub-section (f) so that it reads as follows:

"(d) support partnerships with business schools, skills training committees, and educational institutions such as Durham College and Trent University; ~~and~~

(e) encourage business to offer their employees continuous educational skills and training programs~~.~~; and

(f) in recognition of the City Centre's significance as a major employment node with excellent access to higher order transit, collaborate with partners and consider strategies and tools to advance employment growth within the City Centre."

3.16 Adding a new section 5.8, Financial Incentives, in Chapter Five – Economic Development, to read as follows:

"5.8 City Council shall consider an incentive program to encourage green building design in any new development in the City Centre, which may include density bonuses, loans, development charge reduction, Community Improvement Plan grants or an expedited development application review process."

3.17 Revising section 7.8, Location of Major Community Facilities, in Chapter Seven – Community Services, by amending sub-section (a) and adding new sub-sections (e) to (g) to read as follows:

"7.8 City Council shall,

(a) encourage the location of major indoor community, cultural, athletic and recreational uses and facilities in or close to the ~~Downtown Core~~ City Centre;

(b) ...;

(c) ...; ~~and~~

(d) ...;

(e) co-operate with the arts and cultural organizations to locate and develop an arts centre containing a theatre, gallery, studio and offices for arts organizations;

(f) encourage the location of an arts centre in a prominent location, in proximity to other civic and community facilities; and

(g) encourage the location of a new senior citizens centre on the recreation complex lands within the City Centre in a location that can share facilities, such as parking, with other civic institutions."

3.18 Revising section 11.10, City Centre Neighbourhood Policies, in Chapter Eleven – Urban Neighbourhoods, by replacing sub-sections (c) and (d) and deleting sub-section (e) and adding new sections 11.10A, 11.10B, 11.1OC, 11.10D, 11.10 E, 11.10F, 11.10G, 11.10H, 11.10I and 11.10K to read as follows:

"11.10 City Council shall,

(a) encourage the highest mix and intensity of uses and activities in the City to be in this neighbourhood;

(b) encourage schools that may be needed in the neighbourhood to accommodate future population growth, to be integrated with other uses, buildings and/or sites within the neighbourhood;

(c) ~~despite Table 6 of Chapter Three, establish a maximum residential density of 55 units per net hectare for lands located on the north side of Kingston Road that are designated Mixed Use Areas and abut lands developed as low density development~~ promote the design of compatible and attractive built forms, streetscapes and site works by requiring new development in the City Centre to have regard to the following:

(i) the Detailed Design Considerations of this Plan; and

(ii) the City Centre Urban Design Guidelines.

(d) ~~prior to exercising its option to obtain lands for roadway purposes opposite Walnut Lane, require the preparation of a traffic impact analysis in consultation with area residents to determine appropriate mitigation measures; and~~

~~(c) within the lands at the south-east corner of Kingston Road and Valley Farm Road, identified as a Special Policy Area on Map 18,~~

~~(i) permit the lands to be developed for residential, limited commercial, and park and recreational uses;~~

~~(ii) despite Table 6 of Chapter Three, establish a minimum net residential density of 89 units per hectare and a maximum net residential density of 120 units per hectare;~~

~~(iii) despite Table 6 of Chapter Three, establish a maximum gross leasable floor area for commercial uses of 1,000 square metres; and~~

~~(iv) have regard for the Development Guidelines for the Pickering Downtown Core and the Kingston Road Corridor in reviewing any development proposals;~~

CITY POLICY
City Centre Placemaking

11.10A City Council shall,

(a) encourage the transformation of the City Centre into a more liveable, walkable and human-scaled neighbourhood with inviting public spaces such as parks, squares and streets;

(b) encourage development proponents to locate and integrate commercial uses such as cafes and bistros into development adjacent to the public realm to create social gathering places and vibrant street life;

(c) encourage the development of streetscapes, public spaces and pedestrian routes that are safe and comfortable for all genders and ages, accessible and easy to navigate regardless of physical ability;

(d) encourage street-facing facades to have adequate entrances and windows facing the street;

(e) encourage publicly accessible outdoor and indoor spaces where people can gather;

(f) encourage new development to be designed, located and massed in such a way that it limits any shadowing on the public realm, parks and public spaces in order to achieve adequate sunlight and comfort in the public realm through all four seasons;

(g) implement street standards that balance the needs of vehicles and pedestrians and support adjacent land uses through their design;

(h) encourage the transformation of existing strip-commercial development into mixed-use development to bring conveniences closer to residents and public transit, and to provide additional housing;

(i) recognize the intersection of Kingston and Liverpool Roads as a gateway to the City Centre and consider public squares, transit waiting areas and tall buildings to be appropriate uses for lands fronting all four corners of the gateway;

(j) in the design of the planned public library expansion create a stronger relationship between the library and Esplanade Park, and enhance the relationship between the existing library and the public realm along Esplanade Street South and Glenanna Street through the use of transparent glazing and street related entrances; and

(k) prioritize placemaking opportunities on public lands for capital funding, and seek opportunities to partner with the private sector to incorporate designs that advance the placemaking opportunities in development plans on private lands;

CITY POLICY
City Centre District Energy

11.10B City Council shall,

(a) support the siting and construction of small district energy systems such as a cogeneration facility or geothermal plant in suitable locations, as a method of generating heat, cooling and electricity to buildings and reducing greenhouse emissions;

(b) examine opportunities to work with the development industry and other partners to prepare district energy feasibility studies in support of large scale development proposals; and

(c) pursue funding partnerships with other government and non-government agencies to advance the establishment of district energy services to high intensification development areas in the City Centre.

CITY POLICY
City Centre Public Realm

11.10C City Council,

(a) despite the location of new parks and squares as identified on Map 18 of Neighbourhood 8: City Centre may permit modifications as long as the general intent of these spaces meet the City's requirements;

(b) shall strive to locate either a park or square, within a 5-minute walk of all residences and places to work located within the City Centre;

(c) in accordance with the public art policies of section 13.13, shall encourage opportunities for public art contributions and/or the integration of public art with development and infrastructure;

(d) in consultation with the Toronto and Region Conservation Authority, shall require the proponents of new development to prepare a plan to rehabilitate Krosno Creek by enhancing the natural heritage features and incorporating passive recreational uses such as walking paths and seating areas;

(e) in consultation with the Toronto and Region Conservation Authority, shall require the proponents of new development to assess the regulatory flood plain risks associated with lands proposed for redevelopment within the Krosno Creek and Pine Creek flood plains; and implement, where appropriate, a revised flood plain boundary for Krosno Creek and Pine Creek;

(f) in consultation with the Toronto and Region Conservation Authority, shall require the preparation of a plan to rehabilitate Pine Creek, to enhance the natural heritage features and to design, align and construct a multi-modal bridge across Pine Creek; and
(g) may accept privately constructed squares and publicly accessible open spaces as part of a development as fulfilling in whole or in part, the parkland conveyance requirements if all of the following conditions are met:
  (i) the square or publicly accessible open space is designed and maintained to the standards of the City;
  (ii) the square or publicly accessible open space is visible, open and accessible to the public at all times; and
  (iii) the owner enters into an agreement with the City to ensure that the previous conditions are met, to the satisfaction of the City.

CITY POLICY
City Centre Active Frontages At Grade

11.10D City Council shall,

(a) encourage the development of buildings with active frontages at grade in appropriate locations to promote a vibrant and safe street life;
(b) encourage the placement and design of new buildings on lots along the future Kingston-Bayly Connector, Kingston Road, Liverpool Road, Glenanna Road, Pickering Parkway, Bayly Street and the newly proposed east/west local collector road south of the 401 Highway to address these streets edges and prohibit back lotting or surface parking between the building and the street;
(c) require active frontages at grade on the following streets in the City Centre:
  (i) Kingston Road;

(ii) Liverpool Road;
(iii) Bayly Street; and
(iv) the proposed Kingston-Bayly Connector;

(d) in areas of significant new development, zone to permit the location of neighbourhood-supportive services such as grocery stores to be strategically located to ensure as many residents within the City Centre are within a 5 minute walk of these services;

(e) despite Table 5 of Chapter Three and section 11.10 (d), not permit the following land uses within the City Centre:
(i) new vehicle sales and service uses including but not limited to motor vehicle service centres, motor vehicle gas bars and motor vehicle washing establishments;
(ii) the outdoor storage of goods and equipment with the exception of seasonal outdoor display of goods and merchandise;
(iii) new stand alone large format retail stores; and
(iv) new low density employment uses such as self storage and warehousing; and

(f) consider permitting new drive-through facilities within the City Centre through a zoning by-law amendment application, provided it has been demonstrated that the facility does not:
(i) preclude the planned function, placemaking objectives and intensification for a site; and
(ii) compromise traffic operations and the safe and efficient movement of pedestrians and cyclists.

CITY POLICY
City Centre Building Heights

11.10E City Council shall,

(a) require new development in close proximity to established low density residential areas to be gradually transitioned in height;

(b) promote the highest buildings to locate on sites at key gateways along the Kingston Road and Liverpool Road corridors, along or in proximity to Highway 401 or in proximity to higher order transit stations;

(c) consider in the review of development applications for buildings taller than 5 storeys, the following performance criteria:

(i) that buildings be massed in response to the scale of surrounding buildings, nearby streets and public open spaces;

(ii) that upper levels of buildings be set back or a podium and point tower form be introduced to help create a human scale at street level;

(iii) that shadowing impacts on surrounding development, publicly accessible open spaces and sidewalks be mitigated/minimized to the extent feasible;

(iv) that sufficient spacing be provided between the building face of building towers to provide views, privacy for residents and to minimize any shadowing and wind tunnel impacts on surrounding development, streets and public spaces;

(v) that buildings be oriented to optimize sunlight and amenity for dwellings, private open spaces, adjoining public open spaces and sidewalks;

(vi) that living areas, windows and private open spaces be located to minimize the potential for

overlooking adjoining residential properties;

(vii) that informal or passive surveillance of streets and other public open spaces be maximized by providing windows to overlook street and public spaces and using level changes, floor and balcony spaces elevated above the street level to allow views from residential units into adjacent public spaces whilst controlling views into these units; and

(viii) that protection be provided for pedestrians in public and private spaces from wind down drafts;

(d) despite sections 3.6(d) and 3.6 (e) and Table 6, require all new buildings in the City Centre to be at least three (3) functional storeys except for municipal uses in the Civic Centre and in the Open Space System – Natural Areas designation;

(e) despite Section 11.10E (d), permit expansions or additions to existing buildings in the City Centre to be less than 3 functional storeys, if it can be demonstrated to the City's satisfaction that the design, site layout, blocking, and/or phasing of the project can be intensified over time to achieve at least the minimum levels of intensity set out in Table 6 of this Plan;

(f) require any retail pad development on the Pickering Town Centre lands bounded by Liverpool Road, Kingston Road, Pickering Parkway and Glenanna Road to comply with the following:

(i) the placement of buildings shall not preclude future redevelopment;

(ii) despite section 11.10E (d), buildings may be designed with a minimum of only two functional storeys with a three storey massing; and

(g) despite section 11.10E (d), permit new buildings located on lands south of

Kingston Road and west of Liverpool Road, known municipally as 1792 Liverpool Road and 1271 and 1275 - 1279 Kingston Road, and identified in the 2013 Assessment Roll as 18-01-020-017-30200, 18-01-020-017-29100 and 18-01-020-017-29000 respectively, to be designed with a minimum of two functional storeys with a three storey massing.

CITY POLICY
City Centre Street Network & Design

11.10F City Council shall,

(a) in accordance with the policies of section 4.11, require the design of new streets and the design and extension of streets identified on Map 18: Neighbourhood 8: City Centre to have regard for the following:
   (i) be connected to existing streets, and have block lengths generally no longer than 150 metres and block depths generally not less than 60 metres to provide for full urban development potential over time; and
   (ii) be public or publicly accessible and constructed to public street design standards;

(b) require all new or re-designed streets to include a pedestrian zone generally no less than 2.0 metres on both sides;

(c) work with the Region of Durham to implement, where possible, new signalized crossings on Kingston Road and Bayly Street in order to provide opportunities for efficient transportation and safe pedestrian movement;

(d) protect for, and implement, a new north-south arterial road from Kingston Road to Bayly Street to accommodate future growth subject to: the hydro corridor being deemed surplus by Ontario Hydro; the necessary Environmental Assessment studies being completed; the lands being acquired by the City; and, funding being made available to move forward with the project; and

(e) protect for, and implement, the extension of Plummer Street east/west through the hydro corridor to a new City Centre south collector road to accommodate future growth subject to: permission being provided by Ontario Hydro to cross the hydro corridor, or the hydro corridor being deemed surplus by Ontario Hydro; the necessary Environmental Assessment studies being completed; and, funding being made available to move forward with the project.

CITY POLICY
City Centre Transit

11.10G City Council shall,

(a) co-operate with Durham Region Transit and Metrolinx in order that the alignment and location of future transit routes considers access to the greatest concentration of people and jobs and minimizes the distance between transit connections within the City Centre;
(b) select transit junctions and related pedestrian connections as priority areas for design excellence and capital improvements including landscaping, public seating, weather protection and public art; and
(c) require new development adjacent to the transit junctions to be designed to frame the junctions with active uses at grade and entrances oriented towards them.

CITY POLICY
City Centre Pedestrian and Cycling Network

11.10H City Council shall,

(a) require the design of a pedestrian network to be a safe and visually interesting environment for pedestrians;
(b) require the pedestrian network to be integrated with public space elements such as squares, parks and transit junctions;
(c) where a development proposal is situated in an area where mid-block connections or pathways are required, these pedestrian connections are to be included and approved through the site plan control process, subject to the following provisions:

(i) the pedestrian connection(s) shall be designed to be publicly accessible; and

(ii) if a proposed development plan is unable to implement a pedestrian trail or mid-block connection, the applicant must demonstrate an alternative connection on their site to the satisfaction of the City;

(d) accommodate safe and dedicated cycling routes as part of the future reconstruction of streets in the City Centre;

(e) require the redevelopment of properties fronting Bayly Street to dedicate lands for future road widening that includes a minimum three (3) metres wide multi-use path; and

(f) explore educational and way-finding opportunities as part of the streetscape design.

CITY POLICY
City Centre Parking

11.10I City Council shall,

(a) consider in the review of development applications, the following performance criteria with regard to on-site parking and access drives/aisles,

(i) that parking be situated either in parking areas located at the rear or side of the building or on-street, where the development fronts on a collector or local road;

(ii) that the parking format be structured or below grade parking;

(iii) in phased development, that surface parking may be permitted if the proponent has demonstrated how parking will be accommodated in structures at full build out;

(iv) that where active uses at grade are required, parking structures feature active uses at grade to contribute to an animated street environment;

(v) that parking structures be treated architecturally as building fronts with no blank walls;

(vi) that shared parking be encouraged in mixed use areas to minimize land devoted to parking;
(vii) that the implementing zoning by-law may permit a reduction of customer parking for ground floor commercial uses through the provision of on-street parking;
(viii) that surface parking areas be well landscaped and lit to provide a safe and comfortable pedestrian environment; and
(ix) that access driveways to side and rear parking areas be consolidated where practical, and be accessible by a public laneway or drive aisle;

(b) through the implementing zoning by-law, consider the provision of secure bicycle parking facilities in suitable locations;
(c) consider a reduction in the number of required car parking spaces where bicycle parking facilities or transportation demand management measures are provided;
(d) consider shared on-site parking areas for two or more uses where the maximum demand of such parking areas by the individual uses occurs at different periods of the day; and
(e) consider underground parking beneath the City's municipal roads and parks provided the property owner enters into an agreement subject to the terms and conditions acceptable to the City, in consultation with the Region.

CITY POLICY
City Centre Stormwater Management

11.10J City Council

(a) recognizes the need to implement stringent stormwater management criteria to assist with downstream erosion control, water quality control and flooding; accordingly Council shall require stormwater management reports in support of new development to demonstrate achievement of the objectives of the City Centre Stormwater Management Strategy.

CITY POLICY
City Centre Growth to 2031

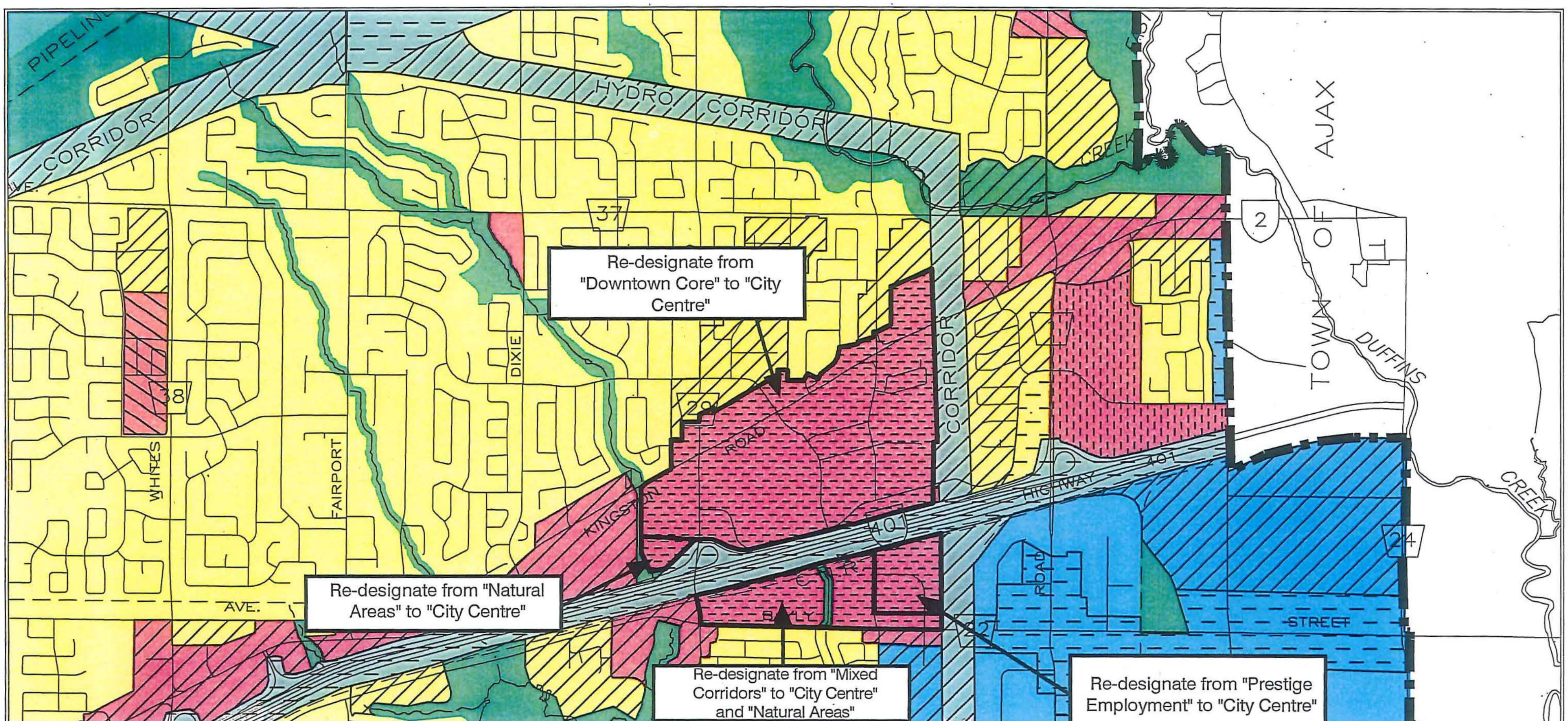
11.10K City Council supports,

(a) a balance of opportunities to live, work and play in the City Centre by adopting a resident to job ratio of 1:1;
(b) growth in all portions of the City Centre and restricts new residential development in City Centre South to 6,300 people or 3,400 units by 2031 until at least an additional 2,000 people or 1,100 new units have been development on lands north of Highway 401 in the City Centre; and
(c) the use of the Holding provisions in the Planning Act and require where necessary, proponents to enter into agreements with the City, Region and other agencies as appropriate, respecting various development related matters including but not limited to:
   (i) requiring a multi-modal transportation study for proposed developments that are anticipated to generate 100 or more vehicle peak hour trips (two-way), or where site and design characteristics may result in traffic or transportation concerns, to assess the impact on the transportation system and the timing and need for future improvements;
   (ii) entering into cost sharing agreements between each other;
   (iii) ensuring that development shall not take place on lands within the defined Krosno Creek and Pine Creek corridors;
   (iv) providing or exchanging easements over lands where necessary;
   (v) providing contributions to the cost of rehabilitating Krosno Creek and Pine Creek, if necessary; and
   (vi) requiring a comprehensive functional servicing and stormwater management plan that addresses

stormwater management and replacement flood storage on the Pickering Town Centre lands."

Implementation: The provisions set forth in the City of Pickering Official Plan as amended, regarding the implementation of the Plan shall apply in regard to this Amendment. In light of the numerous components of the Official Plan that are being revised concurrently, the numbering of the policy sections in this amendment is subject to change in accordance with the sequencing of approvals.

Interpretation: The provisions set forth in the City of Pickering Official Plan, as amended, regarding the interpretation of the Plan shall apply in regard to this Amendment.

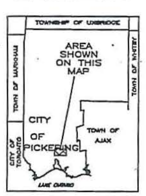


EXTRACT OF

SCHEDULE I TO THE

PICKERING OFFICIAL PLAN

EDITION ?



CITY OF PICKERING
PLANNING & DEVELOPMENT DEPARTMENT
© JUNE, 2014
THIS MAP FORMS PART OF EDITION ? OF THE PICKERING OFFICIAL PLAN AND MUST BE READ IN CONJUNCTION WITH THE OTHER SCHEDULES AND THE TEXT.

LAND USE STRUCTURE

OPEN SPACE SYSTEM
- NATURAL AREAS
- ACTIVE RECREATIONAL AREAS

URBAN RESIDENTIAL AREAS
- LOW DENSITY AREAS
- MEDIUM DENSITY AREAS

EMPLOYMENT AREAS
- GENERAL EMPLOYMENT
- PRESTIGE EMPLOYMENT
- MIXED EMPLOYMENT

FREEWAYS AND MAJOR UTILITIES
- CONTROLLED ACCESS AREAS
- POTENTIAL MULTI USE AREAS

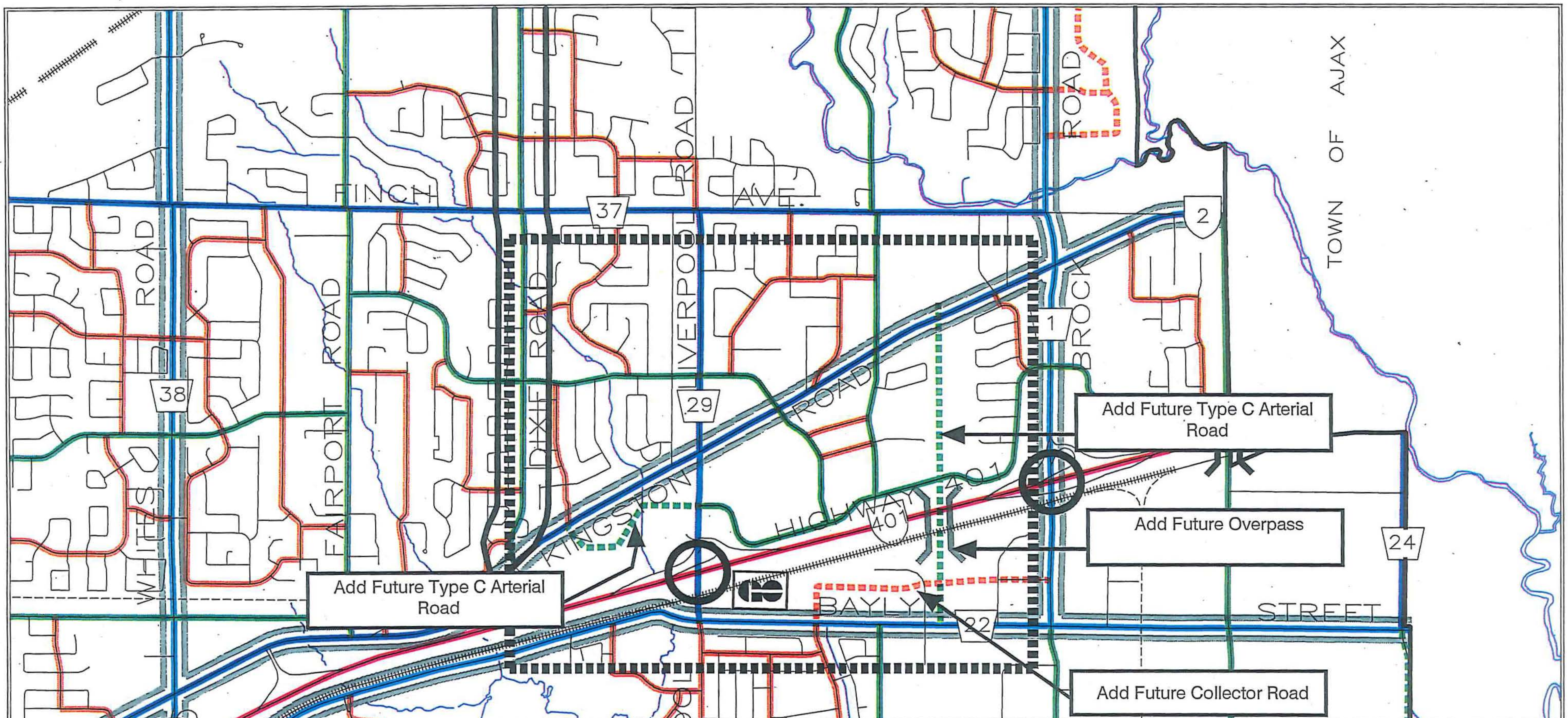
MIXED USE AREAS
- LOCAL NODES
- COMMUNITY NODES
- MIXED CORRIDORS
- SPECIALTY RETAILING NODE
- CITY CENTRE

OTHER DESIGNATIONS
- D1 DEFERRALS

Revise Legend from "Downtown Core" to "City Centre"

N

AMENDMENT 26 **SCHEDULE B**



EXTRACT OF

SCHEDULE II TO THE

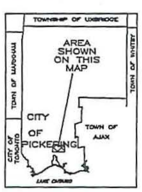
PICKERING OFFICIAL PLAN

EDITION ?

TRANSPORTATION SYSTEM

	EXISTING	FUTURE
FREEWAYS		
TYPE A ARTERIAL ROADS		
TYPE B ARTERIAL ROADS		
TYPE C ARTERIAL ROADS		
COLLECTOR ROADS		

	LOCAL ROADS	
	FREEWAY INTERCHANGES	
	UNDERPASSES/OVERPASSES	
	RAILWAYS	
	GO RAIL	
	GO STATIONS	
	TRANSIT SPINES	
	TRANSIT FEEDER SERVICE	



CITY OF PICKERING
PLANNING & DEVELOPMENT DEPARTMENT
© JUNE, 2014
THIS MAP FORMS PART OF EDITION ? OF THE PICKERING OFFICIAL PLAN AND MUST BE READ IN CONJUNCTION WITH THE OTHER SCHEDULES AND THE TEXT.

City of PICKERING

Notice of Public Open House

The City has received applications for Zoning By-law Amendment, and Draft Plan of Condominium, submitted by Madison Liverpool Limited, for the former Holy Redeemer Catholic Elementary School located at 747 Liverpool Road, as shown on the location map provided below.

The applicant is proposing to rezone the subject lands to permit a residential common element condominium development consisting of 14 single detached dwellings, and 57 townhouse dwellings accessed through an internal private road.

We invite you to attend a Public Open House meeting to learn more about the proposal. The purpose of the meeting is to allow the public to review and comment on the plans that the applicant has submitted. Details of the Public Open House are as follows:

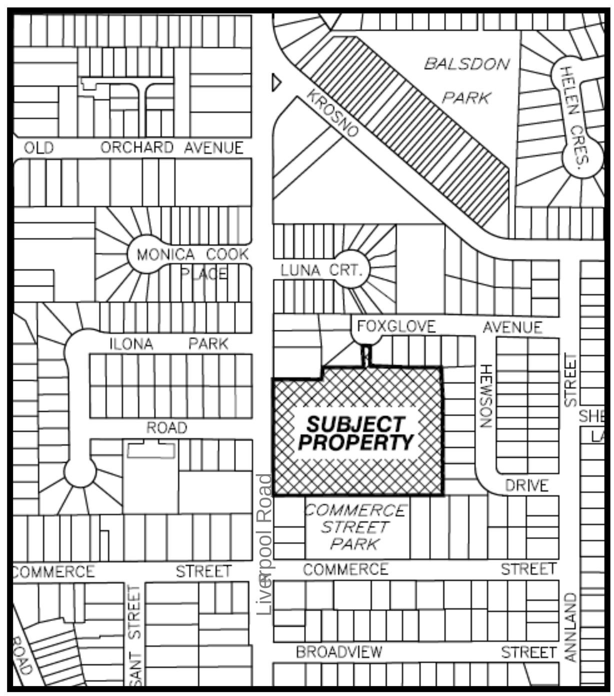
Date: **Tuesday, May 17, 2016**

Time: **6:30 pm to 8:00 pm**
(Presentation at 7:00 pm)

Location: **East Shore Community Centre**
Room 4
910 Liverpool Road
Pickering, ON

A copy of the proposed concept plan is provided on the back of this notice.

Note: You will receive a subsequent notice in the mail inviting you to a Statutory Public Information Meeting held by the City of Pickering Planning & Development Committee.



Your comments and/or questions regarding this proposal can be forwarded to:

Deborah Wylie, MCIP, RPP
Principal Planner - Policy
City Development Department
Tel: 905.420.4660, ext. 2195
Email: deborahwylie@pickering.ca

Personal information collected in response to this planning notice will be used to assist City staff and Council to process this application and will be made public.

City of PICKERING
City Development Department

Submitted Plan

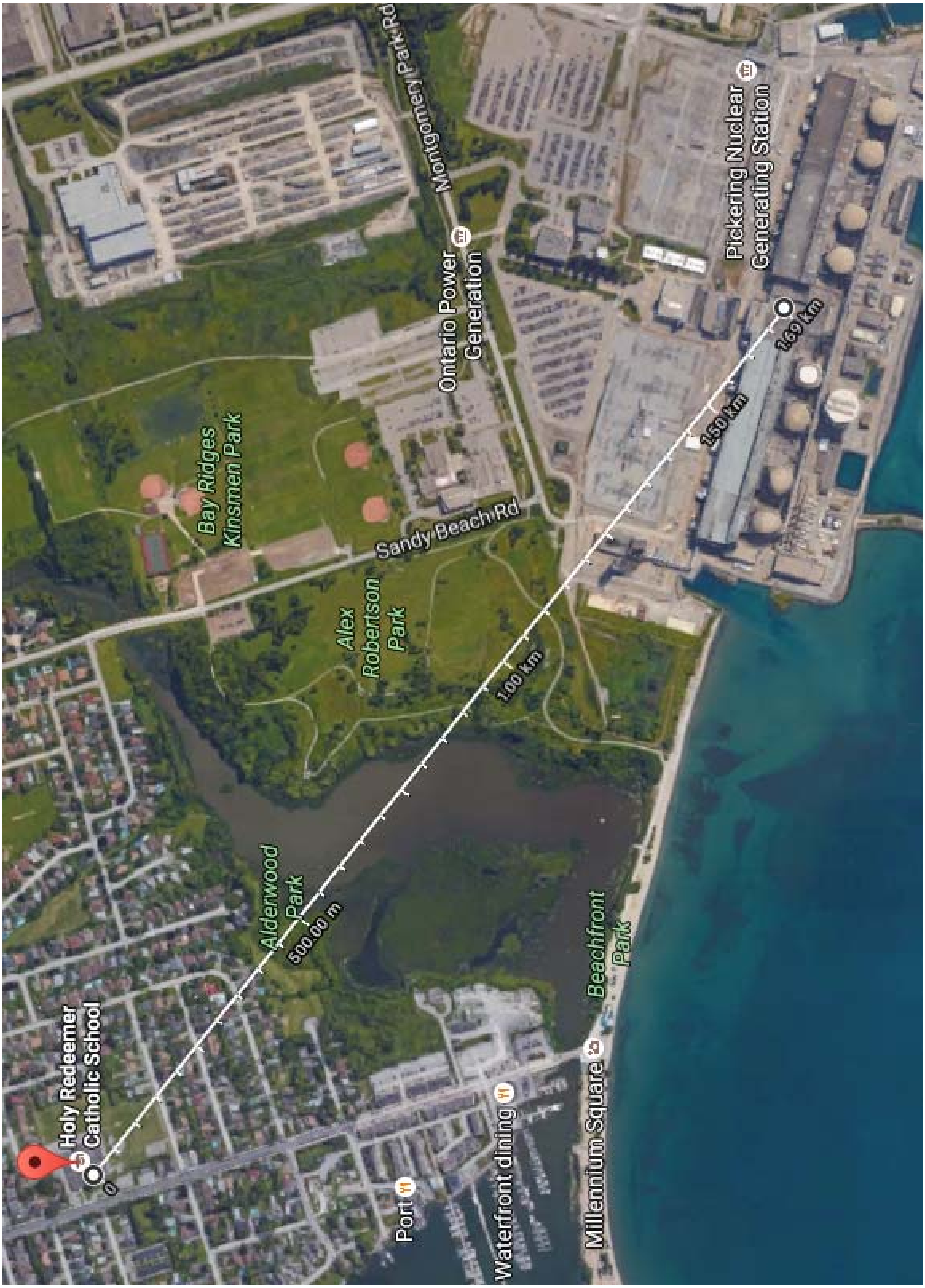
FILE No: CP-2016-01 & A 05-16

APPLICANT: Madison Liverpool Limited

PROPERTY DESCRIPTION: Block Q of Plan M15, Parts 1 to 5, Plan 40WR74 (747 Liverpool Road)

FULL SCALE COPIES OF THIS PLAN ARE AVAILABLE FOR VIEWING AT THE CITY OF PICKERING CITY DEVELOPMENT DEPARTMENT.

DATE: Apr. 15, 2016


Holy Redeemer
Catholic School
0
500.00 m
1.00 km
1.50 km
1.69 km
Alderwood
Park
Alex
Robertson
Park
Bay Ridges
Kinsmen Park
Sandy Beach Rd
Montgomery Park Rd
Ontario Power
Generation
Pickering Nuclear
Generating Station
Beachfront
Park
Millennium Square
Waterfront dining
Port

UNOFFICIAL

WORKING CONSOLIDATION

DURHAM REGIONAL OFFICIAL PLAN

As of January 9, 2013

Note: This Working Consolidation includes approved amendments up to and including Amendment No. 143, including ROPA 128 as approved on January 9, 2013 by the Ontario Municipal Board.

List of Active Appeals to Official Plan Amendment No. 114

Reference	Appellant	Parts of Plan Affected
A114-2	Brooklin Golf Course Ltd.	• Schedule 'A' – Map 'A4'
A114-3	Trinity Development Group Inc.	• Policies 3.2.2, 8C.2.8 and 8C.2.16
A114-4	Ministry of Municipal Affairs and Housing	• Schedule 'A' – Map 'A4' (Conlin/Anderson)
A114-5	Cavenson Developments Inc. and Croftport Developments Inc.	• Policy 8C.2.16
A114-6	Town of Ajax	• Policy 11.3.8, 13.2.4 (deleted) • Schedule 'A' – Map 'A4' (West Durham Link) • Schedule 'C' – Map 'C1' (West Durham Link) • Schedule 'C' – Map 'C2' (West Durham Link) • Schedule 'F' (deleted)
A114-10	Uxbridgegate Developments Inc.	• Schedule 'F' (deleted)
A114-19	Runnymede Development Corporation Limited	• Schedule 'A' – Map 'A4'
A114-20	Runnymede Development Corporation Limited and Tribute Communities	• Policies 1.3.1 p), 8C.2.16 and 11.3.34

This is a list of active appeals to Official Plan Amendment No. 114 as of January 9, 2013. Those parts of the Plan that are appealed, hence not approved, are indicated respectively with an asterisk (*) followed by a reference to the appeal that applies. In some cases, policies and schedules have been further amended by Official Plan Amendment No. 128.

List of Active Appeals to Official Plan Amendment No. 128

Reference	Appellant	Parts of Plan Affected
A128-4	HDP Canada Industrial GP Inc.	• Schedule 'A' – Map 'A4' • Sub-Section 15A – (definition for Major Retail Use)
A128-5	Loblaw Properties Ltd.	• Policies 8A.2.2 a) • Sub-Section 15A – (definition for Major Retail Use) • Schedule 'A' – Map 'A4'
A128-8	Stroud	• Schedule 'A' – Map 'A4'
A128-18	Nordeagle	• Policies 7.3.9 c), 8A.2.9, 8A.2.12, 8C.1.3, 8C.2.5, 8C.2.11, 8C.2.16, 8C.2.17, 11.3.18 • Sub-Section 15A – (definitions for Conversion and Regeneration Area)
A128-29	Herta Kuleshnyk	• Schedule 'A' – Map 'A4'
A128-32	Rosemary McConkey	• Schedule 'A' – Map 'A4'

This is a list of active appeals to Official Plan Amendment No. 128 as of January 9, 2013. Those parts of the Plan that are appealed, hence not approved, are indicated respectively with an asterisk (*) followed by a reference to the appeal that applies. Reference should be made to the 2008 Office Consolidation copy.

List of Active Deferrals to the 1993 Regional Official Plan Approval as of January 9, 2013

Reference	Request from	Location	Parts of Plan Affected
D1	Port Darlington Community Association	Blue Circle Canada Inc. (Formerly St. Marys Cement Corporation), Municipality of Clarington	• Policy 13.2.2 (Special Policy Area 'B') • Schedule 'A' – Map 'A5'
D4	Municipality of Clarington	East Orono Employment Area, Municipality of Clarington	• Schedule 'A' – Map 'A5'

This is a list of active appeals to the 1993 Regional Official Plan Approval, as of January 9, 2013. Those parts of the Plan that are appealed, hence not approved, are indicated respectively with an asterisk (*) followed by a reference to the appeal that applies. Reference should be made to the 2008 Office Consolidation copy.

Summary of Proposed Amendments Not Incorporated into the Regional Official Plan as of January 9, 2013

Amendment 15 Lishman Add Regional Node "k" to Policy 15.3.1	Repealed by By-law 33-96 and superseded by Amendment 49
Amendment 38 Please Save & Recycle Ltd. Permit 9-hole golf course	Adopted by Regional Council on September 24, 1997 and awaiting Ministerial approval

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*A114-2, A114-6, A114-19

*A128-4, A128-5, A128-8, A128-18, A128-29, A128-32

Schedule A Regional Structure Maps
- Map 'A1' – Brock
- Map 'A2' – Uxbridge
- Map 'A3' – Scugog
- Map 'A4' – Pickering, Ajax, Whitby, Oshawa
- Map 'A5' – Clarington

Schedule B Greenlands System Maps
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- Map 'B2' – High Aquifer Vulnerability and Wellhead Protection Areas
- Map 'B3' – Oak Ridges Moraine Land Use
- Map 'B4' – Oak Ridges Moraine Landform Conservation

Schedule C Transportation System Maps
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- *A114-6 Map 'C2' – Road Network, Pickering, Ajax, Whitby, Oshawa, Courtice Urban Areas
- Map 'C3' – Transit Priority Network
- Map 'C4' – Strategic Goods Movement Network

Schedule D High Potential Aggregate Resource Areas Map

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- Table 'E6' – Wellhead Protection Areas – Land Use Restrictions
- Table 'E7' – Arterial Road Criteria
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PART F – APPENDICES

Appendix 1 Amends 1976 Regional Official Plan Referred to in Policy 14.13.2

Appendix 2 Status of Amendments to the 1976 Regional Official Plan Referred to in Policy 14.13.3

8A.2.6 Prior to the consideration of the expansion of an existing Regional Centre, as detailed in an area municipal official plan, it shall be determined if there is a Regional Interest in accordance with Policy 8.3.8. Where there is a Regional Interest, a retail impact study shall be required to justify such expansion, and ensure that the proposal does not unduly affect the planned function and viability of any other Centre.

8A.2.7 Prior to the designation of a new Local Centre in an area municipal official plan or the expansion of an existing Local Centre, the Council of the area municipality shall determine if there is a Regional Interest in accordance with Policy 8.3.9. Where there is a Regional Interest, a retail impact study shall be required to justify such designation or expansion and ensure that the proposal does not unduly affect the planned function and viability of any other Centre.

CORRIDORS

8A.2.8 Regional Corridors are designated as an overlay of the underlying land-use designation on Schedule 'A', Regional Structure. Local Corridors may be designated in area municipal official plans, in accordance with the provisions of this Plan.

***A128-18** 8A.2.9 Regional Corridors shall be planned and developed in accordance with Policy 8A.1.5 and the relevant Policies of the underlying land-use designation, as higher density mixed-use areas, supporting higher order transit services and pedestrian oriented development. The Regional Corridors shall provide efficient transportation links to the Urban Growth Centres and Regional Centres as well as other centres in adjacent municipalities. Portions of Regional Corridors with an underlying Living Area designation, which are identified as appropriate for higher density mixed-use development in area municipal official plans, shall support an overall, long-term density target of at least 60 residential units per *gross* hectare and a *floor space index* of 2.5. The built form should be a wide variety of building forms, generally mid-rise in height, with some higher buildings, as detailed in area municipal official plans.

8A.2.10 Local Corridors shall be planned and developed in accordance with Policy 8A.1.5 as mixed-use areas, with appropriate densities to support frequent transit service. The Local Corridors shall provide efficient transportation links to the Urban Growth Centres and Regional Centres and/or Local Centres within Urban Areas. Portions of Local Corridors with an underlying Living Area designation, which are identified as appropriate for mixed-use development shall support an overall, long-term density target of at least 30 residential units per *gross* hectare and a *floor space index* of 2.0. The built form should be a wide variety

ONTARIOPOWER GENERATION

Report

Internal Use Only	
Document Number: NA44-SR-01320-00001	
Sheet Number: N/A	Revision: R014

Title:
PICKERING A SAFETY REPORT

Pickering A Safety Report

NA44-SR-01320-00001-R014
2010-06-24

Order Number: N/A
Other Reference Number: N/A

Internal Use Only

Revised by: Jacques L. Ricard 24 June 2010
J. Ricard — Date
Contract – Technical Specialist
U2/3 Safe Storage
Nuclear Refurbishment –
Projects & Support

Reviewed by: [signature] 24 June 2010
R. Zaidi — Date
Manager
Safe Storage Engineering
Nuclear Refurbishment –
Projects & Support

Reviewed by: [signature] 24 June 2010
J. Lorencez — Date
Manager
Reactor Safety Engineering
Pickering A

Approved by: [signature] 24 June 2010
D. Francis — Date
Manager
Plant Design Engineering
Pickering A

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List of Tables and Figures

Revision Summary

Revision Number	Date	Comments
R013	2009-06-04	The following DCRs were incorporated. 103148, 103262, 103274, 103273, 103276, 103181, 103161, 103184, 103272, 103165, 103469, 103275, 103159, 103271, 103163, 103268, 103475, 103267, and 103156.
R014	2010-06-30	The main purpose of this revision was to include a description of the systems end state for Units 2 and 3 in Safe Storage. This revision also addressed other minor changes that were previously identified since the last issue. All changes were documented in the following DCRs which were incorporated in this revision: 94439, 103195, 106630, 106632, 106633, 106634, 106635, 106636, 108013, 108393, 108400, 108418, 108424, 108435, 108436, 108437, 108441, 108447, 108452, 108462, 108474, 108477, 108479, 108484, 108485, 108493, 108519, 108665, 108990, 109000. The significant changes are highlighted below.

List of Tables and Figures

Figure/Table	Change
Figure 28	Title revised to align with title for Figure 28 in Part I of the report.
Table 18	Title revised to align with title for Table 18 in Part I of the report.

Part I

Section/Table/Figure	Change
1.1.3	2nd paragraph revised to reflect current status of Units 2 & 3 being defuelled and moderator and HTS drained of D_2O. 3rd paragraph revised to indicate plant details for Units 2 & 3 in safe storage also described as per this revision of the report.
Table 18	Range of years corrected in the table title.
Figure 28	Southern Ontario seismicity map updated for period 1992-2007.
Figure 29	Updated for location of the Pickering Southern Ontario seismic network station (PKRO).

Part II

Section/Table/Figure	Change
Table 32	Entry for Boiler Emergency Cooling, USI 36710: clarification added about BECS credit following a seismic event.
3.2.6	Modified to reflect condition of the PRD equipment airlock following the 2010 Pickering Vacuum Building Outage.
3.7.3.1	Note added in last paragraph to refer to section 6.2.4.5 about PRD bulkheads being modified to separate Units 2 & 3 Reactor Buildings from Pickering A & B common containment envelope.
3.7.3.2	Note added in 3rd paragraph to refer to section 3.2.6 about condition of PRD equipment airlock following the 2010 Pickering Vacuum Building Outage.

		4.1.3.2	Added end state of adjuster units for Units 2 & 3 safe storage.
		4.1.3.3	Added new subsection under heading “Liquid Zone Control End State for Units 2 & 3 Safe Storage” to describe end state of LZC system.
		4.1.3.4	Added end state of shut-off units for Units 2 & 3 safe storage.
		4.1.3.5	Added end state of ion chambers for Units 2 & 3 safe storage.
		4.2.2.2	Under Flux Detector Assemblies heading: added end state of power supplies to flux detector assemblies and electronic circuitry for Units 2 & 3 safe storage. Under Shut-off Units heading: added end state of shut-off units for Units 2 & 3 safe storage.
		5.1.1	Note 1: general statement about end state of Heat Transport System (HTS) for Units 2 & 3 safe storage. Note 2: in regard to meeting IAEA Safeguards commitments for Units 2 & 3 safe storage.
		5.1.1.4	Added end state of steam generators (D_2O side) for Units 2 & 3 safe storage.
		5.1.1.5	Added end state of HTS pumps for Units 2 & 3 safe storage.
		5.1.1.6	Added end state of HTS valves for Units 2 & 3 safe storage.
		5.1.3.3	Added end state of Shutdown Cooling System (SDCS) pumps for Units 2 & 3 safe storage.
		5.1.3.4	Added end state of SDCS heat exchangers for Units 2 & 3 safe storage.
		5.1.4.2	Added end state of Feed, Bleed and Relief system for Units 2 & 3 safe storage.
		5.1.4.3	Added end state of pressurizing pumps for Units 2 & 3 safe storage.
		5.1.4.4	Added end state of bleed condenser for Units 2 & 3 safe storage.
		5.1.4.5	Added end state of bleed cooler for Units 2 & 3 safe storage.
		5.1.4.6	Clarification added about Heavy Water Storage Tank helium cover gas pressure during normal operation for Units 1 and 4. Added end state of Heavy Water Storage Tank for Units 2 & 3 safe storage.
		5.1.4.7	Added end state of pressure relief for Units 2 & 3 safe storage.
		5.1.5.2	Added end state of HT purification system for Units 2 & 3 safe storage.
		5.1.6.1	Added end state of Gland Seal system for Units 2 & 3 safe storage.
		5.1.7	Added end state of HT Heavy Water collection system for Units 2 & 3 safe storage.
		5.1.8	Added end state of Boiler Emergency Cooling system (BECS) for Units 2 & 3 safe storage.
		5.1.9	Added end state of HT sampling system for Units 2 & 3 safe storage.
		5.1.11.1 (new)	End state of Emergency Boiler Water Supply (EBWS) system for Units 2 & 3 safe storage.
		5.5.2.6 (new)	End state of Main Moderator system for Units 2 & 3 safe storage.

		5.5.3.2.1	Section number 5.5.3.2.1 deleted; subsection remains unchanged under heading "Helium Supply".
		5.5.3.6 (new)	End state of Moderator Auxiliary systems for Units 2 & 3 safe storage.
		5.6.2	Note added to specify that general description of AGS applied to Units 1 to 4 before placing it in safe storage for Units 2 & 3.
		5.6.7	Modified to specifically describe Annulus Gas System (AGS) status in the shutdown state for Units 1 and 4.
		5.6.8 (new)	End state of AGS for Units 2 & 3 safe storage.
		5.7.4	Modified to reflect end state of End Shield Cooling system for Units 2 & 3 safe storage.
		5.8	Added end state of D_2O Recovery system for Units 2 & 3 safe storage.
		5.9.4 (new)	End state of Biological Shield, Ring Thermal Shield and Ion Chamber Cooling systems for Units 2 & 3 safe storage.
		5.10	References R-7 through R-10 added regarding conversion of moderator helium storage tank to a D_2O storage tank for Units 2 & 3 safe storage.
		Figure 90	For clarity, the bottom tank which belongs to the 'Miscellaneous D_2O Collection" system was relabelled as such. The direction of flow in the vent line above the "Heavy Water Collection Tank" was corrected.
		Figure 91	The schematic arrangement for BECS shown on this figure was revised to reflect more accurately the arrangement in the field for Units 1 and 4.
		6.1.8.2	Added end state of shut-off rods for Unit 2 safe storage.
		6.2	Note: general statement about end state of Pickering A & B common containment envelope for Units 2 & 3 safe storage.
		6.2.4.5 (new)	End state of Pressure Relief System for Units 2 & 3 safe storage.
		6.2.9	Added end state of Post-Loca Hydrogen Ignition system for Units 2 & 3 safe storage.
		6.2.10	Added end state of Airlocks for Units 2 & 3 safe storage.
		6.3.6 (new)	End state of Emergency Coolant Injection (ECI) system for Units 2 & 3 safe storage.
		6.4.1.1 (new)	End state of Shutdown systems (SDSA & SDSE) for Units 2 & 3 safe storage.
		6.4.3.13	Added new subsection under heading "Start-up Instrumentation End State for Units 2 & 3 Safe Storage" to describe end state of SUI.
		7.1.2.3 (new)	End state of Digital Control Computers (DCC) for Units 2 & 3 safe storage.
		7.1.8.2	Added new subsection under heading "Main Control Panels End State for Units 2 & 3 Safe Storage" to describe end state of MCR panels.
		7.1.10	For clarity, information presented in this section for the SDSE Instrument Rooms was divided into two paragraphs.
		7.4.1	Added end state of Data Extraction System (DES) for Units 2 & 3 safe storage.

		7.5.3.5 (new)	End state of Reactor Regulating System (RRS) for Units 2 & 3 safe storage.
		Figure 117	On shaded diagram, one box was relabelled 'Unit Power Regulator' for consistency with design manual.
		Figure 118	On shaded diagram, one box was relabelled 'Unit Power Regulator' for consistency with design manual.
		8.1.1	Added end state of Main Output Transformers for Units 2 & 3 safe storage.
		8.3.2.1	Added end state of Class IV power supply system for Units 2 & 3 safe storage.
		8.3.2.3	Last paragraph under subsection (a) was clarified with regard to running a standby generator in the peaking mode.
		8.3.2.3	Added new subsection under heading "Class III Power Supply System End State for Units 2 & 3 Safe Storage" to describe end state of Class III.
		8.3.2.4	Modified to reflect end state of Class II power supply system for Units 2 & 3 safe storage.
		8.3.2.5	Modified to reflect end state of Class I power supply system for Units 2 & 3 safe storage.
		Table 52	Class III loads corrected for a number of entries to reflect actual conditions in Unit 4 and end state of Class III power supply system in Unit 3 during safe storage.
		Figure 127	Detail A added to show Class IV 600 V bus BUG in Unit 2 (bus BUG exists in Unit 2 only).
		Figure 128	Class IV 600 V bus BUF was deleted as it does not exist in Unit 3 (nor in Unit 4).
		9.2.4 (new)	End state of Turbine/Generator and Auxiliary systems for Units 2 & 3 safe storage.
		9.3.2	Added end state of Main Steam Supply system for Units 2 & 3 safe storage.
		9.3.4	Added end state of steam generators secondary side systems for Units 2 & 3 safe storage.
		9.4.1	Added end state of Main Condensers for Units 2 & 3 safe storage.
		9.4.2	Added end state of Main Condenser Air Extraction system for Units 2 & 3 safe storage.
		9.5.1.4 (new)	End state of Main Feedwater and Auxiliary Feedwater systems for Units 2 & 3 safe storage.
		9.6.2	Added end state of sampling system (secondary side steam and feedwater) for Units 2 & 3 safe storage.
		9.6.5.1 (new)	End state of Condenser Circulating Water (CCW) system for Units 2 & 3 safe storage.
		10.1.3.4 (new)	End state of Irradiated Fuel Transfer and Storage for Units 2 & 3 safe storage.
		10.1.4	Note: general statement about end state of Pickering A Irradiated Fuel Bay which is essentially unaffected by Units 2 & 3 safe storage.
		10.1.5.4 (new)	End state of the Fuel Handling system for Units 2 & 3 safe storage.

		11.1.1	Added end state of screen house and common water systems for Units 2 & 3 safe storage.
		11.1.2.1	Added end state of Low Pressure Service Water (LPSW) system for Units 2 & 3 safe storage.
		11.1.2.2	Added end state of High Pressure Service Water (HPSW) system for Units 2 & 3 safe storage.
		11.1.2.3	Added end state of Recirculated Cooling Water (RCW) system for Units 2 & 3 safe storage.
		11.1.2.4	Added end state of Emergency Water Storage (EWS) system for Units 2 & 3 safe storage.
		11.1.3.1	Section number 11.1.3.1.1 deleted; subsection remains unchanged under heading “Laundry Facility High Pressure Demineralized Water System”. Added new subsection under heading “Demineralized Water System End State for Units 2 & 3 Safe Storage” to describe end state of that system.
		11.1.4	Added end state of Domestic Water system for Units 2 & 3 safe storage.
		11.2.1.2	Under High Pressure Instrument Air (HPIA) heading: added end state of HPIA system during Units 2 & 3 safe storage. Under Low Pressure Instrument Air (LPIA) heading: added end state of LPIA system during Units 2 & 3 safe storage. Section number 11.2.1.2.1 deleted; subsection remains unchanged under heading “Backup Instrument Air”.
		11.2.1.3	Added end state of Service Air system for Units 2 & 3 safe storage.
		11.2.1.4	Added end state of Breathing Air system for Units 2 & 3 safe storage.
		11.2.2.1	Added new subsection under heading “Inactive Drainage System End State for Units 2 & 3 Safe Storage” to describe end state of that system.
		11.2.2.2	Added new subsection under heading “Active Drainage System End State for Units 2 & 3 Safe Storage” to describe end state of that system.
		11.2.2.3	Added end state of Sewage system for Units 2 & 3 safe storage.
		11.3.1.1	Added end state of Heating Steam distribution system for Units 2 & 3 safe storage.
		11.3.2.2 (new)	End state of Reactor Building Ventilation system and Stack Monitoring for Units 2 & 3 safe storage.
		11.3.3.1	Added end state of Reactor Auxiliary Bay (RAB) Heating system for Units 2 & 3 safe storage.
		11.3.3.2	Added end state of Reactor Auxiliary Bay (RAB) Ventilation system for Units 2 & 3 safe storage.
		11.3.4.2	Added end state of Irradiated Fuel Bay (IFB) Ventilation system for Units 2 & 3 safe storage.
		11.3.5.2	Added end state of Powerhouse Ventilation system for Units 2 & 3 safe storage.
		11.3.6.2	Added end state of Service Wing air conditioning system for Units 2 & 3 safe storage.

		11.3.7.5	Under Class I heading: modified to reflect end state of ventilation system in Class I enclosure rooms during Units 2 & 3 safe storage. Under Class II heading: description added for end state of ventilation system in Class II enclosure rooms during Units 2 & 3 safe storage.
		11.3.7.3.1	Section number 11.3.7.3.1 deleted; subsection remains unchanged under heading “Heating”.
		11.3.7.8	Added end state of ventilation system in Main Transformer enclosure and of Standby Generators Fuel Pumphouse heating system for Units 2 & 3 safe storage.
		11.3.7.10	Added end state of SDSE Instrument Rooms air conditioning system for Units 2 & 3 safe storage.
		11.3.8	Added end state of air conditioning and chilled water systems in Main Control Room, Control Equipment Rooms, and associated offices for Units 2 & 3 safe storage.
		11.4.3.1 (new)	End state of Heavy Water Vapour Recovery system for Units 2 & 3 safe storage.
		11.5.1.1 & 11.5.1.2	Clarification added that the Dedicated Fire Pumps have been installed under Units 2 & 3 safe storage projects.
		11.5.1.3 (new)	End state of Fire Protection system for Units 2 & 3 safe storage.
		11.5.3.1	Added end state of Operational Lighting system for Units 2 & 3 safe storage.
		11.5.3.2	Added end state of Emergency Lighting system for Units 2 & 3 safe storage.
		11.5.6	Added end state of Cranes and Hoists for Units 2 & 3 safe storage.
		11.5.8.1 (new)	End state of Calandria Vault Drying system for Units 2 & 3 safe storage.
		11.5.10.1 (new)	End state of Powerhouse Emergency Venting System (PEVS) for Units 2 & 3 safe storage.
		12.3.2.1 (new)	End state of Fixed Area Radiation Monitors for Units 2 & 3 safe storage.
		12.3.3.8 (new)	End state of Access Control for Units 2 & 3 safe storage.
		13.3	Added end state of Liquid Radioactive Effluent Sampling and Monitoring system for Units 2 & 3 safe storage.

Table 14: Recreation Establishments [R-98]

	Number of Establishments		
	Durham Region	**York Region**	**Toronto Metropolitan**
Horse Race Tracks	35	73	155
Other Spectator Sports	16	32	68
Sports Stadiums and Other Presenters with Facilities	1	7	22
Zoos and Botanical Gardens	4	1	5
Amusement and Theme Parks	7	9	19
Golf Courses and Country Clubs	42	76	51
Skiing Facilities	6	2	4
Marinas	16	27	36
Accommodations:			
RV Parks and Campgrounds	10	15	6
Hunting and Fishing Camps	4	4	12
Recreational (except Hunting and Fishing) and Vacation Camps	4	19	50

Table 15: Airports and Airstrips with Runways >100 ft Wide ([R-111] [R-112])

Map ID [[R-112]]	Name	Distance to Pickering		Surface Type	Length	Width
		km	Mi		ft	ft
167	Toronto City Centre	31.5	19.5	Asphalt	4000	150
29	Toronto/Downsview	32.3	20.0	Asphalt	7000	200
185	Toronto/Lester B. Pearson	45.6	28.3	Asphalt	11050	200
59	St. Catherines	73.4	45.6	Asphalt	5000	150
610	Stoney Creek	90.3	56.1	Asphalt/Turf	2850	165
195	Orillia	93.1	57.9	Asphalt	2010	150

Table 16: Compression and Shear Wave Velocities of the Soil and Rock

Foundation Material	Shear Wave Velocity		Compression Wave Velocity	
	m/s	ft/s	m/s	ft/s
Glacial till	355 to 457	1,100 to 1,500	1,520 to 2,130	5,000 to 7,000
Shale bedrock	914 to 1,520	3,000 to 5,000	4,570	15,000
Limestone bedrock	2,130 to 2,440	7,000 to 8,000	6,170	22,000

0503

IAEA SAFETY STANDARDS SERIES

External Human Induced Events in Site Evaluation for Nuclear Power Plants

SAFETY GUIDE

No. NS-G-3.1

INTERNATIONAL
ATOMIC ENERGY AGENCY
VIENNA

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Under the terms of Article III of its Statute, the IAEA is authorized to establish standards of safety for protection against ionizing radiation and to provide for the application of these standards to peaceful nuclear activities.

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The IAEA’s safety standards are not legally binding on Member States but may be adopted by them, at their own discretion, for use in national regulations in respect of their own activities. The standards are binding on the IAEA in relation to its own operations and on States in relation to operations assisted by the IAEA.

Information on the IAEA’s safety standards programme (including editions in languages other than English) is available at the IAEA Internet site

www.iaea.org/ns/coordinet

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EXTERNAL HUMAN INDUCED EVENTS IN SITE EVALUATION FOR NUCLEAR POWER PLANTS

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world''.

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FOREWORD

by Mohamed ElBaradei
Director General

One of the statutory functions of the IAEA is to establish or adopt standards of safety for the protection of health, life and property in the development and application of nuclear energy for peaceful purposes, and to provide for the application of these standards to its own operations as well as to assisted operations and, at the request of the parties, to operations under any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of nuclear energy.

The following bodies oversee the development of safety standards: the Commission for Safety Standards (CSS); the Nuclear Safety Standards Committee (NUSSC); the Radiation Safety Standards Committee (RASSC); the Transport Safety Standards Committee (TRANSSC); and the Waste Safety Standards Committee (WASSC). Member States are widely represented on these committees.

In order to ensure the broadest international consensus, safety standards are also submitted to all Member States for comment before approval by the IAEA Board of Governors (for Safety Fundamentals and Safety Requirements) or, on behalf of the Director General, by the Publications Committee (for Safety Guides).

The IAEA's safety standards are not legally binding on Member States but may be adopted by them, at their own discretion, for use in national regulations in respect of their own activities. The standards are binding on the IAEA in relation to its own operations and on States in relation to operations assisted by the IAEA. Any State wishing to enter into an agreement with the IAEA for its assistance in connection with the siting, design, construction, commissioning, operation or decommissioning of a nuclear facility or any other activities will be required to follow those parts of the safety standards that pertain to the activities to be covered by the agreement. However, it should be recalled that the final decisions and legal responsibilities in any licensing procedures rest with the States.

Although the safety standards establish an essential basis for safety, the incorporation of more detailed requirements, in accordance with national practice, may also be necessary. Moreover, there will generally be special aspects that need to be assessed on a case by case basis.

The physical protection of fissile and radioactive materials and of nuclear power plants as a whole is mentioned where appropriate but is not treated in detail; obligations of States in this respect should be addressed on the basis of the relevant instruments and publications developed under the auspices of the IAEA. Non-radiological aspects of industrial safety and environmental protection are also not explicitly considered; it is recognized that States should fulfil their international undertakings and obligations in relation to these.

The requirements and recommendations set forth in the IAEA safety standards might not be fully satisfied by some facilities built to earlier standards. Decisions on the way in which the safety standards are applied to such facilities will be taken by individual States.

The attention of States is drawn to the fact that the safety standards of the IAEA, while not legally binding, are developed with the aim of ensuring that the peaceful uses of nuclear energy and of radioactive materials are undertaken in a manner that enables States to meet their obligations under generally accepted principles of international law and rules such as those relating to environmental protection. According to one such general principle, the territory of a State must not be used in such a way as to cause damage in another State. States thus have an obligation of diligence and standard of care.

Civil nuclear activities conducted within the jurisdiction of States are, as any other activities, subject to obligations to which States may subscribe under international conventions, in addition to generally accepted principles of international law. States are expected to adopt within their national legal systems such legislation (including regulations) and other standards and measures as may be necessary to fulfil all of their international obligations effectively.

EDITORIAL NOTE

An appendix, when included, is considered to form an integral part of the standard and to have the same status as the main text. Annexes, footnotes and bibliographies, if included, are used to provide additional information or practical examples that might be helpful to the user.

The safety standards use the form 'shall' in making statements about requirements, responsibilities and obligations. Use of the form 'should' denotes recommendations of a desired option.

The English version of the text is the authoritative version.

CONTENTS

1. INTRODUCTION

BACKGROUND

1.1. Facilities and human activities in the region in which a nuclear power plant is located may under some conditions affect its safety. The potential sources of human induced events external to the plant should be identified and the severity of the possible resulting hazard phenomena should be evaluated to derive the appropriate design bases for the plant. They should also be monitored and periodically assessed over the lifetime of the plant to ensure that consistency with the design assumptions is maintained.

1.2. This Safety Guide recommends actions, conditions and procedures and provides guidance for fulfilling the requirements of the Safety Requirements publication, Code on the Safety of Nuclear Power Plants: Siting [1], that concern human induced events external to the plant. The present publication is the first revision of the Safety Guide on External Man-Induced Events in Relation to Nuclear Power Plant Siting issued in 1981 as Safety Series No. 50-SG-S5.

1.3. The general requirements to be followed for establishing design bases are those established in Ref. [1]. As required in Ref. [1], "the potential in the region for external human induced events that may lead to radiological consequences from the nuclear power plant shall be assessed" and consequently adequate design bases for the plant, for the purpose of preventing such radiological consequences, are required to be derived for those external human induced events which can affect safety.

1.4. Full consideration should be given at the stage of site selection to the possibility of disregarding locations having at present, or in the foreseeable future, a potential for severe external human induced events which may jeopardize the safety of the proposed plant and for which engineering solutions may prove unfeasible or impracticable.

1.5. Large, potentially hazardous facilities are relatively easy to identify as to both location and the associated hazards. Consideration should also be given, however, to the potential for effects resulting from minor activities or from activities that might evolve or newly develop in the foreseeable future and which could lead to serious consequences, including effects of potential sources near or as part of the non-nuclear part of the plant. Such activities may occur only occasionally, depending on the practices in a particular locality. It is not possible to produce a comprehensive list of potential sources of external human induced events, since each site is different and practices with regard to industry, transportation and land use may differ from region to region and from country to country. However, a list of likely sources is presented and discussed in the present Safety Guide.

1.6. The recommendations and information set out herein are derived from practices in States for protecting nuclear power plants against human induced events external to the plant. In accordance with this practical experience, no graded approach for human induced events is presented here and therefore only one intensity level for each interacting event is expected for consideration in the design basis. In some instances this approach is complemented with a lower level action to be added deterministically to the design basis and considered in conjunction with different acceptance criteria; however, such a solution can be considered the introduction of a different load case (see, for example, Section 5).

1.7. The establishment of the design basis for any external human induced event depends upon a knowledge of regional characteristics as well as of the conceptual or preliminary design of the proposed plant. In view of the dependence of the plant design on regional characteristics, the safety features of the site and the plant should be examined by iteration. In all cases, before final acceptance of any combination of particular plant and site, enough information should be made available on the design of the plant to allow an expert judgement to be made of the possibility of realistic engineering solutions to the problems associated with external human induced events.

OBJECTIVE

1.8. The purpose of the present Safety Guide is to provide recommendations and guidance for the examination of the region considered for site evaluation[1] for a plant

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[1] For a nuclear power plant, site evaluation typically involves the following stages:

— *Selection stage.* One or more preferred candidate sites are selected after the investigation of a large region, the rejection of unsuitable sites, and screening and comparison of the remaining sites.

— *Characterization stage*. This stage is further subdivided into:
  - Verification, in which the suitability of the site to host a nuclear power plant is verified mainly according to predefined site exclusion criteria;
  - Confirmation, in which the characteristics of the site necessary for the purposes of analysis and detailed design are determined.

— *Pre-operational stage*. Studies and investigations begun in the previous stages are continued after the start of construction and before the start of operation of the plant to complete and refine the assessment of site characteristics. The site data obtained allow a final assessment of the simulation models used in the final design.

— *Operational stage*. Appropriate safety related site evaluation activities are carried out throughout the lifetime of the facility, mainly by means of monitoring and periodic safety review.

in order to identify hazardous phenomena associated with human induced events initiated by sources external to the plant. In some cases it also presents preliminary guidance for deriving values of relevant parameters for the design basis. This Safety Guide is also applicable for periodic site evaluation and site evaluation following a major human induced event, and for the design and operation of the site's environmental monitoring system. Site evaluation includes site characterization; consideration of external events that could lead to a degradation of the safety features of the plant and cause a release of radioactive material from the plant and/or affect the dispersion of such material in the environment; and consideration of population issues and access issues significant to safety (such as the feasibility of evacuation, the population distribution and the location of resources). The process of site evaluation continues throughout the lifetime of the facility, from siting to design, construction, operation and decommissioning.

SCOPE

1.9. The external human induced events considered in this Safety Guide are all of accidental origin. Considerations relating to the physical protection of the plant against wilful actions by third parties are outside its scope. However, the methods described herein may also have some application for the purposes of such physical protection.

1.10. The present Safety Guide may also be used for events that may originate within the boundaries of the site, but from sources which are not directly involved in the operational states of the nuclear power plant units, such as fuel depots or areas for the storage of hazardous materials for the construction of other facilities at the same site. Special consideration should be given to the hazardous material handled during the construction, operation and decommissioning of units located at the same site. In some cases other nuclear facilities (such as fuel fabrication units or fuel processing units) may be located at the same site and therefore should be considered in the hazard evaluation for the plant. While this Safety Guide deals primarily with site characterization stages, it also contains useful guidance for the site selection, pre-operational and operational stages.

1.11. Recommendations for the development of the design bases for design basis external human induced events (DBEHIE) are beyond the scope of the present publication. Those recommendations are discussed in Ref. [2]. Fire effects are mainly dealt with in Ref. [3]. The other IAEA Safety Guides relating to design discuss the effects of human induced events on specific plant systems. For its part, Ref. [4] deals with periodic safety assessment and lifetime monitoring of environmental parameters.

1.12. In this sense, the present Safety Guide concentrates on the definition of hazards for the site and on the general identification of major effects on the plant as a whole, according to the reference probabilistic or deterministic criteria, which are to be used in a design or in a design assessment framework. The next step in the full determination of the design basis for a specific plant is carried out in a design context, being intrinsically dependent on the layout and design. This additional step is therefore discussed in the series of standards relating to design, together with the detailed loading schemes and the design procedures, owing to their constitutive dependence. Hence, in this Safety Guide, the term 'design basis' should be understood as being limited mainly to that part of the determination of the design basis that is independent of any procedure for plant layout or design.

1.13. In the selection between a deterministic and a probabilistic approach for hazard evaluation, several issues are determinant. These include: the availability of data for the site; the possibility of reliable extrapolation to lower excess values; the design approach to be adopted; the compatibility with national standards for hazard evaluation and design; and public acceptance issues. In this context, basic reference is made to a probabilistic approach for the site evaluation stage, while the derivation of single values on the probabilistic distributions to be applied in deterministic design procedures is left to the design stage. The procedures for probabilistic safety assessment (PSA) of external events, as part of the design assessment process, are discussed in another IAEA Safety Guide [5].

1.14. The present Safety Guide does not cover events resulting from the failure of artificial water retaining structures, even if they are human induced, since the consequences in terms of flooding of such a failure fall within the scope of Refs [6, 7]. Likewise, modifications to the groundwater table as a consequence of human activities (such as the construction of wells and dykes) are within the scope of Ref. [8].

STRUCTURE

1.15. Section 2 covers the general approach to site evaluation in relation to external human induced events. Section 3 addresses in detail the information to be collected as well as the investigations to be performed in order to compile a database for identifying potential sources at the beginning of the process of site evaluation. Section 4 deals with the use of the compiled database to conduct the site characterization by means of a screening process and detailed evaluation procedures. Sections 5 to 8 examine the application of this general method to specific induced events such as aircraft crashes, explosions and the release of hazardous fluids, while Section 9 covers general administrative considerations.

2. GENERAL APPROACH TO SITE EVALUATION IN RELATION TO EXTERNAL HUMAN INDUCED EVENTS

2.1. The Code on the Safety of Nuclear Power Plants: Siting (Ref. [1], para. 301) requires that external human induced events that could affect safety be investigated in the site evaluation stage for every nuclear power plant site. Thus, the region is required to be examined for facilities and human activities that have the potential, under certain conditions, to endanger the nuclear power plant over its entire lifetime. Each relevant potential source is required to be identified and assessed to determine the potential interactions with personnel and plant items important to safety.

2.2. It should not be overlooked that, in specific situations, a minor event may lead to severe effects.[2] In evaluating the need for protection against the effects of external human induced events, due account should be taken of the plant's operating procedures and any recommended administrative measures.[3]

2.3. A prognosis should be made for possible regional development over the anticipated lifetime of the plant, with account taken of the degree of administrative control that may be exercised over activities in the region. In this respect, allowance should be made for the fact that technologies in the chemical and petrochemical industries, as well as traffic densities, may evolve rapidly.

2.4. Unless a satisfactory engineering solution can be achieved for protection against those external human induced events which have not otherwise been excluded

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[2] For example, in the safety review of the plant, the potential for a fire of small extent and with no direct effect on the plant was found. Examination of the power supply to the off-site emergency system showed that the power lines should be put underground to protect them against fire in order to prevent any impairment of safety related systems.

[3] In the case of protective doors, for example, the probability and consequences of an event occurring while they are open should be considered. It may then be decided whether or not special additional protection is necessary.

from further consideration, either the site should be deemed unsuitable during the siting stage, or appropriate administrative actions should be taken in the case of an existing plant. Public acceptance issues should also be addressed in the site evaluation stage.

2.5. A quality assurance programme should be established and implemented to cover those items, services and processes which may affect safety and which fall within the scope of the present Safety Guide. The quality assurance programme should be implemented to ensure that data collection, data processing, field and laboratory work, studies, evaluations and analyses, and all other activities necessary to follow the recommendations of this Safety Guide are satisfactorily performed and documented (see Ref. [9]).

3. DATA COLLECTION AND INVESTIGATIONS

TYPE OF POTENTIAL SOURCE

3.1. The sources of external human induced events may be classified as:

— Stationary sources, for which the location of the initiating mechanism (explosion centre, point of release of explosive or toxic gases) is fixed, such as chemical plants, oil refineries, storage depots and other nuclear facilities at the same site.
— Mobile sources, for which the location of the initiating mechanism is not totally constrained, such as any means of transport for hazardous materials or potential projectiles (by road, rail, waterways, air, pipelines). In such cases, an accidental explosion or a release of hazardous material may occur anywhere along a road or other way or pipeline.

IDENTIFICATION OF POTENTIAL SOURCES

3.2. Installations which handle, process or store potentially hazardous materials such as explosive, flammable, corrosive, toxic or radioactive materials should be identified as sources, even if associated with other on-site units under construction, in operation or undergoing decommissioning. The magnitude of the hazard may not bear a direct relation to the size of such facilities, but the maximum amount of hazardous material present at any given time and the process in which it is used should be taken into consideration. Furthermore, the progression of an accident with time, such as fire spreading from one tank to another, should also be considered. Pipelines for hazardous materials should be included in the category of items to be identified. Other sources to be considered are construction yards, mines and quarries which use and store explosives and which may cause the temporary damming of water courses, with possible subsequent flooding or collapse of ground at the site (see Ref. [10]).

3.3. With regard to aircraft crashes, a study should be made of airports and their takeoff, landing and holding patterns, flight frequencies and types of aircraft. Air traffic corridors should also be taken into account.

3.4. The conveyance of hazardous materials by sea or inland waterways may present a significant hazard which should be taken into account. Vessels, together with their loads and water borne debris, may have the potential for mechanically blocking or damaging cooling water installations associated with an ultimate heat sink.

3.5. Since experience indicates that the bulk of sea traffic accidents occur in coastal waters or harbours, shipping lanes near the site should be identified.

3.6. Railway rolling stock and road traffic, together with their loads, are potential sources that should be given careful attention, particularly for busy routes, junctions, marshalling yards and loading areas.

3.7. At military installations, hazardous materials are handled, stored and used, and may be associated with hazardous activities such as firing range practice. In particular, military airports and their associated traffic systems, including training areas, should be considered potential sources.

3.8. In examining the adequacy of a site in respect of external human induced events, attention should also be given to future human activities currently in the planning stage, such as for land with potential for commercial development. Such activities in the future may lead to an increased risk of radiological consequences or to sources of interacting events which do not exceed the screening probability level but may grow to reach that level.

Effects and associated parameters

3.9. The human induced sources of events mentioned earlier may cause events that can generate effects such as:

- air pressure wave and wind;
- projectile impact;
- heat (fire);

— smoke and dust;
— toxic and asphyxiant gases;
— chemical attack by corrosive or radioactive gases, aerosols or liquids;
— shaking of the ground;
— flooding or lack of water;
— ground subsidence (or collapse) and/or landslide;
— electromagnetic interference;
— eddy currents into the ground.

3.10. Some of these effects are of considerably greater importance to safety than others. They could affect both the plant's facilities and items essential for safety, such as by affecting the availability of evacuation routes (the site might lose links to safe areas in the region), the possibility of implementing emergency procedures (access by the operator could be impaired), and the availability of the external grid and the ultimate heat sink. Although many effects may be associated with more than one potential source, usually one or two effects are dominant for each individual source.

3.11. To illustrate the notion of 'interacting mechanisms', examples of originating sources, sequences of events and the main effects that result are given in Tables I–III. Table I gives facilities and transport systems that should be investigated, their relevant features and the initiating events generated from them. Table II gives the progression of initiating events and their possible impacts on the plant, and Table III gives information on the consequences of these impacts on the plant.

TABLE I. IDENTIFICATION OF SOURCES AND ASSOCIATED INITIATING EVENTS

Facilities and transport systems to be investigated	Relevant features of the facilities and traffic	Initiating event
STATIONARY SOURCES		
Oil refinery, chemical plant, storage depot, broadcasting network, mining or quarrying operations, forests, other nuclear facilities, high energy rotating equipment	Quantity and nature of substances Flow sheet of process involving hazardous materials Meteorological and topographical characteristics of the region Existing protective measures in the installation	Explosion Fire Release of flammable, explosive, asphyxiant, corrosive, toxic or radioactive substances Ground collapse, subsidence Projectiles Electromagnetic interference Eddy currents into the ground

TABLE I. (cont.)

Facilities and transport systems to be investigated	Relevant features of the facilities and traffic	Initiating event
Military facilities (permanent and temporary)	Types of activities Quantities of hazardous materials Features of hazardous activities	Projectile generation Explosion Fire Release of flammable, explosive, asphyxiant, corrosive, toxic or radioactive substances
MOBILE SOURCES		
Railway trains and wagons, road vehicles, ships, barges, pipelines	Passage routes and frequency of passage Type and quantity of hazardous material associated with each movement Layout of pipelines including pumping stations, isolation valves Characteristics of the vehicle (including protective measures) Meteorological and topographical characteristics of the region	Explosion Fire Release of flammable, explosive, asphyxiant, corrosive, toxic or radioactive substances Blockage, contamination (such as from an oil spill) or damage to cooling water intake structures Impacts of derailed vehicles
Airport zone	Aircraft movements and flight frequencies Runway characteristics Types and characteristics of aircraft	Abnormal flights leading to crashes
Air traffic corridors and flight zones (military and civil)	Flight frequencies Types and characteristics of aircraft Characteristics of air traffic corridors	Abnormal flights leading to crashes

TABLE II. EVOLUTION OF EVENTS AND IMPACTS ON THE NUCLEAR POWER PLANT

Initiating event	Development of event	Possible impact of each event on the plant[a]
Explosion (deflagration, detonation)	Explosion pressure wave Projectiles Smoke, gas and dust produced in explosion can drift towards the plant Associated flames and fires	(1) (2) (3) (4) (5) (6) (7)
Fire (external)	Sparks can ignite other fires Smoke and combustion gas of fire can drift towards the plant Heat (thermal flux)	(3) (4) (5) (6)
Release of flammable, explosive, asphyxiant, corrosive, toxic or radioactive substances	Clouds or liquids can drift towards the plant and burn or explode before or after reaching it, outside or inside the plant Clouds or liquids can also migrate into areas where operators or safety related equipment can be prevented from functioning	(1) (2) (3) (4) (5) (6)
Aircraft crashes or abnormal flights leading to crashes, collision of planes, projectiles Vehicle impacts	Projectiles Fire Explosion of fuel tanks	(1) (2) (3) (4) (5) (6)
Ground collapse	Ground collapse Interference with cooling water systems	(7) (8) (9)
Blockage or damage to cooling water intake structures	Interference with cooling water systems	(12)
Electromagnetic interference	Electromagnetic fields around electrical equipment	(10)
Eddy currents into ground	Electric potential into ground	(11)

[a] See Table III for an explanation of the numerals.

TABLE III. IMPACT ON THE NUCLEAR POWER PLANT AND CONSEQUENCES

Impact on the plant	Parameters	Consequences of impact
(1) Pressure wave	Local overpressure at the plant as a function of time	Collapse of parts of structure or disruption of systems and components
(2) Projectile	Mass Velocity Shape Size Type of material Structural features Impact angle	Penetration, perforation or spalling of structures or disruption of systems and components Collapse of parts of structure or disruption of systems and components Vibration induced false signals in equipment
(3) Heat	Maximum heat flux and duration	Impaired habitability of control room Disruption of systems or components Ignition of combustibles
(4) Smoke and dust	Composition Concentration and quantity as a function of time	Blockage of intake filters Impaired habitability of control room and other important plant rooms and affected areas
(5) Asphyxiant and toxic substances	Concentration and quantity as a function of time Toxicity and asphyxiant limits	Threat to human life and health and impaired habitability of safety related areas Prevention of fulfilment of safety functions by operators
(6) Corrosive and radio-active liquids, gases and aerosols	Concentration and quantity as a function of time Corrosive, radioactive limits Provenance (sea, land)	Threat to human life and health and impaired habitability of safety related areas Corrosion and disruption of systems or components Prevention of fulfilment of safety functions
(7) Ground shaking	Response spectrum	Mechanical damage
(8) Flooding (or drought)	Level of water with time Velocity of impacting water	Damage to structures, systems and components

TABLE III. (cont.)

Impact on the plant	Parameters	Consequences of impact
(9) Subsidence	Settlement, differential displacement, settlement rate	Collapse of structures or disruption of systems and components, including buried pipes, cables
(10) Electromagnetic interference	Frequency band and energy	False signals on electric equipment
(11) Eddy currents into ground	Intensity and duration	Corrosion of underground metal components Grounding problems
(12) Damage to water intake	Mass of the ship, impact velocity and area, degree of blockage	Unavailability of cooling water

COLLECTION OF INFORMATION

3.12. The collection of information should begin early enough to enable the potential sources of external human induced events in the region to be identified at the stage of site selection. When a potential site has been identified, more detailed information may be necessary to identify reference hazards for external human induced events and to provide data for design basis parameters (the site characterization stage). Furthermore, during the plant's lifetime (the pre-operational and operational stages), more data should be available from monitoring of the site to be used in the periodic safety assessments [4, 5, 11].

3.13. First, a list of sources present in the region should be prepared and divided into different categories, such as stationary and mobile sources. The extent of the relevant region and thus the areas to be examined should be determined for each type of source; this will depend on a number of factors, including the type, quantity and condition of the hazardous material involved and the nature of any mobile source. Usually such areas will extend a few kilometres from the site, but in some instances this distance may need to be greater.

3.14. The procedure of identifying and initially categorizing sources implies that in the early stages of the investigation only such information should be collected as will allow the determination of whether or not the hazard associated with any source should be given further consideration.

3.15. Information about present and planned facilities and activities in the region should be sought from maps, published reports, public records, public and private agencies and individuals knowledgeable about the characteristics of local areas. This information, together with that obtained from the direct investigation of specific facilities which appear to have a potential for impact on the plant, should be verified and examined to identify those activities that should be investigated in greater detail.

3.16. Once the potential sources have been identified, they should be analysed and, as far as they can be readily determined, relevant factors such as the magnitude of the potential event, its probability of occurrence and the distance between the event and the site should be evaluated. It should then be decided which sources and events are important and are to be used in the evaluation of the site's suitability and in the design or assessment of the plant. For these purposes, only events potentially affecting the plant should be considered.

3.17. Assessment of the probability of occurrence of an event with an impact on the plant should begin with the evaluation of the probability of the initiating event and should continue with consideration of only the appropriate combination of probabilities for the associated sequence of events leading to interactions with personnel and with items important to safety.

3.18. For many categories of interacting events there is often insufficient information available concerning the region to permit a reliable evaluation of the probability of occurrence and of the probable severity of the event. It may therefore be useful to obtain statistical data on a national, continental or global basis. Values thus obtained should be examined to determine whether or not they need to be adjusted to compensate for unusual characteristics of the site and its environs. Where there is locally no basis for calculating the severity of the effects of an external human induced event, all available information and assumptions about that particular type of event should be obtained on a global basis so that design bases can be determined by means of engineering judgement.

STATIONARY SOURCES

3.19. The hazards presented to a nuclear power plant from stationary sources such as industrial plants and storage depots arise from the potential for explosions, fires and the formation of gas and dust clouds.

3.20. The information necessary for consideration of the hazards posed by stationary sources covers the following matters: the types of hazardous material involved and the quantities in store, in process and in transit; the types of storage (physical conditions) and processes (flow sheets); the dimensions of major vessels, stores or other forms of containment; the locations of these forms of containment; their construction and their isolation systems; their operating conditions (including the frequency of maintenance); and their active and passive safety features.

3.21. All available information on accidents and failures should be collected, with account taken of the active and passive safety features. Information on the possibility of interaction between materials in different stores or in process, which may lead to a significantly greater hazard, should also be presented.

3.22. Statistical data on the meteorology of the region as well as information on local meteorological and topographical characteristics of the area between the location of the potential sources and the nuclear power plant site should be obtained for use in making realistic evaluations.

3.23. Mines and quarries are hazardous because the explosives used in their exploitation can generate pressure waves, projectiles and ground shock; moreover, mining and quarrying entail the possibility of ground collapse and landslides. Information should be obtained on the locations of all past, present and possible future mining and quarrying work and the maximum quantities of explosives that may be stored at each location. Information on geological and geophysical characteristics of the subsurface in the area should also be obtained to ensure that the plant is safe from ground collapse or landslide caused by such activities.

3.24. Particular difficulty may be experienced in collecting and evaluating relevant information on military bases, including standby installations, on the use of training areas and on other military activities. Nevertheless, the collection and evaluation of such information is important for safety. Appropriate liaison should be established between the relevant civil and military authorities to ensure that site selection is facilitated and that the design basis parameters are evaluated in those cases where military activities may present a hazard to the nuclear power plant.

MOBILE SOURCES

3.25. The hazards to a nuclear power plant arising from surface transport (by road, rail, sea, inland waterways and pipelines) are similar to those from industrial plants. On-site transport of hazardous material relevant to other units should also be considered. Air traffic presents a different type of hazard because of the possibility of an aircraft crash on to the nuclear power plant.

3.26. Information on such sources in the region should be collected to determine:

(a) the locations of possible sources of external human induced events associated with transport systems;
(b) the probability of occurrence and the severity of the events.

Surface transport

3.27. Information should be collected on fixed traffic facilities in the region, including ports, harbours, canals, dredged channels, railway marshalling yards, road vehicle loading areas and busy junctions and intersections, and on traffic routes in relation to the site.

3.28. Information should be collected on the characteristics of traffic flows in the region, such as: the nature, type and quantities of material conveyed along a route in a single transport movement; the sizes, numbers and types of the vessels; speeds, control systems and safety devices; and accident statistics including consequences. Similar information should be collected for pipelines: on the nature of the substance transported, the flow capacity, the internal pressure, the distances between valves or pumping stations, safety features, and accident records including consequences.

Air traffic

3.29. The information collected on air traffic should include the locations of airports and air traffic corridors in the region, the airports' takeoff, landing and holding patterns, the types of warning and control devices available, the types and characteristics of aircraft and their flight frequencies. Information on aircraft accidents for the region and for similar types of airport and air traffic should be collected. Information should be collected for both civil and military air traffic. Of particular interest are military aircraft training areas which may show a comparatively high frequency of crashes in their vicinity and areas where low flying is practised.

SOURCE DISPLAY MAP

3.30. Source display maps should be prepared showing the locations and distances from the nuclear power plant of all sources identified in the data collection stage which may potentially affect the site, such as chemical plants, refineries, storage facilities, construction yards, mines and quarries, military facilities, means of transport (by air, land and water), transport facilities (docks, moorings, loading areas, marshalling yards, airports), pipelines for hazardous liquids and gases, drilling installations and wells. Any other facilities that may need to be considered for potential adverse effects on the nuclear power plant because of the products manufactured, handled or stored in them or transported to them should be identified and located on the maps. After the evaluation of the potential sources and the establishment of the design basis events, a final version of the source display map should be prepared that includes all the data for the sources corresponding to the adopted interacting events.

3.31. These maps should reflect any foreseeable developments in human activities that may potentially affect safety over the projected lifetime of the nuclear power plant. Relevant information should be obtained by examining development plans for the region.

4. SCREENING AND EVALUATION PROCEDURES

GENERAL PROCEDURE

4.1. The information collected is initially used in a two step screening stage to eliminate those sources which should not be considered further, on the basis of distance or probability. This preliminary screening may be carried out by the use of a ‘screening distance value’ and/or, where the available data permit, by evaluating the probability of occurrence of the event.

4.2. For some sources a simple deterministic study, based on information on the distance and characteristics of the source, may be sufficient to show that no significant interacting event can occur. By means of such an analysis it is therefore often possible to select a screening distance value for a particular type of source beyond which the effects of such sources may be ignored.

4.3. A second screening criterion is based on the probability of occurrence. In this Safety Guide the limiting value of the annual probability of occurrence of events with potential radiological consequences is called the screening probability level (SPL)[4]. Such a value should be defined by the regulatory body coherently with the policy for risk management in the region for nuclear and industrial facilities. Initiating events with a probability of occurrence lower than this screening probability level should not be given further consideration, regardless of their consequences.

4.4. In general the design procedures for nuclear power plants are deterministic and therefore the design basis is assumed to provide the designer with a single point evaluation of the true probabilistic distribution of interacting effects on the plant. However, sometimes a lack of confidence in the quality of the data — that is, in their accuracy, applicability, completeness or quantity — may preclude the use of a quantitative probabilistic criterion in deciding whether to establish a design basis for a particular event or sequence of events or to eliminate them from consideration (by screening). In such cases, a pragmatic approach on the basis of expert judgement should be taken in deciding which events or sequence of events should be considered in a detailed hazard evaluation.

4.5. For each type of source or event not eliminated by the two step screening process, a more detailed evaluation should be made. Sufficiently detailed information to demonstrate the acceptability of the site in respect of external human induced events and to determine the relevant hazards should be collected. Figure 1 shows a flow diagram of the steps in the procedures for preliminary screening and detailed evaluation.

PRELIMINARY SCREENING

4.6. Relatively simple procedures may be used in a preliminary screening of sources and interacting events. The starting point is the identification of all stationary and mobile sources of potential external human induced events in the region and all possible initiating events for each source, as indicated in Section 3 (see boxes 1 and 2 in Fig. 1).

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[4] In some States, a value for the probability of 10^{-7} per reactor-year is used in *the design of new facilities* as one acceptable limit on the probability value for interacting events having serious radiological consequences, and this is considered a conservative value for the SPL if applied to all events of the same type (such as all aircraft crashes, all explosions). Some initial events may have very low limits on their acceptable probability and should be considered in isolation.

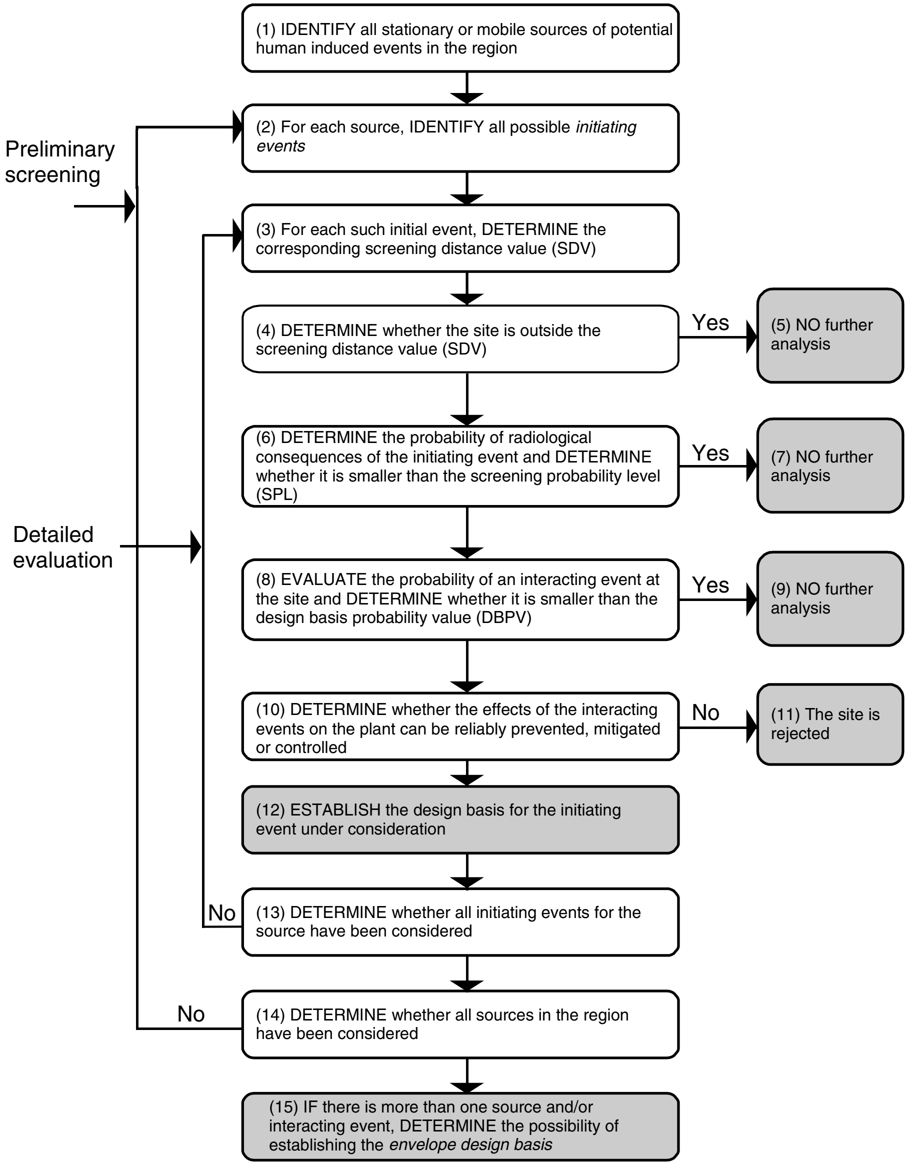

FIG. 1. General flow diagram for the screening and evaluation procedure (shaded boxes represent completed sequences).

4.7. After the step mentioned in para. 4.6, a screening distance value (SDV) should be determined for each particular type of source (stationary and mobile) using a conservative approach such that the effects of interacting events beyond this distance should not be considered further (see box 3 in Fig. 1). The determination of the SDV should take into account the severity and extent of the event, as well as the expected characteristics of the nuclear power plant to be located at the site. These characteristics may be assumed for the early stages of siting to be those corresponding to the standard plant design. If the site is outside the SDV for the initiating event under consideration, no further action is necessary (see boxes 4 and 5 in Fig. 1). For sources generating effects of the same nature, a further screening could be performed which would depend upon an enveloping criterion and which should exclude those sources that generate interacting events that are enveloped by those for other selected sources, even if the site is inside the SDVs for these sources.

4.8. If the site is not outside the SDV for the initiating event under consideration, the probability of occurrence of such an event should be determined and compared with the specified SPL (see box 6 in Fig. 1). If the probability of occurrence of the event under consideration is smaller than the SPL, no further analysis should be made (see box 7 in Fig. 1).

4.9. The SPL should be chosen with due consideration, given that the radiological risk associated with external human induced events should not exceed the range of radiological risks associated with accidents of internal origin or with other external causes.

4.10. It is emphasized that the validity of the SPL approach depends on the assumption that a sufficiently low probability of occurrence for an interacting event adequately compensates for the hazard arising from that event. Events associated with major, possibly catastrophic, hazards should not be screened out unless their probability is shown to be significantly below the SPL.

4.11. In this respect, owing essentially to the high uncertainties usually associated with the probabilistic evaluation itself or because of particular concern on the part of the population, some States have selected a two step approach for such events with major hazards associated. In the first step, events with major consequences are evaluated (kept or screened out) on a probabilistic basis. In the second step, independently of the result of the first step and in a purely deterministic way, design parameter values that are lower than the maximum conceivable and are based on good engineering practice are included in the design basis to provide the plant with protection against such generic events. A detailed probabilistic evaluation of the risks associated with the lower deterministic level is not carried out and the scenario is directly included in the design basis.[5]

4.12. In practice, the recommended approach should be followed cautiously, with account taken of the following:

— The uncertainties in the estimation of the load intensity–probability curve. The reliability of this basic tool is affected mainly by uncertainties in the extrapolation of historical data to very low probability levels, such as those usually associated with the SPL. Appropriate statistical approaches should be taken, and comparisons should be made with analogous statistics used for other events and for other kinds of facilities in the region with similar levels of risk.
— The differences between the probability of the onset of the initiating event and the probability of interacting effects on the plant, after propagation of the effects from the source to the site.
— The number of various possible sources of external human induced events whose individual estimated probability (for each source) for the same kind of interacting event may be less than the SPL but whose total estimated probability (for all sources) may exceed it.

DETAILED EVALUATION

4.13. If the probability of occurrence of the initiating event under consideration is greater than the specified SPL value, a detailed evaluation should be made. This implies that the associated interacting events should be determined as well as their corresponding probabilities of occurrence.

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[5] Typical examples:

— In the aircraft crash scenario, a load–time function generically related to a small commercial aircraft is selected, without any reference to the probability of a crash, the fuel content or the impact direction. This would provide for protection in the design against flying objects of similar mass and velocity (such as missiles induced by winds, crashes of upper structural components and human actions).
— In the explosion scenario, a ‘plane wave’ is often selected without any reference to the source. It should be applied as an additional external pressure on the structures, in order to provide for protection against any accidental low level explosions in the neighbourhood of the plant not explicitly accounted for in a dedicated event analysis.

4.14. Once an interacting event has been identified, an upper bound should be established for the conditional probability that this event will cause unacceptable radiological consequences. This upper bound, denoted herein as the conditional probability value (CPV), should be conservatively evaluated for the specific type of nuclear power plant under consideration.[6]

4.15. In the selection of a single point value on the general probabilistic distribution for the event, due attention should be paid to the generation of consistent recommendations in the design and construction stage. For example, the material capacities should be selected consistently with the assumptions for the probability of the event's being exceeded, since the global design reliability is strongly dependent on the combination of both assumptions: on the definitions of the event and of the material capacities.

4.16. A design basis probability value (DBPV) for the interacting event under consideration should then be determined by dividing the SPL by the CPV.

4.17. The probability of occurrence of each interacting event should then be compared with the DBPV obtained as indicated for the interacting event under consideration. Either of the following two situations may arise (see box 8 in Fig. 1):

(1) If the probability is less than the DBPV, no further consideration should be given to that event (see box 9 in Fig. 1).
(2) If the probability is greater than the DBPV, it should be evaluated to establish whether or not the effects of the interacting event on the plant can be reliably limited by preventing or mitigating them or by taking engineering or administrative measures (see box 10 in Fig. 1). If so, a detailed hazard evaluation for the interacting event should be carried out and the event should be considered a postulated initiating event for the plant safety analysis; otherwise the site should be rejected (see box 11 in Fig. 1).

The primary causes of postulated initiating events may be credible equipment failures and operator errors (both within and external to the facility), human induced events or natural events. The specification of the postulated initiating events should be acceptable to the regulatory body for the nuclear power plant.

[6] In some States this upper bound has been globally taken as 0.10. The issue should be carefully considered, however, to ensure that the value adopted is indeed an upper bound and is consistent with the limit of the probability value associated with the occurrence of an initiating event having radiological consequences (often taken as 10^{-7} per year).

DESIGN BASIS EVENTS AND PARAMETERS

4.18. In the event that a probabilistic approach is applied to hazard evaluation, the design basis parameters for a particular interacting event should be those corresponding to a probability of occurrence equal to the DBPV.[7]

4.19. For two or more external human induced interacting events of a given type whose probabilities are similar (to within about an order of magnitude) and for which the plant should be protected, the design basis event should be based on the event having the most severe radiological consequences.

4.20. Events within the following categories are discussed in greater detail in the subsequent sections because of their relevance to many possible nuclear power plant sites:

— aircraft crashes;
— chemical explosions (detonation and deflagration);
— moving fluids and drifting clouds of explosive, flammable, corrosive, toxic, asphyxiant or radioactive material.

4.21. Certain other events specific to a particular site should also be considered, for which a similar methodology should be adopted.

5. AIRCRAFT CRASHES

GENERAL

5.1. The potential for aircraft crashes[8] that may affect the plant site should be considered in the early stages of the site evaluation process and it should be assessed over the entire lifetime of the plant [4]. The potential will result from the

[7] In general this step necessitates the determination of a hazard curve which correlates with the design parameter under consideration; for example, the peak overpressure associated with an incident blast wave in relation to the probability that such a parameter will not be exceeded.

[8] Wilful actions that may potentially affect the nuclear power plant site are excluded from consideration here.

contributions to the probability of occurrence of an aircraft crash of one or more of the following events[9]:

Type 1 event: A crash occurs at the site deriving from the general air traffic in the region. To evaluate the probability of occurrence of such crashes, the site is considered as a tract or circular area of 0.1–1 km^2 and the region as a circular area of 100–200 km in radius.

Type 2 event: A crash occurs at the site as a result of a takeoff or a landing operation at a nearby airport.

Type 3 event: A crash occurs at the site owing to air traffic in the main civil traffic corridors and the military flight zones.

PRELIMINARY SCREENING

Screening distance value approach

5.2. In a preliminary evaluation, consideration should be given to potential sources for crashes in the site region within defined distances from the site. The SDV, which is determined on the premise that any potential hazard beyond the screening distance is minor enough to be ignored, is developed from a deterministic and a probabilistic evaluation of a spectrum of aircraft hazards.

5.3. The information to be collected for evaluating the SDV includes:

- distance from the nearest major airport to the site and the locations of landing strips in relation to the location of the plant;
- the types and frequency of air traffic;
- the routes of air traffic corridors and the locations of air route crossings;
- the distances from the plant to military installations such as military airports and bombing and firing practice ranges.

[9] In general this probability might be calculated either in relation to the statistics for crash initiating events or in relation to the statistics of crash rates. However, the latter approach relies on data more easily available and therefore it is more widely applied in States. In the following discussion, reference is made only to the crash rate approach.

The SDV may be estimated for Type 2 and Type 3 events only[10].

5.4. Aircraft hazards may be dismissed in the initial screening if the proposed site does not lie within the SDVs determined for all types of potential events of this kind,[11] provided that the probability of occurrence of a Type 1 event is smaller than the SPL.

Screening probability level approach

5.5. If the site is not located outside the SDV estimated as indicated earlier, the probabilistic approach should be used for screening purposes. Thus, if the probability of occurrence of interacting events for all types of aircraft is less than the specified SPL, no detailed evaluation is necessary and a presentation of verifying information is sufficient. However, if the probability is equal to or greater than the SPL, a detailed evaluation should proceed.

5.6. In the application of the SPL screening criterion, the following should be borne in mind:

- The probability of Type 1 events should be carefully evaluated, in particular in densely populated regions with several civil airports and thus more flights. Appropriate zoning of the area considered should be carried out to avoid non-conservative averaging.
- The probability of aircraft crashes is usually higher in the vicinity of airports, both civil and military (Type 2 events). A separate check should be carried out for areas in the vicinity of airports.

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[10] If the probability of a commercial aircraft crashing during a takeoff or a landing operation is assumed to be in the range 10^{-5}–10^{-6}, which may be taken as a starting point in the evaluation of the probability of occurrence associated with Type 2 events, it may be taken that crashes tend to occur within approximately semicircular areas of 7.5 km in radius centred at the ends of the runways.

[11] One State adopts the following criteria for estimating the SDV. The potential hazards arising from aircraft crashes are taken into account if: airways or airport approaches pass within 4 km of the site; airports are located within 10 km of the site for all but the biggest airports; for large airports, if the distance d in kilometres to the proposed site is less than 16 km and the number of projected yearly flight operations is greater than $500d^2$. Where the distance d is greater than 16 km, the hazard will be considered if the number of projected yearly flight operations is greater than $1000d^2$. For military installations or air space usage such as practice bombing or firing ranges, which might pose a hazard to the site, the hazard will be considered if there are such installations within 30 km of the proposed site.

— For Type 3 events, the probability of crashes of civil aircraft near air traffic control corridors should be carefully examined, but in general for areas outside air traffic control corridors this probability decreases markedly and it is usually smaller than the specified SPL (for example, 10^{-7}/a). This is not necessarily true for military aircraft which may not follow programmed flight plans or flight regulations.

DETAILED EVALUATION

5.7. When a detailed evaluation is necessary, the probability of an aircraft crashing in the region should be determined for each class of aircraft considered (small, medium and large civil and military aircraft) by using the aircraft crash statistics called for in Section 3. The results should be expressed in the form of crashes per year per unit area. This probability will be a function of site location in relation to the airport runways. Crashes are more likely to occur within the last three or four kilometres before the extreme landing perimeter of the runway, and in sectors oriented within about 30° either side of the runway axis.

5.8. The estimated probability of an aircraft crash affecting the plant may be determined in terms of crashes per year per unit area multiplied by an effective area for damage to items important to safety.

5.9. The size of the effective area depends on: the average angle of the trajectory relative to the horizontal; the plan areas of the relevant structures and their heights; other areas relating to items important to safety; and allowances to be made for the size of the aircraft.[12] In calculating target areas, allowance should be made for skidding. A skid length of several hundred metres is possible though the aircraft's momentum would be significantly reduced. Skidding impacts are only possible at low descent angles; they are unlikely to occur for angles of above 15°.

5.10. The steps to be taken after this detailed evaluation are described in Section 4.

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[12] Some States have decided to design all nuclear power plants against aircraft crashes, having found a probability of about 10^{-6} per year for aircraft crashing on an area of 10 000 m^2 anywhere in the country. Consequently, a single idealized load function for a certain type of aircraft has been derived that is accepted as representative of aircraft crashes for design purposes in those States. In other States, figures of 10 000 m^2 to 40 000 m^2 have been used for the effective area. In the calculation of these values, trajectory angles of 10°–45° to the horizontal have been assumed.

HAZARD EVALUATION

Design basis events

5.11. For several types of aircraft the probability of a crash at any given site may be equal to or greater than the DBPV. The plant should be protected against crashes of aircraft of any type. General assurance is provided if the plant is protected against the aircraft crash that would be expected to produce the most severe consequences for the plant.

5.12. The plant layout — and particularly the physical separation and the redundancy of items important to safety, especially for vulnerable parts of the plant — should also be taken into consideration. This contributes to the basis for deciding whether or not an acceptable engineering solution is possible.

5.13. When the probability of an aircraft crash is equal to or exceeds the DBPV, the severity of the effects should be determined. In addition, for the deterministic assumption of a reference aircraft crash that envelops a set of possible scenarios (see para. 4.11), a detailed analysis of the effects induced should be carried out, with consideration given to local structural effects, direct damage by primary and secondary missiles, induced vibrations and effects caused by the fuel. Examples of effects that should be considered and included in the design basis are set out below.

Primary impact and secondary projectiles

5.14. The evaluation of the effects of an aircraft crash should include analyses of the potential for structural failure due to shearing and bending forces, for perforation of the structure, for spalling of concrete within structures and for the propagation of shock waves that could affect items important to safety.

5.15. A crashing aircraft may break up into parts which become separate projectiles with their own trajectories. An analysis should be made on the basis of engineering judgement of the projectiles that could be produced and their significance, with due regard for the possibility of simultaneous impacts on separate redundant systems. In special circumstances the effects of secondary projectiles should be considered.

Effects caused by aircraft fuel

5.16. The following possible consequences of the release of fuel from a crashing aircraft should be taken into account:

— burning of aircraft fuel outdoors causing damage to exterior plant components important to safety;
— the explosion of part or all of the fuel outside buildings;
— entry of combustion products into ventilation or air supply systems;
— entry of fuel into buildings through normal openings, through holes caused by the crash or as vapour or an aerosol through air intake ducts, leading to subsequent fires, explosions or side effects.

Design basis parameters

5.17. The design basis parameters for the direct impact of an aircraft on the plant's structures may be defined to different levels of detail depending on the level necessary for the final evaluation. This will depend on the importance of this event for the design of the specific plant and for the degree of conservatism assumed in the entire design process. Two examples are as follows:

— Distribution of mass and stiffness along the aircraft concerned (one or more), nose shape, area of impact, velocity and angle of incidence — when the structural evaluation includes detailed local analyses of the potential for structural failure due to shearing and bending forces, for spalling and scabbing of concrete within the structures, and for perforation of the structures.
— A load–time function, which may be independent of the specific aircraft and representative of a class of aircraft, with associated mass, velocity and application area when the structural evaluation includes only a preliminary screening of local effects in comparison with other design events, or for a generic evaluation of the induced vibration effects on structures and components.

5.18. The type of fuel and the maximum amount of fuel potentially involved in an accident should always be evaluated in order to quantify the fire interaction effects and correlate them with the potential structural damage. The amount of fuel should be evaluated for this purpose on the basis of the type of aircraft and typical flight plans.

5.19. Estimation of the same quantities may be necessary also for parts of an aircraft that have become separated to form secondary projectiles.

5.20. Load–time functions developed for some types of aircraft may be useful in the site selection process or for assessment of the design. For examples of standard load–time functions, see Ref. [2].

6. RELEASE OF HAZARDOUS FLUIDS

GENERAL

6.1. Section 6 deals with hazardous fluids (explosive, flammable, corrosive and toxic, including liquefied gases) which are normally kept in closed containers but which upon release could cause a hazard to items important to safety and to human life. This subject should be given particular attention in view of the potential release of the following substances:

- — Flammable gases and vapours which can form explosive clouds and can enter ventilation system intakes and burn or explode,
- — Asphyxiant and toxic gases which can threaten human life and impair crucial safety functions,
- — Corrosive and radioactive gases and liquids which can threaten human life and impair the functionality of equipment.

6.2. Initiating events and dispersion mechanisms are discussed in Section 6. Explosive effects (if they are a concern) are then discussed in Section 7. The mechanisms of interaction with the nuclear power plant differ greatly from one event to another (see Table I), but the propagation phenomena can be discussed for the entire range of hazardous substances. Toxic, corrosive and asphyxiant effects are considered in the design stage and are covered in other Safety Guides.

PRELIMINARY SCREENING FOR HAZARDOUS LIQUIDS

6.3. Activities and facilities involving the processing, handling, storage or transport of flammable, toxic or corrosive liquids within the SDV should be identified. The SDV selected will depend on a number of factors such as the physical properties of the substance, the regional topography and the type and extent of industrialization. It is usually close to the SDV used for the fixed sources of explosions (see Section 7).

6.4. If the potential hazard within the SDV to items important to safety arising from these activities and facilities is less than that due to similar materials to be stored on the site and against which protection has been provided, then no further investigation should be carried out. Otherwise the potential hazards due to off-site activities should be evaluated using in the first instance a conservative and simple deterministic approach.

DETAILED EVALUATION FOR HAZARDOUS LIQUIDS

6.5. If there are sources of hazardous liquids that have not been eliminated in the preliminary evaluation, a more detailed evaluation of the potential hazard from these sources should be made.

6.6. The locations of the sources of liquid should be identified and the maximum inventory, quantity in store or amount otherwise contained should be determined for each facility.

6.7. The probability of rupture of a container or of any leak from the facility store should be evaluated.

6.8. The maximum quantities of hazardous liquids that could be released, the rate of release and the related probability of release should be evaluated as a worst possible case.

6.9. The probability of release of a hazardous liquid from a mobile source in transit within the SDV should be evaluated on the assumption that the maximum quantity being transported is released. If a more precise evaluation is necessary, the quantity to be assumed should be assessed on the basis of the probabilities of the different quantities being present at the same time in the release. Mobile sources, such as barges and ships carrying large amounts of hazardous liquids within the SDV, should be assumed to become stranded at the point of approach to the nuclear power plant for which the most unfavourable effects would result.

6.10. An important route for hazardous interaction with the nuclear power plant is provided by the water intake; danger may arise owing to spillage at an adjacent plant or tanker accidents, often after an uncontrolled drifting. Parameters for the dilution and dispersion of the liquid and its entry into the water intake should be evaluated and the nuclear power plant should be adequately protected. Consideration should be given to the fact that spillage of explosive or highly flammable liquids on water may produce floating pools, which may approach a nuclear power plant on the shore or along a river bank. A conservative estimate should be made and dispersion characteristics should be considered. Consideration should also be given to the possibility that liquids with low flash points may be extracted from contaminated sources of intake water.

6.11. The nearest point to the nuclear power plant where hazardous liquids may collect in pools should be determined, with account taken of the topography of the land and the layout of the plant.

6.12. The probabilities of hazardous interactions with items important to safety and with personnel should then be evaluated.

HAZARD EVALUATION FOR HAZARDOUS LIQUIDS

Design basis event

6.13. The location and size of, and the flow paths to and from, any pool formed by hazardous liquids should be determined and the associated hazards to the nuclear power plant should be assessed.

6.14. It may be possible to prevent the flow of liquid towards the nuclear power plant by means of engineered structures such as earthworks. For a fixed source such a barrier may be constructed in its immediate vicinity and the hazard to the nuclear power plant would thereby be reduced.

Design basis parameters

6.15. The important parameters and properties that should be established for inclusion in the design basis for protection of the nuclear power plant against hazardous liquids are as follows:

- amount of liquid,
- surface area of the pool,
- chemical composition,
- concentration (corrosion potential),
- partial pressure of vapours,
- boiling temperature,
- ignition temperature,
- toxicity.

GENERAL REMARKS FOR GASES, VAPOURS AND AEROSOLS

6.16. Gases, vapours and aerosols from volatile liquids or liquefied gases may, upon release, form a cloud and drift. The drifting cloud may affect the nuclear power plant in the following two ways:

- When the cloud remains external to the plant (either near the source or after drifting) it is a potential hazard similar to some of the other external human

induced events considered in this Safety Guide (fires, explosions and related effects).
- The cloud can permeate plant buildings, posing a hazard to personnel and items important to safety, particularly for a cloud of toxic, asphyxiant or explosive gas. It can also affect the habitability of the control room and other important plant areas.

6.17. The most practical method of defence against a hazard of this type is to ensure protection from the potential source by means of distance.

6.18. Clouds of toxic or asphyxiant gases can have severe effects on the personnel of a nuclear power plant. Corrosive gases can damage safety systems and may, for example, cause loss of insulation in electrical systems. These matters should be given careful consideration.

6.19. Meteorological information should be taken into account in estimating the danger due to a drifting cloud as local meteorological conditions will affect dispersion. In particular, dispersion studies based on probability distributions of wind direction, wind speed and atmospheric stability class should be made.

6.20. For the postulated event of an underground release of hazardous gases or vapours, consideration should be given to escape routes and to seepage effects which may result in high concentrations of hazardous gases in buildings or the formation of hazardous gas clouds within the SDV.

PRELIMINARY SCREENING FOR GASES, VAPOURS AND AEROSOLS

6.21. The surroundings of the nuclear power plant should be examined for the purpose of identifying all possible sources of hazardous clouds within the SDV.[13] Particular attention should be paid to the following sources:

- chemical plants,
- refineries,
- above ground and underground storage systems,
- pipelines for volatile liquids, gases and liquefied gases,
- transport routes and their associated potential sources external to the SDV on which hazardous clouds may be generated.

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[13] In some States an SDV in the range of 8–10 km is used for the sources of hazardous clouds.

6.22. The preliminary evaluation is intended to screen out those facilities and activities to which no further consideration should be given. The criteria should be conservative and simple in their application; for example, by taking account of the existence of similar, larger potential sources closer to the site and the quantities of materials to be stored on the site. The first step in this evaluation should be based on the assumption that the maximum inventories of the plant and the storage area are involved.

6.23. A conservative and simple method should be adopted in the first step of the preliminary evaluation for mobile sources within the SDV also. The maximum amount of hazardous material that may reach the point of the greatest potential hazard to the nuclear power plant for a given transport system should be determined, and this amount should be assumed to be present for any incident that may occur. The effects of interacting events on the plant should be evaluated and if they are not significant they should be given no further consideration. Particular care should be exercised in the consideration of explosive clouds since theory concerning the behaviour of such clouds is still developing.

6.24. If further consideration is necessary, the evaluation should be progressively refined to yield the probability of occurrence of an interacting event, with account taken of the frequency of passage of hazardous shipments and the probability of an accident during such a passage. If the resultant probability of occurrence of the interacting event is greater than the SPL, a more detailed evaluation should be made.

6.25. The potential sources that are not eliminated by this initial screening process should be given consideration in the detailed evaluation.

DETAILED EVALUATION FOR GASES, VAPOURS AND AEROSOLS

6.26. In the detailed evaluation the probability of occurrence of an interacting event due to gas clouds — that is, the probability that flammability or toxicity limits are exceeded — should be assessed and the following factors should be taken into consideration:

— the probability of occurrence of the initiating event (for example, pipe rupture);
— the quantity of material released and the release rate;
— the probability that a cloud will drift towards the nuclear power plant;
— the dilution due to atmospheric dispersion;
— the probability of ignition for explosive clouds.

For factors (3) and (4), the probability distributions of wind direction, wind speed and atmospheric stability classes should be considered, unless conservative values are assumed for these parameters. For underground releases, seepage effects should be taken into account.

6.27. The steps to be followed after the detailed evaluation of the probability that toxicity or flammability concentration limits may be exceeded at the nuclear power plant are set out in Section 4.

HAZARD EVALUATION FOR GASES, VAPOURS AND AEROSOLS

6.28. In evaluating the hazard associated with drifting clouds of hazardous gases, vapours or aerosols, the probability of occurrence and the characteristics of the interacting event should be considered. The interaction could consist of the generation of significant levels of airborne toxic substances in the nuclear power plant or of flammable or explosive substances inside or outside the plant. The associated effects of clouds of these types on the safety of the plant should be evaluated in each case and a design basis event for each type should be established.

Generation of drifting clouds of hazardous gases, vapours or aerosols

6.29. For evaluating the generation of a drifting cloud of hazardous gases, vapours or aerosols and its interaction with items important to safety, distinctions should be drawn between the following:

— subcooled liquefied gases; and
— gases liquefied by pressure and non-condensable compressed gases.

Gases in group (1) are kept, generally, in insulated containers at very low temperatures, while gases in group (2) are maintained at ambient temperatures.

Subcooled liquefied gases

6.30. Usually the release of a subcooled liquefied gas will occur as a steady leak over a considerable period of time (at a given leak rate), but the possibility of an effectively instantaneous release (a total sudden release) should also be considered, depending on the following conditions associated with the release:

— the type of storage container and its associated piping;
— the maximum size of the opening from which the material may leak;

— the maximum amount of material that may be involved;
— the relevant circumstances and mode of failure of the container.

6.31. The starting point for the detailed analysis is the evaluation of a range of leak rates and related failure probabilities or the total amount of material released and the related failure probability. If a large amount of subcooled liquefied gas is released, much of it may remain in the liquid phase for a long time. It should be treated as a liquid throughout this period, although a fraction will vaporize almost instantaneously.

6.32. The characteristics of the pool formed by the liquid, such as its location, surface area and evaporation rate, should be evaluated, with account taken of the wind speed and the permeability and thermal conductivity of the soil (if the spillage occurs on soil). Where applicable, any ponds or catchment areas should be surfaced with low conductivity materials to confine spilled liquids.

6.33. To evaluate the maximum concentration at the site, the models presented in Ref. [12] may be used. They should be used with caution, since often the gases released are at a very low temperature and the models are not strictly applicable to a gas–air mixture of negative or positive buoyancy.

Gases liquefied by pressure and non-condensable compressed gases

6.34. The formation of a large cloud is more likely for gases liquefied by pressure and non-condensable compressed gases than it is for subcooled liquefied gases. The detailed analysis is easier because the source is more easily defined and in some cases dispersion of the cloud is governed by simpler phenomena.

6.35. As with subcooled liquefied gases, the release should be characterized by a leak rate or by a sudden total release, and a similar evaluation should be carried out. The assumptions to be used will depend on the type of storage tank, the process vessels, their associated piping and the associated failure probability.

6.36. In making an appropriate assumption for the amount of material available to be released in the event of an accident, account should be taken of the time interval before action is taken to stop the leak. For example, pipeline valves may close automatically, thus isolating the ruptured section.

6.37. With buried pipes, the soil cover is usually insufficient to prevent the escape of gases released from the pipes. Seepage may occur or gas may escape through fractures or discontinuities. In all cases, when the characteristics of the gaseous release to the atmosphere have been established, a model should be selected to determine the dispersion of the gas towards the nuclear power plant site. Attention should be given to the meteorological conditions assumed at the time of formation of the cloud and during its dispersion in the atmosphere. Owing to the uncertainty in other factors, such as the amount and the rate of the release, it may be sufficient to use a simplified dispersion model derived for an average site.

Design basis parameters

6.38. The calculated concentrations should be compared with reference concentrations that depend on the characteristics of the material and of the hazard. For flammable or explosive clouds the reference concentration is the lower limit of flammability. For toxic material the toxicity limits are the reference concentrations.

6.39. For a toxic, corrosive or flammable cloud the following are important characteristics relevant to the design:

— chemical composition,
— concentration with time and distance,
— toxicity limit and asphyxiant properties,
— flammability limit.

7. EXPLOSIONS

GENERAL CONSIDERATIONS

7.1. Section 7 deals with explosions of explosive solid, liquid or gaseous substances at or near the source. For the purposes of evaluating the dispersion, as mentioned earlier, moving clouds of explosive gases and vapours are also considered.

7.2. The word explosion is used in this Safety Guide broadly to mean any chemical reaction between solids, liquids, vapours or gases which may cause a substantial rise in pressure, possibly owing to impulse loads, drag loads, fire or heat. An explosion can take the form of a deflagration, which generates moderate pressures, heat or fire, or a detonation, which generates high near field pressures and associated drag loading but usually without significant thermal effects. Whether or not the ignition of a particular chemical vapour or gas causes a deflagration or a detonation in air depends primarily on the concentration of the chemical vapour or gas. At concentrations two to three times the deflagration limit, detonation can occur. The deflagration limit and therefore the related effects are in general related to the burning velocity.

7.3. For a gas cloud, there is evidence that the maximum burning velocity (relative to the non-burning gases) increases with the size of the gas cloud and that there is an upper limit for the burning velocity for homogeneous mixtures. This limit seems to be a function of the power of ignition and the turbulence induced by different obstacles. For deflagrations in free air and in the absence of significant turbulence, the burn velocity will probably not exceed some tens of metres per second. The chemical reaction will form a pressure wave travelling with a velocity close to the speed of sound, creating a peak overpressure of a few tenths of a bar (up to approximately 0.3 bar or 30 kPa) in the incident wave. With a moderate amount of confinement and for a saturated hydrocarbon such as butane, the burn velocity will be higher and deflagration overpressures of 1 bar are obtainable. If more reactive fuels such as ethylene are present in the maximum free field conditions — that is, where the pressure wave may propagate without interactions with structures — pressures may rise to 5 bar or more. It is also possible that ignition of a gas cloud initiates a deflagration, which owing to turbulence or partial confinement (for example, multiple reflection) becomes a detonation affecting only a limited volume. In this case, an overpressure of between a few tenths of a bar (a few tens of kilopascals) and 20 bar (about 2 MPa) may be generated in the surrounding space.

7.4. In a detonation of solid substances and/or a partial detonation of a fuel–air gas or vapour mixture, the reaction is shock induced, will travel at velocities higher than the speed of sound and will produce high peak overpressures. With high explosives (such as trinitrotoluene (TNT)) the pressure peaks in the near field may be of the order of 1000 bar (100 MPa). However, at standoff ranges of interest, the overpressure will probably be less than 0.5 bar. Engineering relationships should be used for determining the correlation between the pressure peak, the explosive yield and the distance from the explosion.

7.5. In evaluating the potential for explosions, all potential sources lying within the SDV should be taken into consideration, as described in Section 3. This process should permit the evaluation, for each identified source, of the following parameters:

- The nature and maximum amount of the material that may simultaneously explode,
- The distance and orientation from the explosion centre to the site,

where the explosive mass is usually expressed in terms of TNT equivalent mass for generic explosive substances.

7.6. An explosion will cause a pressure wave to propagate away from the source, in which the shock front moves with supersonic velocity. The evolution in time of the overpressure, that is, the pressure above the initial atmospheric pressure, should be determined using standard procedures. The pressure at any fixed point in the free field — that is, the pressure that would be registered if the pressure wave were free to propagate without the presence of interacting structures — is designated as side-on or incident overpressure. Upon reflection of the pressure wave by interacting obstacles, the overpressure may increase several times and is designated as reflected overpressure.[14]

PRELIMINARY EVALUATION FOR STATIONARY SOURCES OF EXPLOSIONS

7.7. If on the basis of past experience or available information it is established that the nuclear power plant under consideration could safely withstand a sudden incident overpressure, then the SDV for any initiating event should be determined by calculating the scaled distance corresponding to that overpressure.[14]

7.8. The SDV associated with explosions should be estimated by means of a simplified conservative approach based on the engineering relationship between the TNT equivalent mass and the distance.

7.9. After identification and evaluation of the basic parameters of the explosion, the potential sources of explosions should be preliminarily assessed by simple deterministic methods applied conservatively with the aim of deciding whether further consideration should be given. Detailed analyses should be made of the potential hazards due to the sources not screened out in order to arrive at a design basis event or to exclude explosions from further consideration.

7.10. It is usually enough to determine the potential hazard from the dominant source of a given type in the vicinity of the nuclear power plant and to demonstrate that it provides an envelope for all sources of the same type. The analysis of the potential for effects on items important to safety should proceed in stages with increasing levels of detail.

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[14] In one State it is assumed that a typical plant does not need any analysis for reflected overpressures of less that 0.07 bar, for which SDV = $18W^{1/3}$ (W in kg, SDV in m). Other States simply adopt an SDV for explosions in the range of 5–10 km.

7.11. If the site is located within the SDV, an evaluation of the probability of occurrence of the explosion should be undertaken. The probability of an explosion occurring at hazardous industrial plants, refineries and storage depots is usually higher than the SPL. Unless there is adequate justification, a conservative assumption should be made that the maximum amount of explosive material usually stored at the source will explode, and an analysis should then be made of the effects of interacting events (incidence of pressure waves, ground shock and projectiles) on items important to safety. The secondary effects of fires resulting from explosions should also be considered, as discussed in Section 8.

7.12. The evaluation of the probability of occurrence of an explosion necessitates data on the relative frequency of explosions in industrial and military installations or transport routes in the site vicinity. If such information is not available, reference should be made to global statistics and/or to expert opinion after technical inspections of the potential sources in the vicinity of the site.

DETAILED EVALUATION FOR STATIONARY SOURCES OF EXPLOSIONS

7.13. If facilities exist or activities take place within the SDV in which the amount of explosive material is large enough to affect safety and the probability of occurrence of an explosion is higher than the SPL value, then a more detailed evaluation should be made in order to establish a design basis event. If as a result of the detailed evaluation using more specific data the calculated probability of occurrence of a postulated explosion exceeds the DBPV, a design basis explosion should be determined.

7.14. For the purposes of evaluating the importance of the interacting event, the protection necessary against the design basis explosion should be compared with that already provided against overpressures from other external events such as extreme winds and tornadoes.

PRELIMINARY EVALUATION FOR MOBILE SOURCES OF EXPLOSIONS

7.15. If there is a potential for explosions within the SDV on transport routes, the potential effects should be estimated. If these effects are significant, the frequency of shipments of explosive cargoes should be determined. The probability of occurrence of an explosion within the SDV should be derived from this, and if it is less than the SPL no further consideration should be given. Particular attention should be paid to the potential hazards associated with large explosive loads such as those transported on railway freight trains or in ships.

7.16. Appropriate methods for calculating the probability of an explosion should be used. If there are not enough statistical data available for the region to permit an adequate analysis, reference should be made to global statistics, to pertinent data from similar regions and/or to expert opinion, after technical inspections of the potential sources in the site region.

DETAILED EVALUATION FOR MOBILE SOURCES OF EXPLOSIONS

7.17. If the probability of an explosion within the SDV is greater than the SPL, a detailed evaluation should be made using specific and detailed data from the potential sources in the vicinity of the site. The consequences of an explosion should first be evaluated for a simplified case on the basis of the assumption that, for a given transport route, the total amount of explosive material that is transportable in one shipment explodes at the point of approach for which the most adverse effects on items important to safety are produced. If the consequences for this simplified case have an unacceptable impact on items important to safety, more information should be collected and improved assumptions should be made concerning the quantity of explosive as well as the probability of its exploding at any specific point along the route.

HAZARD EVALUATION

7.18. The pressure waves, drag level and local thermal effects at the plant would differ according to the nature and amount of the explosive material, the configuration of the explosive, meteorological conditions, the plant layout and the topography. Certain assumptions are usually made to develop the design basis for explosions, with data on the amounts and properties of the chemicals involved taken into account. TNT equivalents are commonly used to estimate safe distances for given amounts of explosive chemicals and for a given pressure resistance of the structures concerned. For certain explosive chemicals, the pressure–distance relationship has been determined experimentally and should be used directly.

7.19. Projectiles that may be generated by an explosion should be identified by using engineering judgement and taking into account the source of these projectiles. In particular, the properties of the explosive material concerned and the characteristics of the facility in which the explosion is assumed to occur should be considered.

7.20. Consideration should also be given to possible ground motion and to other secondary effects such as the outbreak of fire, the release or production of toxic gases and the generation of dust.

7.21. For the established design basis explosion the following parameters should be determined:

— the properties of the exploding substance;
— the properties of the pressure waves (maximum side-on or incident and reflected overpressures and evolution with time of the pressure wave);
— the properties of the projectiles generated (material, size, impact velocity);
— the ground shock, especially for buried items.

It should be noted that the layout of structures at the site can result in substantial superposition of reflected pressure waves with a resultant increase in the pressure. Some knowledge of the conceptual or preliminary design of the proposed plant should be acquired for the purpose of establishing the design basis. The design basis will then be reviewed in the design stage or in the design assessment stage.

8. OTHER EXTERNAL HUMAN INDUCED EVENTS

GENERAL

8.1. In addition to the three main types of external human induced events, namely those due to aircraft crashes, explosions and hazardous fluids, there may be other types of interacting event which can result from external human induced events. Fires are one such type which may be common to a number of external human induced events. In particular, fires may be caused by an event such as an aircraft crash or a chemical explosion.

FIRES

8.2. A survey should be made at and around the site to identify potential sources of fire, such as forests, peat, storage areas for low volatility flammable materials (especially hydrocarbon storage tanks), wood or plastics, factories that produce or store such materials, their transport lines, and vegetation.

8.3. The area to be examined for the possible occurrence of fires that may affect items important to safety should have a radius equal to the SDV for this type of hazard.[15]

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[15] This radius is some 1–2 km from the nuclear power plant.

8.4. The precautions taken to protect the nuclear power plant against internal fires also offer some protection against external fires and should be taken into account in evaluating the effects of external fires on the plant.

8.5. The protection provided against fire hazards at the source of the fire should also be taken into account. For example, automatic sprinkler systems or the presence of permanent local fire fighters can reduce the probability of a serious fire.

8.6. The main fire related hazard to the nuclear power plant site is the burning of parts of the plant and the resulting damage. Local structural collapse may occur. Smoke and toxic gases may affect plant operators and certain plant systems. Particular attention should be paid to sources causing possible common mode failures. For instance, the off-site emergency power supply could be interrupted by fire, while the emergency diesel generators may fail to function owing to smoke being drawn into their air intakes.

8.7. The possibility should be considered that emergency access may be prevented and escape routes may be cut off by a large fire.

8.8. Parameters and properties that define the magnitude of a fire are:

— the maximum heat flux,
— the magnitude of hazards from burning fragments and smoke,
— the duration of the fire.

8.9. It should be taken into consideration that the heat flux is inversely proportional to the distance from the fire, although other factors may affect this relationship.

SHIP COLLISION

8.10. Ship collision may constitute a particular hazard to the water intake structures of a nuclear power plant.

8.11. If the ship collision probability is found to be greater than the SPL, a detailed analysis should be conducted to assess the consequences of such an impact. In such an analysis, the simulation of uncontrolled drifting of ships and recreational boats (especially sailing vessels) should be conducted, according to the direction of dominant winds and currents. The collision of large ships in normal cruising can usually be screened out by the implementation of administrative measures and safeguards.

8.12. Important parameters that should be analysed are:

— impact velocity,
— impact area,
— mass and stiffness of the ship,
— substances transported,
— potential secondary effects such as oil spills and explosions.

ELECTROMAGNETIC INTERFERENCE

8.13. Electromagnetic interference can affect the functionality of electronic devices. It can be initiated by both on-site (high voltage switchgear, portable telephones, portable electronic devices, computers) and off-site sources (radio interference, the telephone network).

8.14. The presence of central telephone installations close to the site could give rise to specific provisions for the design stage, but usually such high frequency waves do not represent exclusion criteria for sites since specific engineering measures for the qualification of equipment should be taken in the design stage and administrative procedures should be adopted on site to avoid local interference.

8.15. In the site evaluation stage, potential sources of interference should be identified and quantified (for example, intensity, frequency). They should be monitored over the lifetime of the plant for the purpose of ensuring the proper qualification of plant components.

9. ADMINISTRATIVE ASPECTS

9.1. In compliance with the current requirements in some States, the competent national authority should give due consideration to the present and future development of activities in the region that may give rise to external human induced events, taking into account the required degree of protection of the nuclear power plant.

9.2. The means of effecting controls on development and the extent to which they are exercised are still under consideration in the States concerned, but it is envisaged that where they are to be used they may be necessary from the time a site is selected.

9.3. When the source of an induced external event is found to be within the SDV or to have a higher probability of occurrence than the SPL, and in cases for which it is not practicable to regard the event as a design basis event for the nuclear power plant, consideration may be given to controlling the distance and/or the size of the source in such a way that it will always be outside the SDV or always have a probability of occurrence lower than the SPL. This entails administrative control by a competent authority. The effectiveness of the administrative control should be monitored over the lifetime of the plant and periodically reassessed [4, 5, 10].

9.4. Dedicated monitoring systems should be designed and operated at the site to confirm the site evaluation and design assumptions and to prevent the evolution of initiating events into nuclear accidents. To this extent, specific operational procedures should be set up for real time monitoring and operator action following an accident caused by an external human induced event.

9.5. Public acceptance issues may strongly affect the site evaluation phase and should be given due consideration.

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[a] A revision of this publication is in preparation.

GLOSSARY

conditional probability value (CPV). The upper bound for the conditional probability that a particular type of event will cause unacceptable radiological consequences. The term is used in the detailed event screening process for site evaluation.

design basis probability value (DBPV). A value of the annual probability for a particular type of event to cause unacceptable radiological consequences. It is the ratio between the SPL and the CPV. The term is used in the detailed event screening process for site evaluation.

initiating event. An identified event that leads to anticipated operational occurrences or accident conditions and challenges safety functions.

interacting event. An event or a sequence of associated events that, interacting with a facility, affect site personnel or items important to safety in a manner which could adversely influence safety.

postulated initiating events. An event identified during design as capable of leading to anticipated operational occurrences or accident conditions. The primary causes of postulated initiating events may be credible equipment failures and operator errors (both within and external to the facility), human induced or natural events.

screening distance value (SDV). The distance from a facility beyond which, for screening purposes, potential sources of a particular type of external event can be ignored.

screening probability level (SPL). A value of the annual probability of occurrence of a particular type of event below which, for screening purposes, such an event can be ignored

site evaluation. The analysis of the sources of external events for a site that could give rise to hazards with potential consequences for the safety of a nuclear power plant constructed on that site.

siting. The process of selecting a suitable site for a facility, including appropriate assessment and definition of the related design bases.

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Briefing Note – Darlington NGS
For meeting with OPG, November 28, 2005

Background:

- The first reactor went into power operation in early 1990.
- The operating licence was renewed for a 5 year period on 1 April 2003.
- Darlington is subject to age-related degradation similar to other CANDU reactors.
- The most significant age-related degradation issue is the localized thinning of feeder pipes in the Heat Transport System due to flow accelerated corrosion (FAC).
- OPG has a number of initiatives underway to mitigate feeder thinning before the projected date for reactor refurbishment (fuel channel replacement).
- If the initiatives are successful, the first refurbishment outage at Darlington is likely to be required about

Current Situation:

- OPG has given notice to the CNSC (letter 5 November 2005) of its intent to refurbish Darlington NGS and Pickering B NGS.
- OPG plans to begin making investment decisions regarding refurbishment in 2008. The decisions for Darlington are likely to be made in the 2009 – 2010 timeframe.
- As input to the investment decisions, OPG needs the results of the screening level environmental assessment and the results of the CNSC's "consideration of the results of OPG's safety review to confirm the ongoing safe operations of the station".
- To meet OPG's timeframe, both the environmental assessment and the consideration of OPG's safety review will need to be completed by early 2008. This imposes new demands on CNSC resources which are earlier than anticipated in current plans.

Prospect for New Build:

- OPG has two potential sites that may be available for a new build:
    - Darlington – The site is sized to accommodate two 4 unit stations. The advantage of this site is that it is virtually ready for construction to begin. However, major population areas are beginning to encroach on the site.
    - Wesleyville – The site is on Lake Ontario some distance east of Darlington and was originally intended for a large fossil fired plant. Construction was started but abandoned before major equipment was installed. The buildings still remain and have been used as a warehouse. The advantage of this site is that it is further removed from major population areas compared to Darlington.

Prepared by: G. Schwarz
Reviewed by: Ian M. Grant

Approved by : ______________________ 24 November 2005
J.K. Pereira — Date

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Report

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Darlington NGS
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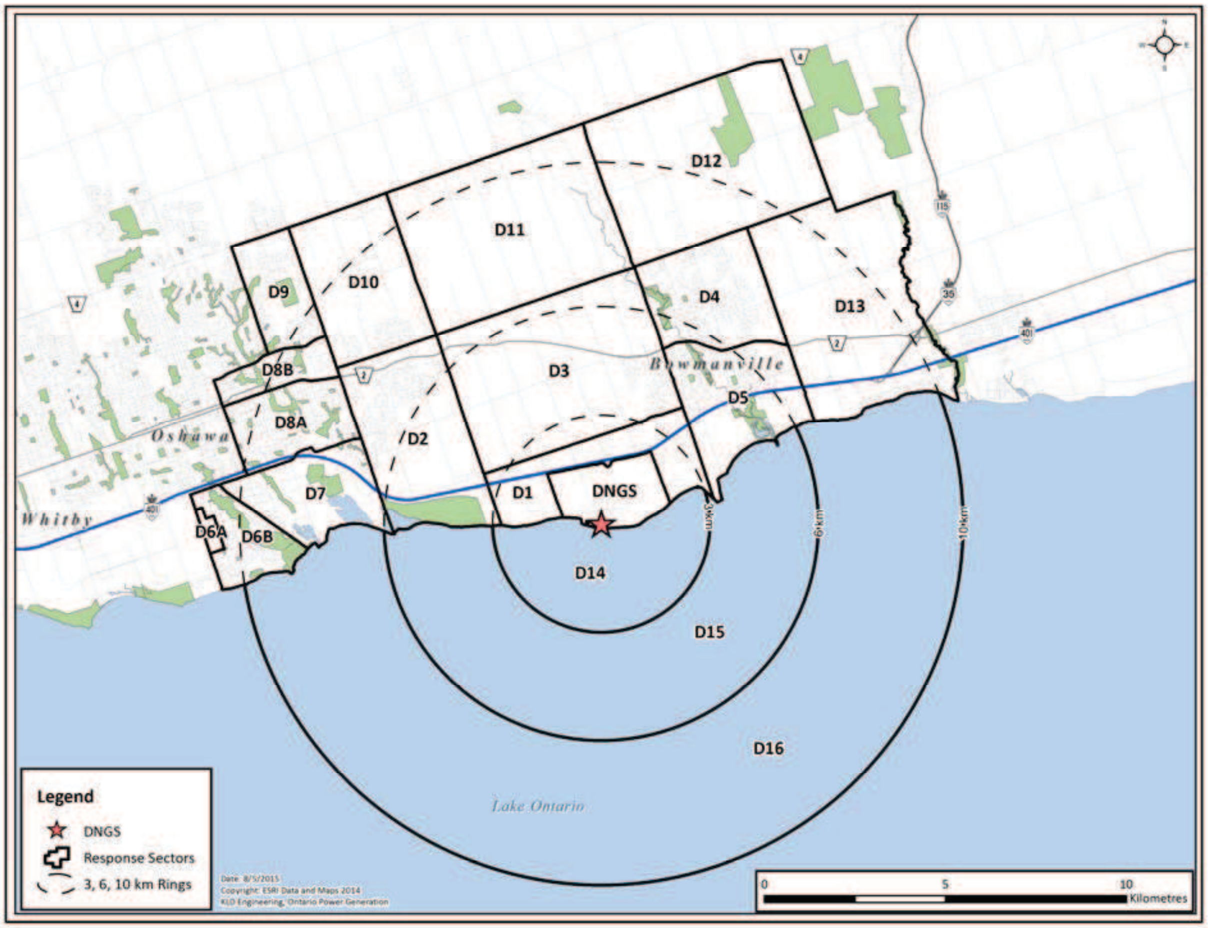
DARLINGTON NUCLEAR GENERATING STATION

Development of Evacuation Time Estimates



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EXECUTIVE SUMMARY

This report describes the analyses undertaken and the results obtained by a study to develop Evacuation Time Estimates (ETE) for the Darlington Nuclear Generating Station (DNGS) located in the Municipality of Clarington in Durham Region, Ontario. ETE provide OPG, the Province, and the Region with the estimated times to evacuation the Primary Zone (PZ) and various subsets of the PZ.

A traffic/evacuation simulation model is used to compute ETE using the procedure shown in Figure ES-1. The supply input to the model is in the form of a link-node analysis network – a computerized replica of the roadway system within the study area (a circle centered at DNGS with a radius of 15 km). The link-node analysis network is calibrated to include roadway characteristics such as free speed (speed that drivers are comfortable traveling at in the lack of traffic congestion), number of lanes, type of traffic control (signal, stop sign, manned), etc. Resident population from 2011 Statistics Canada data and employee and transient data provided by Durham Region and phone calls to individual facilities are used to compute the evacuation vehicle demand. The supply and demand are fed into the Dynamic Traffic Simulation Model (DYNEV-II). The two main outputs of the DYNEV-II model are ETE for general population (evacuees with personal vehicles) and route-specific evacuation speeds, which are used to compute the ETE for special facilities (schools, medical facilities, etc.) and the transit-dependent population.

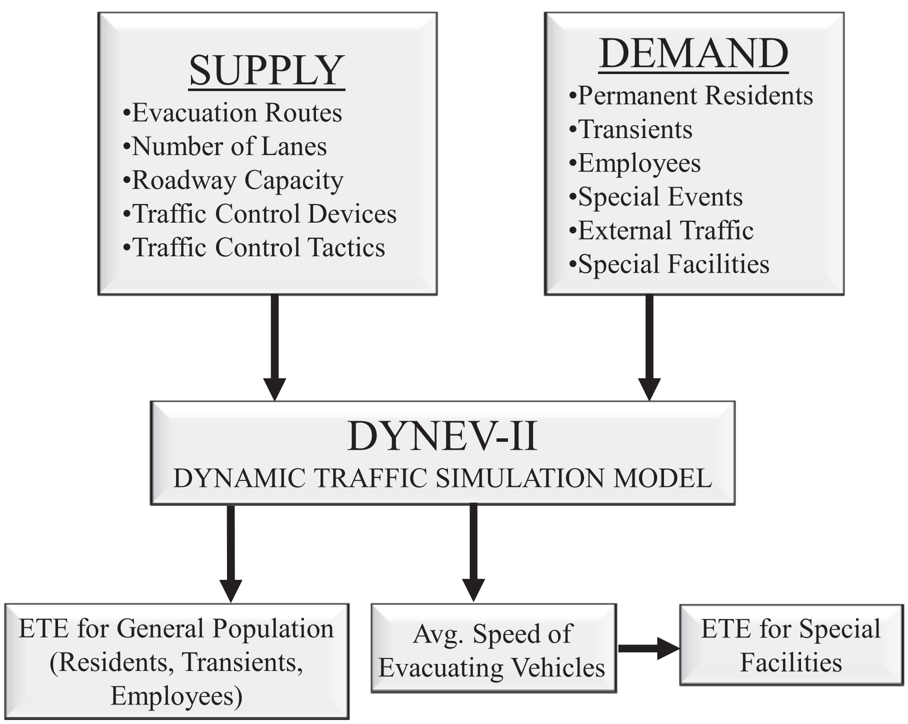

Figure ES-1. ETE Methodology

The general population ETE are presented in Tables 7-1 and 7-2. These data are the times needed to clear the indicated regions of 90 and 100 percent of the population occupying these regions, respectively. For definitions of scenarios (demand changes due to temporal variations) and regions (area to be evacuated varies with wind direction and speed), see Section 6 and Appendix H, respectively. These computed ETE include consideration of mobilization time and of estimated voluntary evacuations from other regions within the PZ and from the Shadow Region (area extending from the PZ boundary to 15 km radially from the plant). Critical findings of the study include:

- The ETE computed for this study are shorter than the ETE computed in the previous study (2009). This reduction in ETE is the result of changes in study assumptions based on recently published guidelines for developing ETE studies, and of more accurate demand data.
- General population ETE were computed for 364 unique cases – a combination of 26 unique Evacuation Regions and 14 unique Evacuation Scenarios. Table 7-1 and Table 7-2 document the ETE for the 90th and 100th percentiles. These ETE range from 1:55 (hr:min) to 3:40 at the 90th percentile and from 4:15 to 4:55 at the 100th percentile.
- Inspection of Table 7-1 and Table 7-2 indicates that the ETE for the 100th percentile are significantly longer than those for the 90th percentile, ranging from 1:05 to 2:45. This is the result of the slight traffic congestion and long mobilization tail. See Section 7.
- Inspection of Table 7-3 and Table 7-4 indicates that a staged evacuation protective action strategy provides no benefit to evacuees from within the contiguous (3km) zone and adversely impacts many evacuees located beyond the contiguous zone. See Section 7.6 for additional discussion.
- Comparison of Scenarios 9 (winter, weekend, midday) and 13 (winter, weekend, midday) indicates that the special event (Apple Fest and Craft Sale in Bowmanville) has little impact on the ETE for the 90th percentile and no impact on the 100th percentile ETE. See Section 7.5 for additional discussion.
- Comparison of Scenarios 1 and 14 in Table 7-1 indicates that events such as adverse weather or traffic accidents which close a lane on Hwy 401 westbound, does not affect ETE for the 90th and 100th percentile. See Section 7.5 for additional discussion.
- The majority of the PZ is congested during a full PZ evacuation. All congestion within the PZ clears by 3 hours and 30 minutes after the Advisory to Evacuate. All congestion within the study area clears by 4 hours and 15 minutes. See Section 7.3 and Figures 7-3 through 7-8 for additional discussion.
- Separate ETE were computed for schools, day camps, medical facilities, and transit-dependent persons. The average single-wave ETE for these facilities range from being comparable to the general population ETE to approximately an hour longer than the general population ETE at the 90th percentile. See Section 8 for additional discussion.
- Table 8-5 indicates that there are enough buses, wheelchair vehicles, and ambulances available to evacuate the ambulatory, wheelchair bound, and bedridden transit-dependent population within the PZ in a single wave. See Section 8.4.

- A traffic control point is recommended at the intersection of Darlington-Clarke Townline Road and Concession St E in Bowmanville due to the large number of vehicles evacuating along Concession St E from Bowmanville. This traffic control point has since been operationalized by Durham Region Police Service (DRPS). See Section 9 and Appendix G.
- The general population ETE at the 100th percentile is insensitive to reductions in the base trip generation time of 4 hours and 15 minutes due to the traffic congestion within the PZ for the first 3½ hours. After this, trip generation dictates ETE. See Table M-1.
- The general population ETE is affected by the voluntary evacuation of vehicles in the Shadow Region (quadrupling the shadow evacuation percentage increases 90th and 100th percentile ETE by 20 minutes). An evacuation of 100 percent of the Shadow Region increases 90th percentile ETE by 20 minutes and 100th percentile ETE by 45 minutes. See Table M-2.
- Projected ETE values for 2015, 2025, 2035, 2045, and 2055 are provided as a sensitivity study in Appendix M. See Section M.3 for future ETE results.
- A full closure of Hwy 401 has little impact on the DNGS ETE due to ample roadway capacity within the PZ. See Section M.4.

Table 7-1. Time to Clear the Indicated Area of _90_ Percent of the Affected Population

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Region	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Special Event	Roadway Impact
Entire Contiguous Zone, Middle Ring, and Full Primary Zone														
R01	1:55	1:55	1:55	1:55	1:55	1:55	1:55	2:00	1:55	1:55	2:00	1:55	1:55	1:55
R02	2:25	2:25	2:10	2:15	2:15	2:25	2:30	2:55	2:10	2:15	2:40	2:15	2:15	2:25
R03	2:35	2:40	2:20	2:30	2:25	2:35	2:40	3:05	2:20	2:25	2:55	2:25	2:20	2:35
Evacuate Contiguous Zone and Downwind to Primary Zone Boundary														
R04	2:25	2:35	2:15	2:25	2:25	2:30	2:35	3:00	2:10	2:20	2:45	2:25	2:25	2:25
R05	2:30	2:35	2:15	2:25	2:25	2:30	2:35	3:10	2:15	2:20	2:50	2:25	2:20	2:30
R06	2:25	2:35	2:15	2:25	2:25	2:30	2:35	3:05	2:15	2:20	2:50	2:25	2:20	2:25
R07	2:20	2:35	2:15	2:20	2:20	2:25	2:35	3:00	2:15	2:20	2:45	2:20	2:20	2:20
R08	2:05	2:05	2:00	2:00	1:55	2:05	2:05	2:15	2:00	2:00	2:10	1:55	2:00	2:05
R09	1:55	1:55	1:55	1:55	1:55	1:55	1:55	2:00	1:55	1:55	2:00	1:55	1:55	1:55
R10	2:05	2:05	1:55	2:00	1:55	2:05	2:05	2:25	1:55	2:00	2:10	1:55	1:55	2:05
R11	2:20	2:20	2:05	2:15	2:05	2:15	2:25	2:50	2:05	2:10	2:35	2:05	2:05	2:20
R12	2:30	2:30	2:15	2:20	2:15	2:25	2:30	2:55	2:10	2:15	2:45	2:20	2:10	2:30
R13	2:25	2:30	2:15	2:20	2:15	2:25	2:25	2:55	2:10	2:15	2:50	2:20	2:10	2:25
R14	2:20	2:25	2:05	2:10	2:15	2:20	2:20	2:45	2:05	2:10	2:30	2:10	2:05	2:20
Staged Evacuation - Evacuate Contiguous Zone and Downwind to Primary Zone Boundary														
R15	3:10	3:20	3:10	3:15	3:20	3:10	3:20	3:35	3:10	3:15	3:25	3:20	3:10	3:10
R16	3:15	3:20	3:10	3:15	3:20	3:15	3:25	3:35	3:10	3:20	3:35	3:20	3:10	3:15
R17	3:15	3:20	3:10	3:20	3:20	3:15	3:20	3:35	3:10	3:20	3:35	3:20	3:10	3:15
R18	3:10	3:20	3:05	3:15	3:15	3:10	3:20	3:35	3:05	3:15	3:30	3:15	3:05	3:10
R19	2:25	2:30	2:20	2:25	2:30	2:25	2:25	2:40	2:25	2:25	2:30	2:35	2:20	2:25
R20	1:55	1:55	1:55	1:55	1:55	1:55	1:55	2:00	1:55	1:55	2:00	1:55	1:55	1:55
R21	2:45	2:50	2:45	2:45	2:50	2:45	2:50	3:00	2:45	2:45	3:00	2:50	2:45	2:45
R22	3:00	3:05	2:55	3:05	3:05	3:00	3:10	3:25	2:55	3:05	3:20	3:05	2:55	3:00
R23	3:05	3:15	3:05	3:10	3:10	3:05	3:15	3:30	3:05	3:15	3:25	3:10	3:05	3:05
R24	3:10	3:15	3:05	3:10	3:10	3:05	3:15	3:30	3:05	3:10	3:30	3:10	3:05	3:10
R25	3:00	3:05	2:55	3:00	3:00	3:00	3:05	3:15	2:55	3:00	3:10	3:00	2:55	3:00
R26	3:15	3:25	3:10	3:20	3:15	3:15	3:25	3:40	3:10	3:20	3:35	3:15	3:10	3:15

Table 7-2. Time to Clear the Indicated Area of *100* Percent of the Affected Population

	Summer		Summer		Summer	Winter			Winter			Winter	Winter	Summer
	Midweek		Weekend		Midweek Weekend	Midweek			Weekend			Midweek Weekend	Weekend	Midweek
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Midday		Midday		Evening	Midday			Midday			Evening	Midday	Midday
Region	Good Weather	Rain	Good Weather	Rain	Good Weather	Good Weather	Rain	Snow	Good Weather	Rain	Snow	Good Weather	Special Event	Roadway Impact
Entire Contiguous Zone, Middle Ring, and Full Primary Zone														
R01	4:15	4:15	4:15	4:15	4:15	4:15	4:15	4:45	4:15	4:15	4:45	4:15	4:15	4:15
R02	4:20	4:20	4:20	4:20	4:20	4:20	4:20	4:50	4:20	4:20	4:50	4:20	4:20	4:20
R03	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
Evacuate Contiguous Zone and Downwind to Primary Zone Boundary														
R04	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R05	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R06	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R07	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R08	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R09	4:15	4:15	4:15	4:15	4:15	4:15	4:15	4:45	4:15	4:15	4:45	4:15	4:15	4:15
R10	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R11	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R12	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R13	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R14	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
Staged Evacuation - Evacuate Contiguous Zone and Downwind to Primary Zone Boundary														
R15	4:25	4:30	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R16	4:25	4:30	4:25	4:25	4:25	4:25	4:30	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R17	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R18	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R19	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R20	4:15	4:15	4:15	4:15	4:15	4:15	4:15	4:45	4:15	4:15	4:45	4:15	4:15	4:15
R21	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R22	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R23	4:25	4:30	4:25	4:25	4:25	4:25	4:30	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R24	4:25	4:25	4:25	4:30	4:25	4:25	4:30	4:55	4:25	4:30	4:55	4:25	4:25	4:25
R25	4:25	4:25	4:25	4:25	4:25	4:25	4:25	4:55	4:25	4:25	4:55	4:25	4:25	4:25
R26	4:25	4:30	4:25	4:35	4:25	4:25	4:30	4:55	4:25	4:30	4:55	4:25	4:25	4:25

Table M-4. PZ Population by Study Year

Response Sector	2011 Population	2015 Extrapolated Population	2025 Extrapolated Population	2035 Extrapolated Population	2045 Extrapolated Population	2055 Extrapolated Population
DNGS	0	0	0	0	0	0
D01	78	82	94	107	121	138
D14	0	0	0	0	0	0
Contiguous Zone Total:	**78**	**82**	**94**	**107**	**121**	**138**
D02	17,057	17,960	20,438	23,258	26,463	30,114
D03	7,852	8,269	9,411	10,707	12,182	13,860
D04	20,467	21,555	24,526	27,904	31,754	36,131
D05	8,391	8,834	10,052	11,444	13,015	14,812
D15	0	0	0	0	0	0
Middle Ring Total:	**53,845**	**56,700**	**64,521**	**73,420**	**83,535**	**95,055**
D06A	0	0	0	0	0	0
D06B	14,073	15,016	17,667	20,783	24,448	28,758
D07	4,293	4,583	5,391	6,338	7,456	8,775
D08A	16,456	17,555	20,658	24,301	28,584	33,628
D08B	5,858	6,248	7,356	8,651	10,176	11,971
D09	12,315	13,139	15,459	18,186	21,393	25,168
D10	7,397	7,789	8,862	10,084	11,476	13,060
D11	1,209	1,272	1,447	1,649	1,875	2,135
D12	723	761	865	988	1,123	1,276
D13	2,102	2,215	2,519	2,868	3,264	3,710
D16	0	0	0	0	0	0
PZ Total:	**118,271**	**125,278**	**144,745**	**167,268**	**193,330**	**223,536**
Shadow Region	**103,672**	**110,356**	**129,070**	**150,949**	**176,574**	**206,609**
PZ & Shadow Region	**221,943**	**235,634**	**273,815**	**318,217**	**369,904**	**430,145**

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Joint Review Panel

Environmental Assessment Report

Darlington New Nuclear Power Plant Project

August 2011

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Darlington New Nuclear Power Plant Project
Joint Review Panel

August 25, 2011

The Honourable Peter Kent, P.C, M.P.
Minister of the Environment
Les Terrasses de la Chaudière
10 Wellington Street, 28th Floor
Gatineau, Quebec
K1A 0H3

Dear Minister:

The Joint Review Panel for the Darlington New Nuclear Power Plant Project has completed its environmental assessment of the Project in accordance with its mandate issued on October 30, 2009. The Panel hereby submits its report for the consideration of the Government of Canada.

Yours truly,

Alan R. Graham, Chair

Jocelyne Beaudet, Member

Joseph Kenneth Pereira, Member

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Report Summary

The Darlington New Nuclear Power Plant Project (the Project) is a proposal by Ontario Power Generation (OPG) for the site preparation, construction, operation, decommissioning and abandonment of up to four new nuclear reactors at its existing Darlington Nuclear site in the Municipality of Clarington, Ontario. The Project is expected to generate up to 4,800 megawatts of electricity for delivery to the Ontario grid with an initial need of 2,000 megawatts.

The Project includes the preparation of the site; construction of up to four new reactors and associated facilities; the operation and maintenance of the reactors and related facilities for approximately 60 years, including the management of conventional and radioactive waste; and the decommissioning and eventual abandonment of the nuclear reactors and associated facilities.

The Minister of the Environment and President of the Canadian Nuclear Safety Commission determined that a review of the Project by a joint review panel would ensure that the Project was subject to an effective and efficient environmental assessment and regulatory process. On October 30, 2009, the Minister and the President appointed a three-member Joint Review Panel (Panel) to consider the environmental assessment and the Application for a Licence to Prepare Site for the proposed Project.

The mandate of the Panel was to assess the environmental effects of the Project and to determine whether it is likely to cause significant adverse environmental effects taking into account the implementation of mitigation measures that are technically and economically feasible. The review of the Project was framed by the *Canadian Environmental Assessment Act* and the *Nuclear Safety and Control Act*. The Panel incorporated other federal, provincial and municipal policies and requirements, industry standards and best practices in its analysis and recommendations.

The components of the review included a public review and comment period, two technical review sessions, requests to OPG for additional information deemed necessary by the Panel, three open house information sessions at public venues in the Project area, submissions from federal, provincial and municipal governments, Aboriginal groups and other interested parties, and a 17-day public hearing in the Municipality of Clarington.

The Panel concludes that the Project is not likely to cause significant adverse environmental effects, provided the mitigation measures proposed and commitments made by OPG during the review, and the Panel's recommendations are implemented.

The Panel directs recommendations to responsible authorities and federal authorities, as well as to the Government of Canada, the Government of Ontario, the Municipality of Clarington and OPG.

Following is a consolidation of the Panel's recommendations. Each recommendation is numbered chronologically as it appears in the text of the main report. The report section reference is provided for each recommendation.

The Canadian Nuclear Safety Commission

Prior to Site Preparation

Recommendation # 2 (Section 4.5):
The Panel recommends that prior to site preparation, the Canadian Nuclear Safety Commission require OPG to conduct a comprehensive soils characterization program. In particular, the potentially impacted soils in the areas OPG identifies as the spoils disposal area, cement plant area and asphalt storage area must be sampled to identify the nature and extent of potential contamination.

Recommendation # 6 (Section 4.6):
The Panel recommends that prior to site preparation, the Canadian Nuclear Safety Commission require OPG to update its preliminary decommissioning plan for site preparation in accordance with the requirements of Canadian Standards Association Standard N294-09. The OPG preliminary decommissioning plan for site preparation must incorporate the rehabilitation of the site to reflect

the existing biodiversity in the event that the Project does not proceed beyond the site preparation phase.

OPG shall prepare a detailed preliminary decommissioning plan once a reactor technology is chosen, to be updated as required by the Canadian Nuclear Safety Commission.

Recommendation # 7 (Section 4.6):
The Panel recommends that prior to site preparation, the Canadian Nuclear Safety Commission require that OPG establish a decommissioning financial guarantee to be reviewed as required by the Canadian Nuclear Safety Commission. Regarding the decommissioning financial guarantee for the site preparation stage, the Panel recommends that this financial guarantee contain sufficient funds for the rehabilitation of the site in the event the Project does not proceed beyond the site preparation stage.

Recommendation # 8 (Section 5.1):
The Panel recommends that prior to site preparation, the Canadian Nuclear Safety Commission require OPG to develop a follow-up and adaptive management program for air contaminants such as Acrolein, NO_2, SO_2, SPM, $PM_{2.5}$ and PM_{10}, to the satisfaction of the Canadian Nuclear Safety Commission, Health Canada and Environment Canada. Additionally, the Canadian Nuclear Safety Commission must require OPG to develop an action plan acceptable to Health Canada for days when there are air quality or smog alerts.

Recommendation # 9 (Section 5.1):
The Panel recommends that the Canadian Nuclear Safety Commission, in collaboration with Health Canada, require OPG to develop and implement a detailed acoustic assessment for all scenarios evaluated. The predictions must be shared with potentially affected members of the public. The OPG Nuisance Effects Management Plan must include noise monitoring, a noise complaint response mechanism and best practices for activities that may occur outside of municipal noise curfew hours to reduce annoyance that the public may experience.

Recommendation # 10 (Section 5.2):
The Panel recommends that the Canadian Nuclear Safety Commission require OPG to undertake a detailed site geotechnical investigation prior to commencing site preparation activities. The geologic elements of this investigation should include, but not be limited to:

- collecting site-wide information on soil physical properties;
- determining the mechanical and dynamic properties of overburden material across the site;
- mapping of geological structures to improve the understanding of the site geological structure model;
- confirming the lack of karstic features in the local bedrock at the site; and
- confirming the conclusions reached concerning the liquefaction potential in underlying granular materials.

Recommendation # 12 (Section 5.3):
The Panel recommends that before in-water works are initiated, the Canadian Nuclear Safety Commission require OPG to collect water and sediment quality data for any future embayment area that may be formed as a consequence of shoreline modifications in the vicinity of the outlet of Darlington Creek. This data should serve as the reference information for the proponent's post-construction commitment to conduct water and sediment quality monitoring of the embayment area.

Recommendation # 13 (Section 5.3):
The Panel recommends that the Canadian Nuclear Safety Commission require OPG to collect and assess water quality data for a comprehensive number of shoreline and off-shore locations in the site study area prior to commencing in-water works. This data should be used to establish a reference for follow-up monitoring.

Recommendation # 20 (Section 5.5):
The Panel recommends that the Canadian Nuclear Safety Commission require OPG to perform a thorough evaluation of site layout opportunities before site preparation activities begin, in order to minimize the overall effects on the terrestrial and aquatic environments and maximize the opportunity for quality terrestrial habitat rehabilitation.

Recommendation #22 (Section 5.5):
The Panel recommends that the Canadian Nuclear Safety Commission require OPG to develop a follow-up program for insects, amphibians and reptiles, and mammal species

and communities to ensure that proposed mitigation measures are effective.

Recommendation # 25 (Section 5.5):
The Panel recommends that the Canadian Nuclear Safety Commission require OPG to conduct more sampling to confirm the presence of Least Bittern before site preparation activities begin. The Panel recommends that the Canadian Nuclear Safety Commission require OPG to develop and implement a management plan for the species at risk that are known to occur on site. The plan should consider the resilience of some of the species and the possibility of off-site compensation.

Recommendation # 38 (Section 5.9):
The Panel recommends that the Canadian Nuclear Safety Commission require that the geotechnical and seismic hazard elements of the detailed site geotechnical investigation to be performed by OPG include, but not be limited to:

Prior to site preparation:
- demonstration that there are no undesirable subsurface conditions at the Project site. The overall site liquefaction potential shall be assessed with the site investigation data; and
- confirmation of the absence of paleoseismologic features at the site and, if present, further assessment to reduce the overall uncertainty in the seismic hazard assessment during the design of the Project must be conducted.

During site preparation and/or prior to construction:
- verification and confirmation of the absence of surface faulting in the overburden and bedrock at the site.

Prior to construction:
- verification of the stability of the cut slopes and dyke slopes under both static and dynamic loads with site/Project-specific data during the design of the cut slopes and dykes or before their construction;
- assessment of potential liquefaction of the northeast waste stockpile by using the data obtained from the pile itself upon completion of site preparation;
- measurement of the shear strength of the overburden materials and the dynamic properties of both overburden and sedimentary rocks to confirm the site conditions and to perform soil-structure interaction analysis if necessary;
- assessment of the potential settlement in the quaternary deposits due to the groundwater drawdown caused by future St. Marys Cement quarry activities; and
- assessment of the effect of the potential settlement on buried infrastructures in the deposits during the design of these infrastructures.

Prior to operation:
- development and implementation of a monitoring program for the Phase 4 St. Marys Cement blasting operations to confirm that the maximum peak ground velocity at the boundary between the Darlington and St. Marys Cement properties is below the proposed limit of three millimetres per second (mm/s).

Recommendation # 41 (Section 6.1):
The Panel recommends that prior to site preparation, the Canadian Nuclear Safety Commission coordinate discussions with OPG and key stakeholders on the effects of the Project on housing supply and demand, community recreational facilities and programs, services and infrastructure as well as additional measures to help deal with the pressures on these community assets.

Recommendation # 47 (Section 6.7):
The Panel recommends that prior to site preparation, the Canadian Nuclear Safety Commission ensure the OPG Traffic Management Plan addresses the following:
- contingency plans to address the possibility that the assumed road improvements do not occur;
- consideration of the effect of truck traffic associated with excavated material disposal on traffic operations and safety;
- further analysis of queuing potential onto Highway 401; and
- consideration of a wider range of mitigation measures, such as transportation-demand management, transit service provisions and geometric improvements at the Highway 401/Waverley Road interchange.

Recommendation # 48 (Section 6.7):
In consideration of public safety, the Panel recommends that prior to site preparation, the Canadian Nuclear Safety Commission coordinate

a committee of federal, provincial and municipal transport authorities to review the need for road development and modifications.

During Site Preparation

Recommendation #5 (Section 4.6):
To avoid any unnecessary environmental damage to the bluff at Raby Head and fish habitat, the Panel recommends that no bluff removal or lake infill occur during the site preparation stage, unless a reactor technology has been selected and there is certainty that the Project will proceed.

Recommendation # 19 (Section 5.4):
The Panel recommends that the Canadian Nuclear Safety Commission require OPG to expand the scope of the groundwater monitoring program to monitor transitions in groundwater flows that may arise as a consequence of grade changes during the site preparation and construction phases of the Project. The design of the grade changes should guide the determination of the required monitoring locations, frequency of monitoring and the required duration of the program for the period of transition to stable conditions following the completion of construction and the initial period of operation.

Recommendation # 21 (Section 5.5):
The Panel recommends that the Canadian Nuclear Safety Commission require OPG to compensate for the loss of ponds, like-for-like, preferably in the site study area. The Panel also recommends that the Canadian Nuclear Safety Commission require OPG to use best management practices to prevent or minimize the potential runoff of sediment and other contaminants into wildlife habitat associated with Coot's Pond during site preparation and construction phases.

Prior to Construction

Recommendation # 1 (Section 4.5):
The Panel understands that prior to construction, the Canadian Nuclear Safety Commission will determine whether this environmental assessment is applicable to the reactor technology selected by the Government of Ontario for the Project. Nevertheless, if the selected reactor technology is fundamentally different from the specific reactor technologies bounded by the plant parameter envelope, the Panel recommends that a new environmental assessment be conducted.

Recommendation # 3 (Section 4.5):
The Panel recommends that the Canadian Nuclear Safety Commission require that as part of the Application for a Licence to Construct a reactor, OPG must undertake a formal quantitative cost-benefit analysis for cooling tower and once-through condenser cooling water systems, applying the principle of best available technology economically achievable. This analysis must take into account the fact that lake infill should not go beyond the two-metre depth contour and should include cooling tower plume abatement technology.

Recommendation # 14 (Section 5.3):
The Panel recommends that following the selection of a reactor technology for the Project, the Canadian Nuclear Safety Commission require OPG to conduct a detailed assessment of predicted effluent releases from the Project. The assessment should include but not be limited to effluent quantity, concentration, points of release and a description of effluent treatment, including demonstration that the chosen option has been designed to achieve best available treatment technology and techniques economically achievable. The Canadian Nuclear Safety Commission shall also require OPG to conduct a risk assessment on the proposed residual releases to determine whether additional mitigation measures may be necessary.

Recommendation # 16 (Section 5.3):
The Panel recommends that prior to the start of construction, the Canadian Nuclear Safety Commission require the proponent to establish toxicity testing criteria and provide the test methodology and test frequency that will be used to confirm that stormwater discharges from the new nuclear site comply with requirements in the *Fisheries Act*.

Recommendation # 17 (Section 5.4):
The Panel recommends that the Canadian Nuclear Safety Commission require OPG to provide an assessment of the ingress and transport of contaminants in groundwater on site during successive phases of the Project as part of the Application for a Licence to Construct. This assessment shall include consideration of the impact of wet and dry deposition of all contaminants of potential concern and

radiological constituents, especially tritium, in gaseous emissions on groundwater quality. OPG shall conduct enhanced groundwater and contaminant transport modelling for the assessment and expand the modelling to cover the effects of future dewatering and expansion activities at the St. Marys Cement quarry on the Project.

Recommendation # 26 (Section 5.5):
The Panel recommends that the Canadian Nuclear Safety Commission require OPG to develop a comprehensive assessment of hazardous substance releases and the required management practices for hazardous chemicals on site, in accordance with the *Canadian Environmental Protection Act*, once a reactor technology has been chosen.

Recommendation # 27 (Section 5.6):
The Panel recommends that prior to any destruction of the Bank Swallow habitat, the Canadian Nuclear Safety Commission require OPG to implement all of its proposed Bank Swallow mitigation options, including:

- the acquisition of off-site nesting habitat;
- the construction of artificial Bank Swallow nest habitat with the capacity to maintain a population which is at least equal to the number of breeding pairs currently supported by the bluff and as close to the original bluff site as possible; and
- the implementation of an adaptive management approach in the Bank Swallow mitigation plan, with the inclusion of a threshold of loss to be established in consultation with all stakeholders before any habitat destruction takes place.

Recommendation # 35 (Section 5.7):
In the event that a once-through condenser cooling system is chosen for the Project, the Panel recommends that prior to operation, the Canadian Nuclear Safety Commission require OPG to include the following in the surface water risk assessment:

- the surface combined thermal and contaminant plume; and
- the physical displacement effect of altered lake currents as a hazardous pulse exposure to fish species whose larvae passively drift through the area, such as lake herring, lake whitefish, emerald shiner and yellow perch.

If the risk assessment result predicts a potential hazard then the Canadian Nuclear Safety Commission shall convene a follow-up monitoring scoping workshop with Environment Canada, Fisheries and Oceans Canada and any other relevant authorities to develop an action plan.

Recommendation # 37 (Section 5.7):
In the event that a once-through condenser cooling system is chosen for the Project, the Panel recommends that prior to construction, the Canadian Nuclear Safety Commission require OPG to determine the total area of permanent aquatic effects from the following, to properly scale mitigation and scope follow-up monitoring:

- the thermal plume + 2^{o} C above ambient temperature;
- the mixing zone and surface plume contaminants;
- physical displacements from altered lake currents; and
- infill and construction losses and modifications.

Recommendation # 39 (Section 5.9):
The Panel recommends that prior to construction, the Canadian Nuclear Safety Commission require OPG to prepare a contingency plan for the construction, operation and decommissioning Project stages to account for uncertainties associated with flooding and other extreme weather hazards.

OPG shall conduct localized climate change modelling to confirm its conclusion of a low impact of climate change. A margin/bound of changes to key parameters, such as intensity of extreme weather events, needs to be established to the satisfaction of the Canadian Nuclear Safety Commission. These parameters can be incorporated into hydrological designs leading up to an application to construct a reactor, as well as measures for flood protection.

OPG must also conduct a drought analysis and incorporate any additional required mitigation/design modifications, to the satisfaction of the Canadian Nuclear Safety Commission, as part of a Licence to Construct a reactor.

Recommendation # 40 (Section 5.9):
The Panel recommends that prior to construction, the Canadian Nuclear Safety Commission require OPG to:

- establish an adaptive management program for algal hazard to the Project cooling water

system intake that includes the setup of thresholds for further actions; and
- factor the algal hazard assessment into a more detailed biological evaluation of moving the intake and diffuser deeper offshore as part of the detailed siting studies and the cost-benefit analysis of the cooling system.

Recommendation # 52 (Section 6.8):
The Panel recommends that prior to construction, the Canadian Nuclear Safety Commission require OPG to make provisions for on-site storage of all used fuel for the duration of the Project, in the event that a suitable off-site solution for the long-term management for used fuel waste is not found.

Recommendation # 53 (Section 6.8):
The Panel recommends that prior to construction, the Canadian Nuclear Safety Commission require OPG to make provisions for on-site storage of all of low and intermediate-level radioactive waste for the duration of the Project, in the event that a suitable off-site solution for the long-term management for this waste is not approved.

Recommendation # 57 (Section 7.2):
The Panel recommends that prior to construction, the Canadian Nuclear Safety Commission require OPG to undertake an assessment of the off-site effects of a severe accident. The assessment should determine if the off-site health and environmental effects considered in this environmental assessment bound the effects that could arise in the case of the selected reactor technology.

Recommendation # 58 (Section 7.2):
The Panel recommends that prior to construction, the Canadian Nuclear Safety Commission confirm that dose acceptance criteria specified in RD-337 at the reactor site boundary—in the cases of design basis accidents for the Project's selected reactor technology—will be met.

Recommendation # 63 (Section 8.1):
The Panel recommends that prior to construction, the Canadian Nuclear Safety Commission require OPG to evaluate the cumulative effect of a common-cause severe accident involving all of the nuclear reactors in the site study area to determine if further emergency planning measures are required.

During Operation

Recommendation # 15 (Section 5.3):
The Panel recommends that following the start of operation of the reactors, the Canadian Nuclear Safety Commission require OPG to conduct monitoring of ambient water and sediment quality in the receiving waters to ensure that effects from effluent discharges are consistent with predictions made in the environmental impact statement and with those made during the detailed design phase.

Recommendation # 18 (Section 5.4):
The Panel recommends that based on the groundwater and contaminant transport modelling results, the Canadian Nuclear Safety Commission require OPG to expand the Radiological Environmental Monitoring Program. This program shall include relevant residential and private groundwater well quality data in the local study area that are not captured by the current program, especially where the modelling results identify potential critical groups based on current or future potential use of groundwater.

Recommendation # 36 (Section 5.7):
In the event that a once-through condenser cooling system is chosen for the Project the Panel recommends that during operation, the Canadian Nuclear Safety Commission require OPG to undertake adult fish monitoring of large-bodied and small-bodied fish to confirm the effectiveness of mitigation measures and verify the predictions of no adverse thermal and physical diffuser jet effects.

Recommendation # 54 (Section 7.1):
The Panel recommends that during operation, the Canadian Nuclear Safety Commission require OPG to implement measures to manage releases from the Project to avoid tritium in drinking water levels exceeding a running annual average of 20 Becquerels per litre at drinking water supply plants in the regional study area.

Recommendation # 61 (Section 8.1):
The Panel recommends that during operation, the Canadian Nuclear Safety Commission require OPG to monitor aquatic habitat and biota for potential cumulative effects from the thermal loading and contaminant plume of the discharge structures of the existing Darlington Nuclear Generating Station and the Project.

Over the Life of the Project

Recommendation # 4 (Section 4.6):
The Panel recommends that the Canadian Nuclear Safety Commission exercise regulatory oversight to ensure that OPG complies with all municipal and provincial requirements and standards over the life of the Project. This is of particular importance because the conclusions of the Panel are based on the assumption that OPG will follow applicable laws and regulations at all jurisdictional levels.

Recommendation # 11 (Section 5.2):
The Panel recommends that the Canadian Nuclear Safety Commission require OPG to develop and implement a follow-up program for soil quality during all stages of the Project.

Recommendation # 43 (Section 6.2):
The Panel recommends that the Canadian Nuclear Safety Commission engage appropriate stakeholders, including OPG, Emergency Management Ontario, municipal governments and the Government of Ontario to develop a policy for land use around nuclear generating stations.

Recommendation # 56 (Section 7.1):
The Panel recommends that over the life of the Project, the Canadian Nuclear Safety Commission require OPG to conduct ambient air monitoring in the local study area on an ongoing basis to ensure that air quality remains at levels that are not likely to cause adverse effects to human health.

Fisheries and Oceans Canada

Prior to Construction

Recommendation # 30 (Section 5.7):
In the event that a once-through condenser cooling system is chosen for the Project, the Panel recommends that prior to the construction of in-water structures, Fisheries and Oceans Canada require OPG to conduct:

- additional impingement sampling at the existing Darlington Nuclear Generating Station to verify the 2007 results and deal with inter-year fish abundance variability and sample design inadequacies; and
- additional entrainment sampling at the existing Darlington Nuclear Generating Station to better establish the current conditions. The program should be designed to guard against a detection limit bias by including in the analysis of entrainment losses those fish species whose larvae and eggs are captured in larval tow surveys for the seasonal period of the year in which they occur. A statistical optimization analysis will be needed to determine if there is a cost-effective entrainment survey design for round whitefish larvae.

Recommendation # 32 (Section 5.7):
In the event that a once-through condenser cooling system is chosen for the Project, the Panel recommends that Fisheries and Oceans Canada require OPG to mitigate the risk of adverse effects from operation, including impingement, entrainment and thermal excursions and plumes, by locating the system intake and diffuser structures in water beyond the nearshore habitat zone. Furthermore, OPG must evaluate other mitigative technologies for the system intake, such as live fish return systems and acoustic deterrents.

During Construction

Recommendation # 31 (Section 5.7):
Irrespective of the condenser cooling system chosen for the Project, the Panel recommends that Fisheries and Oceans Canada not permit OPG to infill beyond the two-metre depth contour in Lake Ontario.

Over the Life of the Project

Recommendation # 28 (Section 5.7):
The Panel recommends that Fisheries and Oceans Canada require OPG to continue conducting adult fish community surveys in the site study area and reference locations on an ongoing basis. These surveys shall be used to confirm that the results of 2009 gillnetting and 1998 shoreline electrofishing reported by OPG, and the additional data collected in 2010 and 2011, are representative of existing conditions, taking into account natural year-to-year variability.

Specific attention should be paid to baseline gillnetting monitoring in spring to verify the findings on fish spatial distribution and relatively high native fish species abundance in the embayment area, such as white sucker and round whitefish. The shoreline electrofishing habitat use study is needed to establish the contemporary baseline for later use to test for effects of lake infill armouring, if employed, and the effectiveness of mitigation.

Recommendation # 29 (Section 5.7):
The Panel recommends that Fisheries and Oceans Canada require OPG to continue the research element of the proposed Round Whitefish Action Plan for the specific purpose of better defining the baseline condition, including the population structure, genome and geographic distribution of the round whitefish population as a basis from which to develop testable predictions of effects, including cumulative effects.

Recommendation # 33 (Section 5.7):
The Panel recommends that Fisheries and Oceans Canada require OPG to conduct an impingement and entrainment follow-up program at the existing Darlington Nuclear Generating Station and the Project site to confirm the prediction of adverse effects, including cumulative effects, and the effectiveness of mitigation. For future entrainment sampling for round whitefish, a statistical probability analysis will be needed to determine if unbiased and precise sample results can be produced.

Transport Canada

Prior to Construction

Recommendation # 49 (Section 6.7):
The Panel recommends that prior to construction, Transport Canada ensure that OPG undertake additional quantitative analysis, including collision frequencies and rail crossing exposure indices, and monitor the potential effects and need for mitigation associated with the Project.

Recommendation # 50 (Section 6.7):
The Panel recommends that prior to construction, Transport Canada require OPG to conduct a risk assessment, jointly with Canadian National Railway, that includes:

- an assessment of the risks associated with a derailment or other rail incident that could affect the Project;
- an analysis of the risks associated with a security threat, such as a bomb being placed on a train running on the tracks that bisect the Project;
- a comparative evaluation of the effectiveness of various mitigation measures or combination of measures (e.g., blast wall, retaining wall, recessed tracks, berm and railway speed restrictions within the vicinity of the site);
- a determination of the design criteria necessary to ensure the effectiveness of these measures (e.g., the appropriate height, strength, material and design of a blast wall); and
- a critical analysis to confirm that these measures, when properly designed and implemented, would be sufficient to provide protection to the Project site in the event of a derailment at full speed or other adverse event.

Recommendation # 51 (Section 6.7):
In the event that a once-through condenser cooling system is chosen for the Project, the Panel recommends that prior to construction, Transport Canada work with OPG to develop a follow-up program to verify the accuracy of the prediction of no significant adverse effects to boating safety from the establishment of an increased prohibitive zone. OPG must also develop an adaptive management program, if required, to mitigate potential effects to small watercraft.

Environment Canada

Prior to Site Preparation

Recommendation # 62 (Section 8.1):
The Panel recommends that prior to site preparation, Environment Canada evaluate the need for additional air quality monitoring stations in the local study area to monitor cumulative effects on air quality.

During Site Preparation

Recommendation # 24 (Section 5.5):
The Panel recommends that during the site preparation stage, Environment Canada shall ensure that OPG not undertake habitat destruction or disruption between the period of May 1 and July 31 of any year to minimize effects to breeding migratory birds.

Prior to Construction

Recommendation # 34 (Section 5.7):
In the event that a once-through condenser cooling system is chosen for the Project, the Panel recommends that prior to construction, Environment Canada ensure that enhanced resolution thermal plume modelling is conducted by OPG, taking into account possible future climate change effects. Fisheries and Oceans Canada shall ensure that the results of the modelling are incorporated into the design of the outfall diffuser and the evaluation of alternative locations for the placement of the intake and the diffuser of the proposed condenser cooling water system.

During Operation

Recommendation # 23 (Section 5.5):
The Panel recommends that Environment Canada collaborate with OPG to develop and implement a follow-up program to confirm the effectiveness of OPG's proposed mitigation measures for bird communities should natural draft cooling towers be chosen for the condenser cooling system.

Health Canada

Over the Life of the Project

Recommendation # 55 (Section 7.1):
The Panel recommends that Health Canada and the Canadian Nuclear Safety Commission continue to participate in international studies seeking to identify long-term health effects of low-level radiation exposures, and to identify if there is a need for revision of limits specified in the Radiation Protection Regulations.

The Canadian Environmental Assessment Agency

General

Recommendation # 64 (Section 8.1):
The Panel recommends that the Canadian Environmental Assessment Agency revise the Canadian Environmental Assessment Agency Cumulative Effects Practitioner's Guide to specifically include a consideration of accident and malfunction scenarios.

The Government of Canada

Prior to Construction

Recommendation # 60 (Section 7.3):
The Panel recommends that prior to construction, the Government of Canada review the adequacy of the provisions for nuclear liability insurance. This review must include information from OPG and the Region of Durham regarding the likely economic effects of a severe accident at the Darlington Nuclear site where there is a requirement for relocation, restriction of use and remediation of a sector of the regional study area.

Recommendation # 66 (Section 8.5):
The Panel recommends that the Government of Canada update the *Nuclear Liability and Compensation Act* or its equivalent to reflect the consequences of a nuclear accident. The revisions must address damage from any ionizing radiation and from any initiating event and should be aligned with the polluter pays principle. The revised *Nuclear Liability and Compensation Act*, or its equivalent, must be in force before the Project can proceed to the construction phase.

Over the Life of the Project

Recommendation # 65 (Section 8.5):
The Panel recommends that the Government of Canada make it a priority to invest in developing solutions for long-term management of used nuclear fuel, including storage, disposal, re-processing and re-use.

General

Recommendation # 67 (Section 8.5):
The Panel recommends that the Government of Canada provide clear and practical direction on the application of sustainability assessment in environmental assessments for future nuclear projects.

The Government of Ontario

Over the Life of the Project

Recommendation # 44 (Section 6.2):
The Panel recommends that the Government of Ontario take appropriate measures to prevent sensitive and residential development within three kilometres of the site boundary.

Recommendation # 46 (Section 6.3):
Given that a severe accident may have consequences beyond the three and 10-kilometre zones evaluated by OPG, the Panel recommends that the Government of Ontario, on an ongoing basis, review the emergency planning zones and the emergency preparedness and response measures, as defined in the Provincial Nuclear Emergency Response Plan (PNERP), to protect human health and safety.

The Municipality of Clarington

Over the Life of the Project

Recommendation # 45 (Section 6.2):
The Panel recommends that the Municipality of Clarington prevent, for the lifetime of the nuclear facility, the establishment of sensitive public facilities such as school, hospitals and residences for vulnerable clienteles within the three kilometre zone around the site boundary.

Recommendation # 59 (Section 7.3):
The Panel recommends that the Municipality of Clarington manage development in the vicinity of the Project site to ensure that there is no deterioration in the capacity to evacuate members of the public for the protection of human health and safety.

Ontario Power Generation

Over the Life of the Project

Recommendation # 42 (Section 6.1):
The Panel recommends that on an ongoing basis, OPG pursue its strategy to ensure that Aboriginal students can benefit from the permanent job opportunities that will be available during the lifetime of the Project. In this regard, OPG should collaborate with various secondary and post-secondary education institutions as well as Aboriginal groups to ensure that such programs would be successful.

Project. As such, the Panel is of the view that the demand for such services should be monitored.

The Panel is of the view that the Project is not likely to result in significant adverse socio-economic environmental effects, taking into account the implementation of mitigation measures, such as the Clarington Host Municipality Agreement and the nuisance effects management plan, along with the following recommendation.

Recommendation # 41:
The Panel recommends that prior to site preparation, the Canadian Nuclear Safety Commission coordinate discussions with OPG and key stakeholders on the effects of the Project on housing supply and demand, community recreational facilities and programs, services and infrastructure as well as additional measures to help deal with the pressures on these community assets.

6.1.3 Training and Employment of Aboriginal Persons

This section presents the Panel's review of training and employment opportunities for Aboriginal persons in relation to the Project.

Proponent Assessment
OPG stated that it has programs to support and promote Aboriginal employment. OPG stated that it is committed to building long-term, mutually-beneficial working relationships with Aboriginal communities, in accordance with its Aboriginal relations policy. OPG further stated that it would continue to explore employment and business opportunities with the Aboriginal communities.

OPG provided information regarding various Ontario universities and colleges with Aboriginal programs, as well as the Ontario *Aboriginal Post Secondary Education and Training Policy Framework* (2011). OPG noted that it provides five scholarship programs, three specifically for people of Native ancestry in post-secondary education.

OPG also provided information regarding recruitment and discussed job opportunities in the areas of skilled trades, engineering and applied sciences and corporate and security functions. OPG further noted that it has several initiatives for student positions, including co-op, summer, internship and articling positions.

Panel Assessment
Some Aboriginal groups held that the Project might provide opportunities for employment. They also voiced concerns that their student population may not be able to benefit from the permanent employment opportunities presented by the Project. They noted that although there may be employment opportunities for tradespersons during the construction phase of the Project, skilled, longer-term jobs during the operation and maintenance phases of the Project may not be available to Aboriginal persons. The Aboriginal groups noted that they have held discussions with OPG regarding careers for students in areas such as engineering.

The Panel is of the view that OPG should pursue its strategy to ensure that Aboriginal students are trained so as to be able to benefit from the permanent employment opportunities that would be available during the lifetime of the Project. In this regard, OPG should collaborate with various secondary and post-secondary education institutions, as well as Aboriginal groups, to ensure that such programs would be successful.

As for employment during the site preparation and construction phase, the Panel suggests that every effort should be made to advertise opportunities available to Aboriginal groups.

Recommendation # 42:
The Panel recommends that on an ongoing basis, OPG pursue its strategy to ensure that Aboriginal students can benefit from the permanent job opportunities that will be available during the lifetime of the Project. In this regard, OPG should collaborate with various secondary and post-secondary education institutions as well as Aboriginal groups to ensure that such programs would be successful.

6.2 Land Use and Development

This section presents the Panel's assessment of the effects of the Project on the land use in the local and regional study areas. This section contains discussion on land use around the Project site, including existing land uses, land use policies and plans, ongoing development applications and policy changes.

6.2.1 Proponent Assessment

OPG presented a baseline characterization of the land use around the site, consisting of field surveys to identify and confirm existing land uses, a review of federal, provincial, regional and local land use policies and plans, and monitoring of ongoing development applications and policy changes. OPG also provided a detailed overview of the existing Official Plan land use designations, policies and planning objectives and zoning by-law provisions regulating the Darlington Nuclear site and lands within the local and regional study areas.

OPG explained that the site is directly surrounded by rural and industrial land uses, with Highway 401 running east-west directly north of the Darlington Nuclear site. OPG noted that beyond Highway 401 to the north, the land use is rural residential and agricultural. It noted that the St. Marys Cement facility is located east of the site with a residential neighbourhood bordering St. Marys further east. OPG stated that west of the site are agricultural uses, automotive uses, the Courtice water pollution control plant and Darlington Provincial Park. It noted that the urban areas within the local study area include residential, commercial and employment areas and are generally located in the Municipality of Clarington and in the City of Oshawa. OPG further noted that rural areas within the local study area include agricultural areas, rural hamlets and conservation uses.

OPG also provided descriptions of existing land uses elsewhere within the local study area, including anticipated future development such as 15,592 proposed residential units to be built in Clarington and 13,869 proposed residential units to be built in Oshawa, and planned employment areas.

OPG stated that no commercial fishery was identified in Lake Ontario within the Region of Durham.

OPG presented the following four land use scenarios to assess the land use effects of the Project:

1. Existing Land Uses;
2. Growth Scenario (2006–2031);
3. Growth Scenario (2032–2056); and
4. Long-term Growth Scenario (beyond 2056).

Figure 6: Region of Durham, Long-term Growth Scenario, presents the growth scenario of the Region of Durham from 2006 to 2056 and beyond.

Regarding changes in the use and development of land that may be brought about by the Project, OPG concluded that as the intensity of the use increases on the Darlington Nuclear site, the existing sensitive land uses surrounding the site would likely transition to employment and industrial uses. OPG noted that this was a reflection of land use change over time and was not deemed an effect of the Project.

OPG further concluded that the existing, planned future and long-term land use within the 10 kilometre land use assessment zone and beyond were not anticipated to conflict with the Darlington Nuclear site. OPG explained that the site includes an established nuclear facility and the proposed on-site activities are in keeping with the intended land use for the site as a nuclear generating facility. OPG noted that these activities include ancillary and auxiliary uses in relation to the generation of nuclear power. OPG further noted that limited planned and future growth to 2031 is proposed within proximity to the Darlington Nuclear site.

OPG described mitigation measures to reduce the potential temporary and long-term effects that the Project may have on land use, such as increased noise, dust and traffic. OPG stated that mitigation measures would include site screening and buffering, planned transport routes away from sensitive land uses and consideration of Canadian Nuclear Safety Commission Regulatory Document RD-346, *Site Evaluation for New Nuclear Power Plants* (September 2008) and Ontario Ministry of the Environment Guidance Document D-6, *Compatibility Between Industrial Facilities and Sensitive Land Uses* (July 1995). OPG also identified additional mitigation measures, including host community agreements and ongoing monitoring and discussion with the Region of Durham and the Municipality of Clarington on proposed land use changes and effects on implementation of emergency plans.

6.2.2 Panel Assessment

The Panel notes that CNSC staff retained the services of IBI Group to conduct the review of the land use information.

CNSC staff concurred with the OPG conclusion that existing and future land uses within proximity to the Darlington Nuclear site are not expected to conflict with the Project, particularly given that the proposed on-site activities are in keeping with the intended land use for the site as a nuclear generating facility.

According to CNSC staff, the evaluation of effects on land use and value was largely qualitative in nature, and as noted by the proponent, relied heavily on professional judgement and anticipated changes reasonably expected to result from the Project. Overall, the conclusions and claims made by the proponent related to land use and value appeared to be based on the most dependable data available and represented a reasonable assessment of the potential severity of negative effects to land use and value, particularly given the anticipated benefits of the Project. CNSC staff indicated that their review of comments received from governments and agencies responsible for regulating land use within the local and regional study areas, including the Municipality of Clarington, the City of Oshawa and the Region of Durham, suggested general satisfaction and agreement with the proponent's assessment of the potential effects of the Project on land use and values and proposed mitigation measures.

The Panel notes that CNSC staff concluded that the information submitted by OPG was sufficient to determine the potential adverse effects the Project could have on land use and values and their significance. The data and analysis provided by OPG illustrated that the Project is not likely to result in significant adverse environmental effects, taking into account the implementation of mitigation measures.

The Panel further assessed specific aspects of the mitigation measures proposed by the proponent. OPG presented the growth scenario for the Region of Durham up to 2056. The Panel notes that this scenario includes residential areas less than one kilometre from the fence of the site, in an area bordering Holt Road, planned between 2031 and 2056. The Panel further notes that a residential development is currently being built (see Table 9: Proposed Sensitive Land Uses within Close Proximity to the Darlington Nuclear Site, ID 18).

In Figure 7: Proposed Sensitive Land Uses within the Contiguous Zone of the Darlington Nuclear Site, this residential area appears to be included within the contiguous zone or primary evacuation zone of the Darlington Nuclear site.

Other residential developments in this zone have already been approved by the Municipality of Clarington Council, or are under review, as listed in Table 9.

The Panel considered the information presented by Emergency Management Ontario regarding the emergency response zones surrounding the Darlington Nuclear site. Figure 8: Primary Zone and Response Sectors, illustrates Emergency Management Ontario emergency primary zone and response sectors. Emergency Management Ontario explained that the Exclusion Zone is the one-kilometre on-site area inside the site boundary; the Primary Zone extends from the Exclusion Zone up to a 10-kilometre radius around the site. The Primary Zone includes a Contiguous Zone covering the area from the site boundary up to four kilometres immediately surrounding the Darlington nuclear site.

Emergency Management Ontario further stated that the Secondary Zone extends up to 50-80 kilometres around the site.

For the purpose of the environmental assessment, OPG described the Exclusion Zone for the Project as being 500 metres from the venting or release stacks of the new reactor facility, the Contiguous Zone as a three-kilometre radius and the Primary Zone as a 10-kilometre radius. The Municipality of Clarington measures these zones from the geographical centre of the entire Darlington Nuclear site.

The Panel recognizes that OPG has committed to continuing to engage in discussions with the Region of Durham and the Municipality of Clarington regarding future land use structure in the Primary and Contiguous zones. OPG has also indicated that it would continue to monitor land use activity in proximity to the Project and consult with the Municipality of Clarington and the Region of Durham on proposed land use changes and their effects to ensure maintenance of effective emergency response. The Panel notes, however, that residential development in the D3 area of Figure 8 is expected to take place after 2031 (see also Figure 6).

The Panel believes that OPG and the Municipality of Clarington may be on a

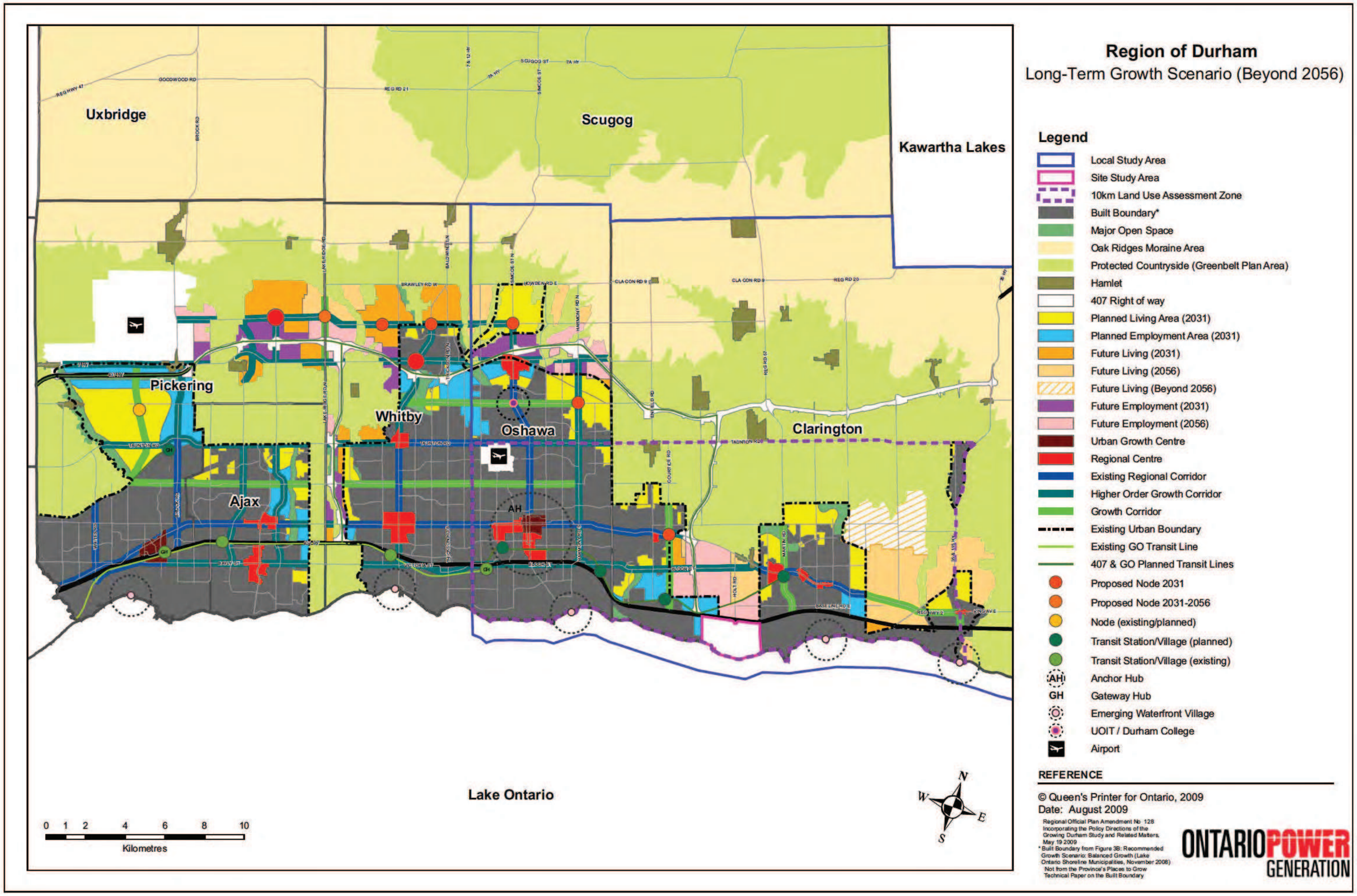

Figure 6: Region of Durham Long-term Growth Scenario

Table 9 - Proposed Sensitive Land Uses within Close Proximity to the Darlington Nuclear Site

Project Location	Application Type	Applicant	Land Use	Area (ha)	Total Units	Singles	Semis	Town-homes	Apts	Description of Application	Approval Date	Status
S. of railway tracks, W. of Green Rd. & N. of Baseline Rd. (PART LOT 17, CON 1)	Combined OPA / ZBLA / Subdivision	WED Investments Ltd. (The Kaitlin Group)	Residential	19.03	389	144	0	44	201	To permit 389 dwelling units, including 144 single detached, 44 townhouses and 201 medium density units, a park block and a public elementary school.	12/12/2005	Under Construction
Clarington Blvd., North of the CPR Rail Corridor	Combined ZBLA / Subdivision	829426 Ontario Ltd. (The Kaitlin Group)	Residential	0	250	0	0	0	0	To permit two blocks with 250 units in total.		With Staff
120, 124, 128, 132, 136 Aspen Springs Dr.	Condominium	Aspen Heights Ltd.	Residential	2.732	162	0	0	0	162	To permit 162 apartment units.	2/12/2007	Council Approved
N. of Baseline Rd. West (LOT 16, CON 1)	Combined ZBLA / Subdivision	970973 Ontario Ltd.	Residential	33.98	106	106	0	0	0	To permit 106 single detached dwelling units.	4/17/1996	Council Approved
Green Rd. & Bagnell Cres.	Part-Lot Control Exemption	Darlington Springs Ltd. (The Kaitlin Group)	Residential	0	98	66	0	32	0	To permit 66 single detached units and 32 townhouse dwelling units, a 1.99ha separate school block, a 1.78 ha neighbourhood park and a neighbourhood commercial block.		With Staff
John Scott Ave. (LOT 13, CON 1)	Combined ZBLA / Subdivision	Municipality of Clarington (Applicant)	Residential	1.34	19	19	0	0	0	To permit 19 single detached dwelling units.		With Staff
73 Remmington St. (N. of Bottrell St, & E. of Green Rd.)	Part-Lot Control Exemption	Aspen Springs West Ltd.	Residential	0.32	8	8	0	0	0	To permit construction of 8 single detached dwelling units.		With Staff
922 Green Rd. (Green Rd., S. of Baseline Rd.)	Combined OPA / ZBLA	896433 Ontario Ltd.	Residential	0	0	0	0	0	0	To convert lands that are currently designated as prestige employment lands to medium and low density residential uses. No residential breakdown has been given.		Application Received

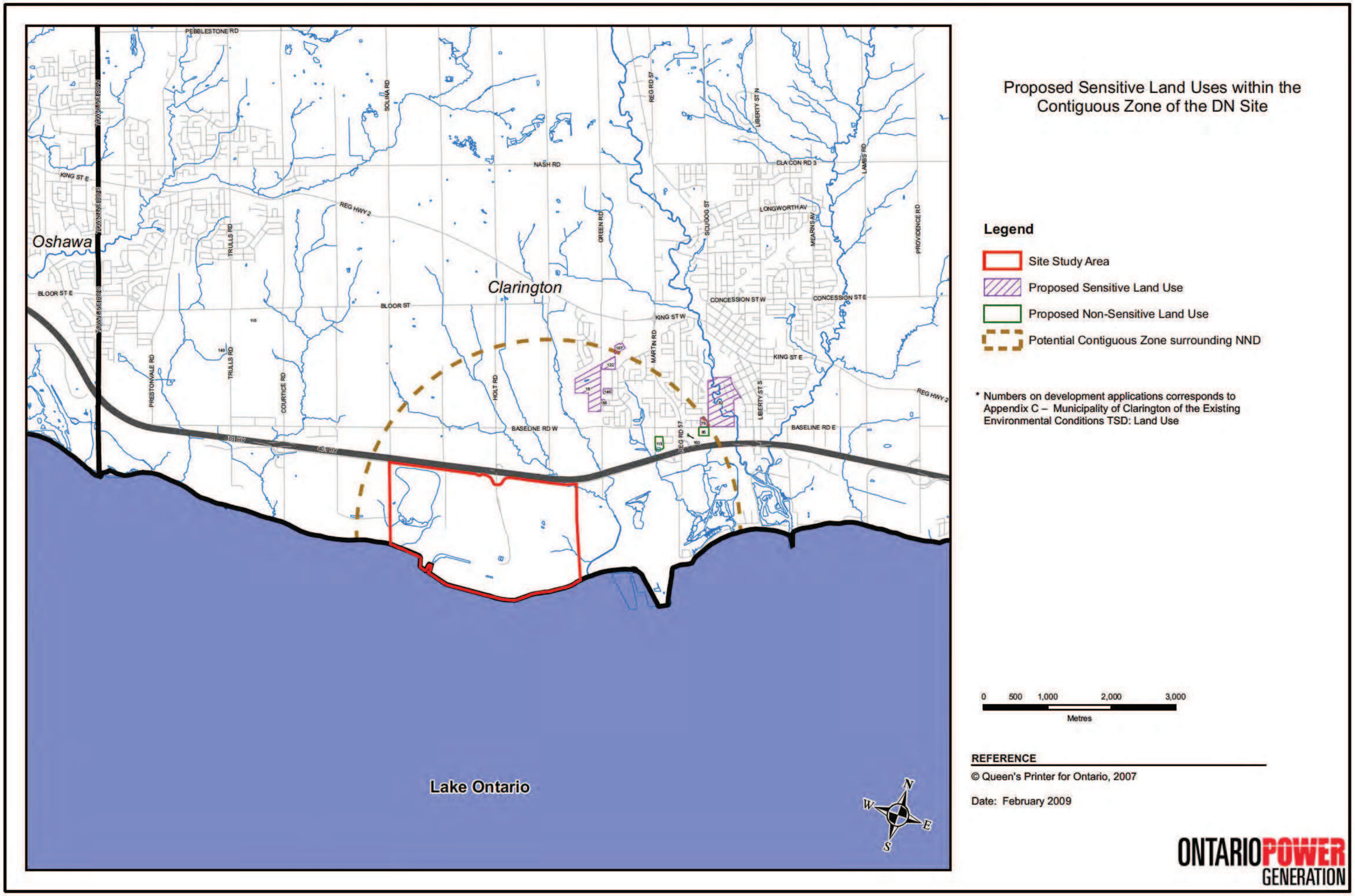

Figure 7: Proposed Sensitive Land Uses within the Contiguous Zone of the Darlington Nuclear Site

Figure 8: Primary Zone and Response Sectors

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'collision course' regarding the development of land neighbouring the Darlington site. Should the Municipality go ahead with the proposed residential developments between 2031 and 2056, a residential living area would be located less than one kilometre from the site boundary.

The Panel recognizes that OPG would be required to meet the dose acceptance criteria stipulated in Canadian Nuclear Safety Commission Regulatory Document RD-337*, Design of New Nuclear Power Plants* (November 2008). The Panel also recognizes that OPG has demonstrated that the dose consequences for anticipated occupational occurrences and design basis accidents meet the dose acceptance criteria in RD-337 as close as 500 metres from the containment for the reactors in the plant parameter envelope. Therefore, land development after 2031 could be permitted as planned and OPG would have no recourse to stop it.

During the hearing, the Panel heard that two schools, Dr. Ross Tilley Public School and Holy Family Separate School, are located 3.39 kilometres and 3.6 kilometres from the centre of the Darlington site, respectively. OPG confirmed that they were 2.8 kilometres and 3.1 kilometres respectively from the closest bounding location of the new reactors. The Panel notes that one of these schools is currently located within the Contiguous Zone for the Project.

Based on its discussion with Emergency Management Ontario at the hearing, the Panel is of the view that although there are appropriate measures in place to ensure that vulnerable populations, including hospitals, schools and retirement homes, can be safely evacuated in the event of an accident, it would be prudent to avoid such developments, and other residential developments, within a three-kilometre zone around the Project site.

The Panel is aware that as a result of incidents such as the 1984 accident in Bhopal, India, buffer zones between industrial developments and residential areas are often imposed. These are put in place not only for accident risk-abatement purposes but also for nuisance-avoidance and aesthetic purposes. The Panel is of the opinion that a situation similar to that in Pickering, where residential areas are found within three kilometres of a nuclear site, must be avoided. The Panel notes that the Municipality of Clarington was open to being given any development criteria in this respect.

Furthermore, given the apparent challenge encountered during the evacuation following the Fukushima Daiichi nuclear accident, the Panel is of the view that it would be prudent to avoid any further residential development north of Highway 401 in the D1, D2, D3 and D5 emergency response sectors. All of these areas are located less than three kilometres from the site boundary.

The Panel believes that appropriate steps must be taken to evaluate and define buffer zones around nuclear facilities in Canada, taking into consideration the lessons learned from the Fukushima Daiichi nuclear accident. The Panel believes that the Government of Ontario should take appropriate measures to ensure that no residential development takes place in the Contiguous Zone.

Recommendation # 43:
The Panel recommends that the Canadian Nuclear Safety Commission engage appropriate stakeholders, including OPG, Emergency Management Ontario, municipal governments and the Government of Ontario to develop a policy for land use around nuclear generating stations.

Recommendation # 44:
The Panel recommends that the Government of Ontario take appropriate measures to prevent sensitive and residential development within three kilometres of the site boundary.

Recommendation # 45:
The Panel recommends that the Municipality of Clarington prevent, for the lifetime of the nuclear facility, the establishment of sensitive public facilities such as school, hospitals and residences for vulnerable clienteles within the three kilometre zone around the site boundary.

6.3 Site Selection Considerations

This section includes the Panel's assessment of site selection for the Project.

6.3.1 Proponent Assessment

OPG stated that it carried out an evaluation of the Darlington Nuclear site to confirm its suitability for the Project in compliance with the

Canadian Nuclear Safety Commission Regulatory Document RD-346, *Site Evaluation for New Nuclear Power Plants*. Based on this evaluation, OPG concluded that the Darlington Nuclear site is suitable for the Project.

OPG noted that the Darlington Nuclear site has been home to the existing Darlington Nuclear Generating Station since 1990 and expressed the view that the performance and operational history of that facility has demonstrated the suitability of the site for that purpose. OPG further stated that the Darlington Nuclear site was originally planned for—and the current station designed with the intention of—eventually becoming a multi-station facility. OPG further stated that nothing has transpired in the subsequent years to render the site unsuitable for this purpose.

OPG noted that it did not evaluate any other sites for the proposed Project because the direction it received from the Government of Ontario was to proceed solely with an evaluation of the Darlington Nuclear site.

6.3.2 Panel Assessment

CNSC staff concluded that OPG provided sufficient information to satisfy the expectations set forth in RD-346. The Panel accepts the CNSC staff conclusion in this regard.

The Panel recognizes that some participants supported the location of the Project because an existing nuclear generating station is currently located at the site. The Panel also recognizes the views of participants who disagreed with the Government of Ontario's selection of the site for the Project. Participants were of the view that the site footprint cannot accommodate cooling towers without lake infill; the site is located near large populations and along the shore of Lake Ontario which is a source of drinking water for millions of inhabitants; and large releases from the Project could also have repercussions in Quebec and the United States. They also felt that proper emergency response measures were not in place to evacuate or relocate populations, for instance in the Greater Toronto Area, in the case of a severe accident. It was felt that alternative sites should have been evaluated by OPG.

The Panel acknowledges that all nuclear generating stations in Ontario are located in the Great Lakes St. Lawrence basin. The Panel recognizes that existing regulations require measures to ensure that severe nuclear accidents do not have significant consequences beyond the site boundary. However, the fact that such accidents have occurred in the last 25 years further emphasizes the need for a prudent approach.

Recommendation # 46:
Given that a severe accident may have consequences beyond the three and 10-kilometre zones evaluated by OPG, the Panel recommends that the Government of Ontario, on an ongoing basis, review the emergency planning zones and the emergency preparedness and response measures, as defined in the Provincial Nuclear Emergency Response Plan (PNERP), to protect human health and safety.

6.4 Current Use of Land and Resources by Aboriginal Persons

This section presents the Panel's assessment of the effects of the Project on traditional land use activities.

6.4.1 Proponent Assessment

OPG indicated that there was no current use of land and/or resources at the Project site, nor would the Project affect traditional land use activities.

OPG described the consultation activities it had undertaken. OPG stated that it engaged Aboriginal, First Nations and Métis communities to determine the lands or resources used by Aboriginal peoples for traditional purposes.

OPG also sought to incorporate traditional knowledge both in the development of the EIS and in the conduct of the environmental assessment.

OPG noted that it created a new knowledge fund to facilitate the contribution of new information and/or research findings that were of relevance to the environmental assessment. OPG further noted that the Métis Nation of Ontario received funding to support a Traditional Ecological Knowledge study.

OPG committed to continuing to engage Aboriginal groups throughout the environmental assessment and licensing processes. OPG concluded that there were no current issues of context of consideration of an Application for a Licence to Construct a reactor, once a technology has been selected. The Panel notes that this would be the stage when more complete design information would be available for more accident analyses in the context of conditions at the Project site. The Panel notes that CNSC staff accepted the information presented by the proponent as being a credible demonstration that the objectives of the review of reactor accidents and malfunctions have been met for the purposes of the environmental assessment.

The Panel is of the view that once a technology has been selected for the Project there will be a need for more specific analysis of potential accidents and the consequent releases and health effects. The review of the Application for a Licence to Construct the reactor would require confirmation that the health effects conclusion from the present assessment remains valid for the predicted accident conditions.

CNSC staff concluded that the Project is not likely to result in significant adverse environmental effects to the health and safety of workers and the public during accidents and malfunctions, taking into account the implementation of mitigation measures.

The Panel concludes that the Project is not likely to result in significant adverse environmental effects on the health and safety of workers and the public during accidents and malfunctions, taking into account the implementation of mitigation measures, such as the functioning of reactor safety systems and the on-site Consolidated Nuclear Emergency Plan and off-site emergency measures, along with the following recommendations.

Recommendation # 57:
The Panel recommends that prior to construction, the Canadian Nuclear Safety Commission require OPG to undertake an assessment of the off-site effects of a severe accident. The assessment should determine if the off-site health and environmental effects considered in this environmental assessment bound the effects that could arise in the case of the selected reactor technology.

Recommendation # 58:
The Panel recommends that prior to construction, the Canadian Nuclear Safety Commission confirm that dose acceptance criteria specified in RD-337 at the reactor site boundary—in the cases of design basis accidents for the Project's selected reactor technology—will be met.

7.3 Emergency Programs

This section presents the Panel's assessment of emergency planning and evacuation measures in the event of an accident at a nuclear power plant. Emergency planning and evacuation require collaborative action on the part of the nuclear facility operator and various levels of government.

7.3.1 Proponent Assessment

For emergency events at nuclear facilities, OPG stated that it has established comprehensive plans with the federal, provincial and municipal government departments that have responsibilities in this area. The purpose of these emergency plans is to ensure that workers at these facilities and members of the public affected by these events would be protected from harm.

OPG stated that emergency response plans for a nuclear reactor accident have been established and are implemented by municipal authorities and by departments and agencies in the provincial and federal governments. OPG further stated that in the case of the Darlington Nuclear site, the plans describe the arrangements for cooperation between it, the Government of Ontario, the Region of Durham and its municipalities, the City of Toronto, Health Canada and the Canadian Nuclear Safety Commission.

OPG stated that a detailed evacuation time estimate study was completed for workers and the public in various evacuation zones to demonstrate that an effective evacuation could be undertaken if a nuclear emergency were to occur with radioactive releases to the environment.

OPG stated that in its assessment of the capacity to respond to an accident at the Project, doses to the public for an upper-bound release were computed and compared to protective action levels established in the Ontario Provincial Nuclear Emergency Response Plan. OPG explained that the outcome was used to determine the need for sheltering, evacuation, and relocation, and to determine the effect on the affected population.

OPG noted that protective action levels, which are based on projected dose, are used as guides for the implementation of various protective actions in the event of a nuclear emergency. OPG stated that for the Government of Ontario to implement sheltering, the lower and upper levels of projected whole body dose to an individual must be one millisievert and 10 millisieverts, respectively. Similarly, the lower and upper levels of projected whole body dose to an individual for the Government of Ontario to implement evacuation are 100 millisieverts and 1000 millisieverts, respectively. Above the projected thyroid doses of 100 millisieverts and 1000 millisieverts, respectively, thyroid blocking would be initiated via the distribution of potassium iodide pills to those affected.

OPG indicated that relocation may be required for residents who are expected to receive a dose of 20 millisieverts or greater during the first year following an accident. OPG stated that the Government of Ontario has also indicated that there could also be a need for ingestion control measures to protect the food chain from contamination and prevent ingestion of contaminated food and water.

In the modelling of the assessed release developed for emergency response purposes, OPG made a number of assumptions concerning the reactor accident source term, the representation of releases from the reactor containment envelope, the model used for analysis of atmospheric dispersion, and treatment of off-site emergency response. OPG stated that the source terms considered were developed based on Canadian Nuclear Safety Commission RD-337 safety goal release thresholds. OPG explained that these source terms were used as bounding releases because they would represent the maximum releases for reactors that would be accepted for licensing in Canada.

OPG further stated that for the analysis of the effects of the accident, the release characteristics were based on an assumed containment hold-up time of 24 hours. OPG noted that after that period releases were modelled as continuous plumes spread over the course of 72 hours. OPG explained that the assumed release duration was representative of a wide range of possible accidents scenarios. OPG expressed the view that this was a reasonable assumption for the purpose of estimating the effects of releases for the environmental assessment.

OPG stated that mean meteorological conditions were assumed for the modelling of the dispersion of the release. OPG further stated that the dispersion analysis was performed using a computer model that has been adopted in many countries for atmospheric dispersion analysis. OPG noted that this modelling was conducted in a manner that was consistent with a standardized method provided in the Canadian Standards Association guideline CAN/CSA N288.2-M91 *Guidelines for Calculating Radiation Doses to the Public from a Release of Airborne Radioactive Material under Hypothetical Accident Conditions in Nuclear Reactors* (1991).

OPG stated that it evaluated evacuation time estimates to assess the feasibility of this emergency response measure for the modelled accident and release. OPG stated that the study area for the evacuation time estimates was the Emergency Planning Zones around the Darlington Nuclear site, which comprised two evacuation regions extending three kilometres and 10 kilometres from the centre of the Project site. OPG stated that it determined evacuation estimates for population and development data from 2006 and for forecasted conditions in 2025. OPG stated that the studies indicated that the 2025 population projection within a 10-kilometre radius of the site could be evacuated in less than nine hours.

7.3.2 Panel Assessment

The Panel notes that CNSC staff performed an evaluation of OPG's emergency response analysis. Based on its review of the information presented by OPG, CNSC staff concluded that the approach adopted by OPG and the assumptions and factors used for modelling the effects of safety goal-based releases were adequate for the purposes of the environmental assessment. Furthermore, CNSC staff stated that consideration of mean meteorological conditions, the assumption of a release duration of 72 hours, and the dispersion analysis computer code used by OPG were all acceptable options for this type of consequence analysis. CNSC staff also accepted that the OPG evacuation time-estimate study demonstrated that an effective evacuation could be completed within a period prior to the anticipated first release of radioactive products from the reactor containment envelope.

Based on the safety goal-based release assessment completed by OPG and the view of CNSC staff, the Panel accepts that an effective evacuation can be completed as required by criteria established by the Government of Ontario for the ten-kilometre-Primary Zone. This conclusion is based on assumed demographics in the region around the site, the implementation of proposed road improvements and the absence of sensitive groups that might require special assistance to move out of the evacuation zone. Given these cautions, the Panel recommends that measures be taken to assure continued capacity for effective evacuation of the zone around the site.

The Panel notes that the assessment presented by the proponent for a nuclear reactor accident followed by off-site releases focused primarily on protection of the health of workers and the public. Beyond this effect, there could be social and economic effects of contamination from the off-site releases that could impact the surrounding area, including Lake Ontario. These are effects that could require remediation over an extended period of time following an accident. OPG presented information of predicted dose rates at various distances from the Project as well as information on criteria for sheltering, evacuation and for long-term relocation in the event of contamination from the release plumes. The latter consequence is a reason for requiring nuclear liability insurance that would provide coverage of social effects and remediation that may be required in the vicinity of the site. The Panel is of the view that the level of liability insurance should be adequate to cover effects and remediation required in the case of a severe accident at the new reactor site. The Panel will address this matter in a later section of this report.

The Panel concludes that although OPG has developed a reasonable emergency response plan in cooperation with all levels of government, there are a number of areas that should be enhanced. As such, the Panel makes the following recommendations.

Recommendation # 59:
The Panel recommends that the Municipality of Clarington manage development in the vicinity of the Project site to ensure that there is no deterioration in the capacity to evacuate members of the public for the protection of human health and safety.

Recommendation # 60:
The Panel recommends that prior to construction, the Government of Canada review the adequacy of the provisions for nuclear liability insurance. This review must include information from OPG and the Region of Durham regarding the likely economic effects of a severe accident at the Darlington Nuclear site where there is a requirement for relocation, restriction of use and remediation of a sector of the regional study area.

7.4 Conventional Malfunctions and Accidents

This section presents the Panel's assessment of the environmental effects of conventional malfunctions and accidents. Conventional malfunctions and accidents are events that only involve non-radiological substances with no potential for release of radioactivity, or other events that result in injury to workers.

7.4.1 Proponent Assessment

OPG identified a number of potential accident scenarios for each phase of the Project. These scenarios were screened to focus on those that were considered to be credible and had potential to affect workers, the public or the environment. OPG stated that five credible bounding scenarios were assessed for potential effects in the environment. These bounding scenarios included a spill of hydrazine, a spill of oil on land, a spill of fuel in Lake Ontario, a spill of chemicals and a fire or an explosion.

Another category of conventional accident considered by OPG was the occurrence of serious injuries in the workplace. This would apply particularly in the case of workers during the site preparation and construction phase of the Project. OPG noted that activities in workplaces in the Province of Ontario are subject to the Ontario *Occupational Health and Safety Act* (R.S.O. 1990, c. O.1), which serves as a framework for the management of worker safety.

Canada's Nuclear Regulator

CNSC Integrated Action Plan

On the Lessons Learned From the Fukushima Daiichi Nuclear Accident

August 2013

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

CNSC Integrated Action Plan on the Lessons Learned From the Fukushima Daiichi Nuclear Accident

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Document availability

This document can be viewed on the CNSC Web site at nuclearsafety.gc.ca or to request a copy of the document in English or French, please contact:

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Preface

This document is prepared by the Canadian Nuclear Safety Commission (CNSC), and describes specific actions to be implemented by staff, licensees and affected federal and provincial stakeholders, to strengthen the defence in depth of Canadian nuclear power plants (NPPs) and major nuclear facilities (Class I nuclear facilities and uranium mines and mills), enhance emergency preparedness, as well as improve regulatory oversight and crisis communication capabilities. This document supersedes all previous versions of the *CNSC Action Plan*.

This *CNSC Integrated Action Plan* encompasses all public and stakeholders' recommendations and comments received during public consultations, as well as the outcomes from two independent reviews: one by the International Atomic Energy Agency (IAEA) Integrated Regulatory Review Service (IRRS) follow-up mission, and the second by an external advisory committee (EAC) established by the President of the CNSC. The IRRS mission concluded that the CNSC response to the Fukushima Daiichi Nuclear accident was robust and comprehensive, and that the CNSC had an "effective and pragmatic framework" in place to implement the lessons learned from this event. In turn, the EAC concluded that the CNSC had acted promptly and appropriately to the Fukushima Daiichi events. The EAC also identified some areas for further enhancements that were considered in the development of the draft *CNSC Action Plan.*

The CNSC Fukushima Task Force concluded that Canadian NPPs are safe and rely on multiple layers of defence in depth. Additional CNSC staff reviews, conducted in response to the event, confirmed that major nuclear facilities and uranium mines and mills are safe, and pose a very small risk to the health and safety of Canadians, or to the environment.

The CNSC management has endorsed the findings and recommendations of the Fukushima Task Force and committed to address each recommendation, as well as those of the EAC, together with comments from stakeholders, through actions described in this *CNSC Integrated Action Plan.*

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Executive Summary

On March 11, 2011, a magnitude 9.0 earthquake, followed by a devastating tsunami, struck Japan. The combined impacts of the earthquake and tsunami caused a severe nuclear accident at the Fukushima Daiichi nuclear power plants (NPP). In response to these events, the Canadian Nuclear Safety Commission (CNSC) requested all licensees of Class I nuclear facilities (which include nuclear processing plants, waste and research facilities) and uranium mines and mills to conduct a review of the initial lessons learned from Fukushima, under subsection 12(2) of the *General Nuclear Safety and Control Regulations*.

In April 2011, the CNSC Executive Vice-President and Chief Regulatory Operations Officer convened a task force to review the licensees' responses to the 12(2) request and evaluate the operational, technical and regulatory implications of the Fukushima Daiichi nuclear accident for the Canadian NPPs. In parallel, CNSC staff reviewed non-power reactor facilities, as well as uranium mines and mills, to confirm that these installations were safe and adequately prepared to deal with potential emergencies. The non-power reactor reviews used a risk-informed approach consistent with the recommendations of the CNSC Task Force, taking into account the specificities of the facilities (including licensed activities, site characteristics and nature of the hazards present at each nuclear site). The areas of improvement identified by the CNSC Task Force for NPPs were also considered for all Class I facilities, and applied in a graded approach.

To address the CNSC Task Force recommendations, the CNSC developed a draft *CNSC Action Plan*, which was presented to the Commission for consideration at a public meeting on May 3, 2012. The document established a four-year plan, for both licensees and CNSC staff, to strengthen reactor defence in depth, enhance emergency response, improve regulatory oversight and crisis communication capabilities, and enhance international collaboration.

The draft *CNSC Action Plan* was subjected to three rounds of public consultations and two independent reviews: one by the International Atomic Energy Agency (IAEA) Integrated Regulatory Review Service (IRRS) follow-up mission, and the second by an external advisory committee (EAC) established by the President of the CNSC. The IRRS mission concluded that the CNSC response to the Fukushima Daiichi nuclear accident was robust and comprehensive, and that Canada had an "effective and pragmatic framework" in place to implement the lessons learned from the event. The EAC concluded that the process followed by the CNSC in response to the accident was appropriate, and identified a number of complementary areas for further enhancements.

At the May 3, 2012 public meeting, the Commission requested that CNSC staff broaden the draft *CNSC Action Plan* to better integrate the EAC recommendations – in particular, to clarify the outcomes of the Fukushima reviews for nuclear facilities other than NPPs, examine areas of human and organizational performance, and to address crisis communication.

This document presents the *CNSC Integrated Action Plan* to be implemented by licensees and CNSC staff. The document reflects comments received from stakeholders during public consultations, and integrates the outcomes from the two independent reviews by the IAEA and EAC, as well as responses to the Commission's requests.

Progress on the implementation of the *CNSC Integrated Action Plan* will be reported to the Commission annually.

Benchmarking activities have demonstrated that the CNSC actions to date compare favourably to those of international peers and in certain areas exceeded international efforts. Nuclear facilities in Canada were found to be safe and pose a very small risk to the health and safety of Canadians and the environment. This *CNSC Integrated Action Plan* is intended to enhance the safety of these facilities and provide to the Commission a clear statement of planned improvements. The implementation status will be reported annually.

1. Overview

On March 11, 2011, a magnitude 9.0 earthquake, followed by a devastating tsunami, struck Japan. The combined impacts of the earthquake and tsunami caused a severe nuclear accident at the Fukushima Daiichi nuclear power plants (NPP). In response to these events, the Canadian Nuclear Safety Commission (CNSC) issued a request to all Class I nuclear facilities, under subsection 12(2) of the *General Nuclear Safety and Control Regulations*, to re-examine the safety cases of their nuclear facilities. In April 2011, the CNSC Executive Vice-President and Chief Regulatory Operations Officer announced the establishment of a task force to evaluate the operational, technical and regulatory implications of the nuclear accident in relation to Canadian NPPs.

On September 30, 2011, the CNSC Fukushima Task Force completed its review and presented its findings and recommendations in the *CNSC Fukushima Task Force Report* (Task Force report). The Task Force made 13 recommendations to further enhance the safety of Canadian NPPs, with a particular emphasis on:

- the capability of Canadian plants to withstand external hazards comparable to those that triggered the Fukushima Daiichi nuclear accident
- emergency preparedness and response in Canada
- the effectiveness of the CNSC regulatory framework
- international collaboration

CNSC Action Plan

To address the CNSC Task Force recommendations, the CNSC developed a four-year *CNSC Action Plan* to be implemented by licensees and CNSC staff to:

- strengthen reactor defence-in-depth
- enhance emergency response
- improve the regulatory framework, and
- foster international collaboration.

The *CNSC Fukushima Task Force Report* and *CNSC Action Plan on the CNSC Fukushima Task Force Recommendations* were subjected to public consultations and independent reviews, as outlined in the following sections.

Public consultations

After the preparation of the draft Task Force report, the CNSC embarked on a series of public consultations to seek additional input and create broader public awareness of the nuclear accident and to engage stakeholders in the development of measures to address the lessons learned from the accident. These activities included:

- October 28, 2011: Round 1 consultation on the Task Force report and accompanying CNSC management response document
- December 21, 2011: Round 2 consultation on the draft *CNSC Action Plan on the Lessons Learned From the Fukushima Nuclear Accident* and the comments received during the first round
- March 2, 2012: Round 3 consultation on the draft *CNSC Action Plan on the Lessons Learned From the Fukushima Nuclear Accident* and comments received during the previous consultation

- May 3, 2012: Presentation to the Commission of supplementary CMD 12-M23.B, integrating the EAC recommendations for actions related to NPPs, major nuclear facilities other than NPPs and, communication and public education.

External advisory committee report

On August 5, 2011, the President of the CNSC established an external advisory committee (EAC), to provide an independent assessment of the federal regulator's actions in response to the Fukushima Daiichi nuclear incident, and to make recommendations for improvements. The EAC submitted its final report on April 12, 2012.

The EAC concluded that the process followed by the CNSC in responding to the Fukushima Daiichi nuclear event was appropriate. This included a flexible, open and transparent process, with three opportunities for public input in the development of its response. The resulting *CNSC Action Plan* established the measures needed to strengthen defence in depth for major nuclear facilities, enhance emergency preparedness and response in Canada and improve the CNSC regulatory framework and processes. In carrying out its mandate, the EAC noted areas for improvement. In particular, these covered: (1) public communication in layman's terms, when describing complex technical matters related to nuclear safety; (2) added clarity on the outcome of the safety assessments of non-NPP facilities; and (3) the incorporation of human and organizational performance aspects in actions being considered to address the apparent gaps identified in the *CNSC Fukushima Task Force Report*.

Specifically, the EAC recommended that the CNSC:

1. continue to work with regulators of other member states of the International Atomic Energy Agency (IAEA) to ensure that the Integrated Regulatory Review Service (IRRS) process is mandatory and transparent, and that the findings and recommendations are enforced
2. work with its fellow regulators in convincing World Association of Nuclear Operators (WANO) members to share the results of their peer review process to promote nuclear safety in all nations with nuclear power plants
3. work with other government departments to ensure better coordination and redefinition of departmental roles and responsibilities should a nuclear accident occur in Canada, the United States or overseas
4. meet with its partner organizations and licensees to establish the frequency and extent of multi-level emergency exercises
5. clarify its position on the 12(2) orders with respect to the non-NPPs
6. examine the area of human and organizational performance (HOP) to achieve a more complete understanding of lessons learned from the Fukushima crisis
7. clarify its plans to address tornado hazards
8. develop a comprehensive communication and education strategy that includes the use of various tools including social media and expands partnerships and relationships with various science media organizations that have the ability to inform the public on nuclear safety
9. should play an active role in ensuring that emergency planning exercises with the United States are conducted regularly

The above recommendations have been fully addressed through the consideration of specific actions, including the assessment of design-basis and beyond-design-basis tornado hazards identified by the CNSC Fukushima Task Force, within the related sections of the *CNSC Integrated Action Plan*.

International Atomic Energy Agency (IAEA) follow-up mission

From November 28, 2011 to December 9, 2011, the CNSC hosted an international team of experts for a follow-up IAEA Integrated Regulatory Review Service (IRRS) mission, which included a review dedicated to the regulatory implications of the Fukushima Daiichi nuclear accident for the Canadian nuclear industry. The IRRS report stated that CNSC actions and responses to the nuclear accident were prompt, comprehensive and robust. Specifically, the IRRS team rated the CNSC response to the Fukushima event as a good practice and approach for international peers to follow, indicating as well that the Canadian regulator had systematically and thoroughly reviewed the lessons learned from the accident, and had made full use of available information, including the review of actions taken by other international regulators.

The IRRS team also acknowledged that the CNSC has an “effective and pragmatic” regulatory framework in place to follow up on the Fukushima Daiichi nuclear accident. The IRRS team did not raise any concerns or make any observations that impacted the draft *CNSC Action Plan*.

Requests from the Commission

Comments from all public consultations (together with revisions to the draft *CNSC Action Plan* arising from EAC recommendations) were presented to the Commission for endorsement at a public meeting on May 3, 2012.

The Commission requested that CNSC staff broaden the draft *CNSC Action Plan* to better integrate the EAC recommendations. Specifically, staff was requested to consider the measures identified by the EAC to clarify the outcome of the Fukushima reviews for major nuclear facilities (other than NPPs), to improve crisis communication, and to consider human and organizational performance.

The actions outlined in this *CNSC Integrated Action Plan* reflect the outcome and comments received from stakeholders during public consultations; they also incorporate the recommendations of the EAC and response to the Commission requests from the May 2012 public meeting.

2. *CNSC Integrated Action Plan*

CNSC staff revised the *CNSC Action Plan*, to reflect the EAC recommendations, as well as the comments received from the public and stakeholders during the three rounds of public consultations, and to address the Commission’s requests.

The *CNSC Action Plan* was based on the findings and recommendations of the *CNSC Fukushima Task Force Report*, which led to the development of specific actions for licensees and the CNSC, aimed at strengthening defence in depth, enhancing emergency response, improving the regulatory framework and enhancing international collaboration. Subsequently, the *CNSC Action Plan* was amended to integrate measures arising from the CNSC staff’s post-Fukushima reviews of major nuclear facilities (other than NPPs) and, as well as the EAC’s recommendation concerning improved crisis communication capabilities.

The *CNSC Integrated Action Plan* is thus applied to all major nuclear facilities and consists of the following categories:

- strengthening defence in depth
- enhancing emergency response

- improving the regulatory framework and processes
- enhancing international collaboration
- communications and public consultation

The independent review conducted by the EAC complemented the findings of the Task Force, particularly in areas of shared responsibilities with other government departments or international regulators.

The EAC also recommended that the CNSC examine the areas of human and organizational performance (HOP) to achieve a more complete understanding of lessons learned from the events in Japan. CNSC staff recognizes HOP is integral to all design, analysis and procedural activities, and supports all levels of defence in depth. As part of the design-basis of NPP operations, the CNSC has in place a comprehensive HOP program that assesses elements such as safety culture, minimum shift complement and fitness for service.

CNSC staff will therefore examine HOP in beyond-design-basis scenarios and accident management. Actions affected by the EAC report have been modified to incorporate HOP considerations. Licensee submissions are expected to demonstrate support of their implementation of the *CNSC Integrated Action Plan*, while taking into account the necessary HOP factors, according to the criteria and expectations developed by CNSC staff.

2.1 Actions related to nuclear power plants

The actions presented in **Annex A – Actions Related to Nuclear Power Plants** outline the measures imposed on nuclear power plant (NPP) licensees to fully address the *CNSC Fukushima Task Force Report* and EAC recommendations, as well as actions required of the CNSC and affected government stakeholders.

The *CNSC Management Response to CNSC Fukushima Task Force Recommendations* – released concurrently with the *CNSC Fukushima Task Force Report* – established the timeline for implementing the *CNSC Action Plan* in a phased approach (in the short-, medium- and long-term timeframe), as shown in table 1 below.

The management response also established general guidance for implementing these recommendations, consistent with risk-informed considerations and related cost-benefit implications.

The actions described in **Annex A** for each recommendation include the following information:

- specific Task Force recommendation
- associated EAC recommendation(s), where applicable
- actions arising from the recommendations include:
    - required deliverable(s)
    - applicable site
    - timeline for completion
- implementation details for the overall recommendations

Table 1: Task Force recommendations and implementation timeline

CNSC Task Force recommendations	Implementation timeline		
	Short-term (Dec. 2012)	**Medium-term (Dec. 2013)**	**Long-term (Dec. 2015)**
Strengthening reactor defence in depth			
1. Verify robustness of NPP designs	✓	✓	✓
2. Assessment of site-specific external hazards		✓	✓
3. Enhance modelling capabilities		✓	
Enhancing emergency response			
4. Assess emergency plans (onsite)	✓		
5. Update emergency facilities and equipment	✓		
6. Offsite emergency plans and programs		✓	
Improving the regulatory framework and processes			
7. *Class I Nuclear Facilities Regulations* amendments		✓	
8. *Radiation Protection Regulations* amendments		✓	
9. Update regulatory document framework	✓	✓	
10. Amend power reactor operating licences	✓		
11. Implementation of periodic safety reviews	✓		
Enhancing international collaboration			
12. Enhance collaboration with CANDU owner countries	✓		
13. Enhance international cooperation	✓		

2.2 Actions related to major nuclear facilities other than NPPs

The review of major facilities other than NPPs was not implicit in the *CNSC Fukushima Task Force Terms of Reference* but was subsequently conducted under the CNSC request to licensees of Class I nuclear facilities and uranium mines and mills, under subsection 12(2) of the *General Nuclear Safety and Control Regulations*.

The Task Force was mandated to focus on NPPs for two reasons. Firstly, the accident took place at a nuclear plant, and therefore the early lessons learned were most relevant to NPPs. Secondly, NPPs (unlike most other Canadian major nuclear facilities) require cooling for a significant period of time following shutdown, to maintain fuel and containment integrity. This adds a level of complexity to accident management and emergency response at a power plant, which does not exist at other facilities. Given this complexity, CNSC staff applied a graded, risk-informed approach for the review of major nuclear facilities other than NPPs.

The major nuclear facilities under consideration include: the Chalk River Laboratories (including the National Research Universal [NRU] reactor), small Canadian research reactors, Class I accelerators, uranium processing facilities, nuclear substance processing facilities, uranium mines and mills and waste management facilities. Since the Chalk River Laboratories (that include the NRU), which are operated by Atomic Energy of Canada Limited (AECL), were in the process of re-licensing in 2011, the response from AECL on Fukushima was incorporated into the CNSC staff licence renewal reviews. The appropriate Fukushima-related actions were added to the licence and NRU *Integrated Implementation*

Plan in October 2011. This was an important part of the public hearings on the licence renewal in June and October 2011. The impact of Fukushima has also been discussed with the Commission at licence renewals for other major nuclear facilities (e.g., Cameco's Blind River and Port Hope facilities) and update reports to the Commission since March 2011.

Table 2 presents the CNSC staff recommendations used for major nuclear facilities (other than NPPs) on strengthening defence in depth, enhancing emergency response, improving the regulatory framework and enhancing international collaboration along with associated timeline for completion. These are closely aligned with the recommendations of the CNSC Task Force with respect to NPPs, as shown in **Annex B**.

Table 2: Major nuclear facilities (other than NPPs) actions and implementation timeline

CNSC Staff recommendations	Implementation timeline		
	Short-term (Dec. 2012)	**Medium-term (Dec. 2013/14)**	**Long-term (Dec. 2016)***
Strengthening defence in depth			
1. Review facilities' safety case	✓	✓	✓
2. Assessment of site-specific external hazards	✓	✓	✓
3. Enhance modelling capabilities (NRU)		✓	✓
Enhancing emergency response			
4. Assess emergency plans (onsite)	✓	✓	✓
5. Update emergency facilities and equipment (CRL)	✓	✓	✓
6. Offsite emergency plans and programs		✓	
Improving the regulatory framework and processes			
7. Improve the regulatory framework and processes		✓	
Enhancing international collaboration			
8. Enhance international collaboration	✓		

* to coincide with the Chalk River Laboratories licence expiry

The actions required of the CNSC and licensees to address the gaps identified by CNSC staff in their review of licensee 12(2) submissions and from the EAC recommendations to strengthen defence in depth and enhance emergency preparedness related to nuclear facilities other than NPPs are presented in **Annex B - Actions Related to Major Nuclear Facilities (Other Than NPPs)**.

The implementation timeframe for actions by CNSC staff and nuclear facilities other than NPPs are consistent with the *CNSC Management Response to CNSC Fukushima Task Force Recommendations*. These actions will be completed in the short-term, medium-term and long-term timeframe.

2.3 Actions related to communication and public education

The EAC recommended that the CNSC develop a comprehensive communication and education strategy, which incorporates the use of various tools – including social media and expanded partnerships and relationships with various science media organizations that have the ability to inform the public on nuclear safety. Moreover, the EAC stressed the importance of communication and public education to provide complex and technical information to members of the public in clear, plain language and in an accessible manner, using the latest technological tools (including social media). The following section highlights several CNSC initiatives that were identified to enhance communications with stakeholders and the public.

The program areas identified by CNSC staff to enhance communications with stakeholders, strengthen readiness, and improve cooperation and ties with organizations involved in the dissemination of information related to nuclear safety include:

- CNSC Web site and social media
- crisis Web site
- educational initiatives
- media
- international participation
- extreme accident scenario video

The CNSC communications and education response to Fukushima consists of several measures and programs to be implemented in the short-term, medium-term and long-term timeframe. The actions required of the CNSC to address the communication gaps identified in the *CNSC Fukushima Task Force Report* and EAC report are presented in **Annex C - Actions Related to Communications and Public Education.**

3. Implementation

The *CNSC Integrated Action Plan* will be implemented by licensees (through existing regulatory oversight programs) for initiatives that pertain to design and operational enhancements, or by the CNSC for those actions dealing with regulatory framework improvements, communications and education, and enhanced international collaboration.

Sharing information and ensuring the public receives clear and consistent information is critical during an emergency. In keeping with its mandate to disseminate objective scientific, technical and regulatory information, the CNSC continues to improve communication and public education, including better communication to Canadians in the event of a nuclear emergency.

Effective clear language communications with stakeholders and the public is a process that requires continuous improvement, and evolves along state-of-the-art means of communication technology. The CNSC is continuously evaluating all facets and means of communication, to remain relevant and to maintain a strong presence in this ever-changing and evolving media.

The Commission will be kept informed on the *CNSC Integrated Action Plan* implementation progress, through annual updates by CNSC staff.

4. Conclusion

The CNSC Fukushima Task Force confirmed that Canadian nuclear power plants are safe and have a robust design that relies on multiple layers of defence. The CNSC management has endorsed the findings and recommendations of the Task Force, and has committed to addressing each recommendation through the actions outlined in this *CNSC Integrated Action Plan,* together with those of the EAC.

CNSC staff also concluded that Class I major nuclear facilities, as well as uranium mines and mills licensees, have demonstrated a strong commitment to nuclear safety. Reviews and safety assessments post-Fukushima demonstrate that these facilities are safe and do not pose any significant risk to the health and safety of Canadians, or to the environment.

To address the recommendations made by the *CNSC Fukushima Task Force Report*, together with those of the EAC report, the CNSC has developed an integrated action plan to reinforce defence in depth at Canadian NPPs, enhance the safety of non-power reactor facilities, strengthen emergency preparedness, improve the regulatory framework, foster international collaboration, and enhance crisis communication capabilities.

The *CNSC Integrated Action Plan* reflects stakeholder input (obtained through several rounds of public consultations), incorporates the outcomes of independent reviews (made by the IAEA and the EAC), and responds to the requests of the Commission.

CNSC staff will update the Commission annually on the *CNSC Integrated Action Plan*'s implementation progress by licensees and staff.

Annex A - Actions Related to Nuclear Power Plants

Part A1 – Strengthening reactor defence in depth

The CNSC Task Force confirmed that Canadian nuclear power plants (NPPs) are safe and have a robust design that relies on multiple layers of defence. The design ensures that there will be no impact on the public from external events regarded as credible. The design also offers protection against more severe external events that are much less likely to occur. Nevertheless, the CNSC Task Force recommended strengthening each layer of defence built into the Canadian NPP design and licensing philosophy.

Human and organizational performance (HOP) is integral to all design, analysis and procedural activities and supports all levels of defence in depth. As part of the design-basis of NPP operations, the CNSC has in place a comprehensive HOP program, which assesses elements such as safety culture, minimum shift complement and fitness for service. CNSC staff will examine HOP in beyond-design-basis scenarios and accident management.

Furthermore, CNSC staff will review regulatory documents to ensure that they adequately address all potential external hazards, including tornadoes. Any identified changes will be addressed through the existing regulatory document preparation process.

Certain design enhancements for severe accident management – such as containment performance (to prevent unfiltered releases of radioactive products), control capabilities (for hydrogen and other combustible gases), and adequacy and survivability of equipment and instrumentation – will be evaluated and implemented wherever practicable. Some of these measures have already been implemented. The following sections describe actions needed to strengthen each layer of defence in depth.

Recommendation 1 – Verify the robustness of NPP designs

Task Force recommendation

Licensees should systematically verify the effectiveness of, and supplement where appropriate, the existing plant design capabilities in beyond-design-basis accident and severe accident conditions, including:

a) overpressure response of the main systems and components **(Actions A.1.1, A.1.2)**
b) containment performance to prevent unfiltered releases of radioactive products **(Action A.1.3)**
c) control capabilities for hydrogen and other combustible gases:
    i) accelerate installation of the hydrogen management capability and sampling provisions **(Action A.1.4)**
    ii) include spent fuel bays and any other areas where hydrogen accumulation cannot be precluded **(Action A.1.5)**
d) make-up capabilities for the steam generators, primary heat transport system and connected systems, moderator, shield tank and spent fuel bays **(Actions A.1.6, A.1.7, A.1.8, A.1.9)**
e) design requirements for the self-sufficiency of a plant site, such as availability and survivability of equipment and instrumentation following a sustained loss of power, and capacity to remove heat from a reactor **(Action A.1.10)**
f) control facilities for personnel involved in accident management **(Action A.1.9)**
g) emergency mitigating equipment and resources that could be stored offsite and brought onsite if needed **(Action A.1.11)**

EAC recommendation 6

The EAC recommends that the CNSC examine the area of human and organizational factors, to achieve a more complete understanding of lessons learned from the Fukushima crisis. **(This recommendation has been applied to actions A.1.3, A.1.6, A.1.7, A.1.8, A.1.9, A.1.10, A.1.11.)**

CNSC staff actions

A.1.1 Action:
Licensees should submit additional evidence (e.g., test results) that provide confidence in the bleed condenser/degasser condenser relief capacity.

Action item(s):
A.1.1.1 An updated evaluation of the capability of bleed condenser/degasser condenser relief valves, providing additional evidence that the valves have sufficient capacity.
A.1.1.2 If required, a plan and schedule either for confirmatory testing of installation or provision for additional relief capacity.

Applicable to: All sites.

Timeline: Completion by end of December 2012.

A.1.2 Action:
Licensees should re-examine the capability of the shield tank/calandria vault relief to discharge steam produced in a severe accident. The benefits of sustainability of shield tank heat sink during accident conditions should also be re-examined.

Action item(s):
A.1.2.1 An assessment of the capability of shield tank/calandria vault relief.
A.1.2.2 If relief capacity is inadequate, an assessment of the benefits available from adequate relief capacity and the practicability of providing additional relief.
A.1.2.3 If additional relief is beneficial and practicable, a plan and schedule for provision of additional relief.

Applicable to: All sites.

Timeline: Completion by end of December 2013.

A.1.3 Action:
Licensees should evaluate the means to prevent the failure of the containment systems and, to the extent practicable, unfiltered releases of radioactive products in beyond-design-basis accidents including severe accidents. If unfiltered releases of radioactive products in beyond-design-basis accidents including severe accidents cannot be precluded, then additional mitigation should be provided. This assessment should consider elements of HOP under accident conditions.

Action item(s):
A.1.3.1 Assessments of adequacy of the existing means to protect containment integrity and prevent uncontrolled release in beyond-design-basis accidents including severe accidents.

A.1.3.2 Where the existing means to protect containment integrity and prevent uncontrolled releases of radioactive products in beyond-design-basis accidents including severe accidents are found inadequate, a plan and schedule for design enhancements to control long-term radiological releases and, to the extent practicable, unfiltered releases.

Applicable to: All sites.

Timeline: Completion by end of December 2015.

A.1.4 Action:
Licensees should complete the installation of passive autocatalytic recombiners (PARs) as quickly as possible.

Action item(s):
A.1.4.1 A plan and schedule for the installation of PARs as quickly as possible.

Applicable to: All sites.

Timeline: Completion by end of December 2012.

A.1.5 Action:
If draining of the irradiated fuel bay (IFB) following a beyond-design-basis event cannot be precluded, the need for hydrogen mitigation should be evaluated.

Action item(s):
A.1.5.1 An evaluation of the potential for hydrogen generation in the IFB area and the need for hydrogen mitigation.

Applicable to: All sites.

Timeline: Completion by end of December 2013.

A.1.6 Action:
Licensees should evaluate the structural integrity of the IFB at temperatures in excess of the design temperature limit. If structural failure cannot be precluded, then additional mitigation (e.g., high-capacity make-up or sprays) should be provided. Consequences of the loss of shielding should be evaluated. This assessment should consider elements of HOP under accident conditions.

Action Item(s):
A.1.6.1 An evaluation of the structural response of the IFB structure to temperatures in excess of the design temperature, including an assessment of the maximum credible leak rate following any predicted structural damage.
A.1.6.2 A plan and schedule for deployment of any additional mitigating measures shown to be necessary by the evaluation of structural integrity.

Applicable to: All sites.

Timeline: Completion by end of December 2013.

A.1.7 Action:

Licensees should evaluate means to provide coolant make-up to the primary heat transport system, steam generators, moderator, shield tank/calandria vault, spent fuel pools and dousing tank where applicable. Means include:

1. Coolant make-up to prevent severe core damage.
2. If severe core damage cannot be precluded, then the make-up coolant should be used in severe accident management guidelines (SAMG) to mitigate the severe accident.

This assessment should consider elements of HOP under accident conditions.

Action item(s):

A.1.7.1 A plan and schedule for optimizing existing provisions and putting in place additional coolant make-up provisions and supporting analyses.

Applicable to: All sites.

Timeline: Completion by end of December 2013.

A.1.8 Action:

Licensees should provide a reasonable level of confidence that the means (e.g., equipment and instrumentation) necessary for severe accident management and essential to the execution of SAMGs will perform their function in the severe accident environment for the duration for which they are needed. This assessment should consider elements of HOP under accident conditions.

Action item(s):

A.1.8.1 A detailed plan and schedule for performing assessments of equipment and instrumentation survivability, and a plan and schedule for equipment upgrade, where appropriate, based on the assessment.

Applicable to: All sites.

Timeline: Completion by end of December 2013.

A.1.9 Action:

Licensees should ensure the habitability of control facilities under conditions arising from beyond-design-basis and severe accidents. This assessment should consider elements of HOP under accident conditions.

Action item(s):

A.1.9.1 An evaluation of the habitability of control facilities under conditions arising from beyond-design-basis and severe accidents and, where applicable, detailed plan and schedule for control facilities upgrades.

Applicable to: All sites.

Timeline: Completion by end of December 2014.

A.1.10 Action:
Licensees should investigate means of extending the availability of power for key instrumentation and control (I&C) needed in accident management actions following a loss of all AC power. This assessment should consider elements of HOP under accident conditions.

Action item(s):
A.1.10.1 An evaluation of the requirements and capabilities for electrical power for key instrumentation and control. The evaluation should identify practicable upgrades that would extend the availability of key I&C, if needed.
A.1.10.2 A plan and schedule for deployment of identified upgrades. A target of eight hours without the need for offsite support should be used.

Applicable to: All sites.

Timeline: Completion by end of December 2012.

A.1.11 Action:
Licensees should procure, as quickly as possible, emergency equipment and other resources that could be either stored onsite or stored offsite and brought onsite to mitigate a severe accident. This assessment should consider elements of HOP under accident conditions.

Action item(s):
A.1.11.1 A plan and schedule for procurement.

Applicable to: All sites.

Timeline: Completion by end of December 2012.

Recommendation 2 – Assessment of site-specific external hazards

Task Force recommendation

Licensees should conduct more comprehensive assessments of site-specific external hazards, to demonstrate that:

a) considerations of magnitudes of design-basis and beyond-design-basis external hazards are consistent with current best international practices **(Action 2.1)**
b) consequences of events triggered by external hazards are within applicable limits **(Action 2.2)**

Such assessments should be updated periodically, to reflect gained knowledge and modern requirements.

EAC recommendation 6

The EAC recommends that the CNSC examine the area of human and organizational factors to achieve a more complete understanding of lessons learned from the Fukushima crisis. **(This recommendation has been applied to Action 2.1.)**

EAC recommendation 7

The EAC recommends that the CNSC clarify its plans to address tornado hazards. **(This recommendation has been applied to Action 2.1.)**

CNSC staff actions

A.2.1 Action:

Licensees should complete the review of the basis for external events against modern state-of-the-art practices for evaluating external events magnitudes and relevant design capacity for these events, including but not limited to: earthquake, floods, tornadoes and fire. This assessment should consider elements of HOP under accident conditions.

Action item(s):

Through implementation of the current S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*:

A.2.1.1 Re-evaluate, using modern calculations and state-of-the-art methods, the site-specific magnitudes of each external event to which the plant may be susceptible.

A.2.1.2 Evaluate if the current site-specific design protection for each external event assessed in 1 above is sufficient. If gaps are identified a corrective plan should be proposed.

Applicable to: All sites.

Timeline: Completion by end of December 2013.

A.2.2 Action:

Implementation of RD-310, *Safety Analysis for Nuclear Power Plants*, is already in progress and being tracked by the CNSC/Industry Safety Analysis Improvement Initiative working group.

Action item(s):

A.2.2.1 No new requirement, since it is already being implemented.

Applicable to: All sites.

Timeline: Completion by end of December 2013.

Recommendation 3 – Enhance modelling capabilities

Task Force recommendation

Licensees should enhance their modelling capabilities and conduct systematic analyses of beyond-design-basis accidents to include analyses of **(Actions A.3.1, A.3.2)**:

a) multi-unit events
b) accidents triggered by extreme external events
c) spent fuel bay accidents

The analyses should include estimation of releases, into the atmosphere and water, of fission products, aerosols and combustible gases.

EAC recommendation 6

The EAC recommends that the CNSC examine the area of human and organizational factors to achieve a more complete understanding of lessons learned from the Fukushima crisis. **(This recommendation has been applied to Actions A.3.1, A.3.2.)**

CNSC staff actions

A.3.1 Action:

1. Licensees should develop/finalize and fully implement severe accident management guidelines (SAMGs) at each station.
2. Licensees should expand the scope of SAMGs to include multi-unit and IFB events.
3. Licensees should demonstrate effectiveness of SAMGs. Licensees should validate and/or refine SAMGs to demonstrate their adequacy in the light of lessons drawn from the Fukushima Daiichi nuclear accident.

This assessment should consider elements of HOP under accident conditions.

Action item(s):

A.3.1.1 Where SAMGs have not been developed/finalized or fully implemented, provide plans and schedules for completion.

A.3.1.2 For multi-unit stations, provide plans and schedules for the inclusion of multi-unit events in SAMGs.

A.3.1.3 For all stations, provide plans and schedules for the inclusion of IFB events in station operating documentation where appropriate.

A.3.1.4 Demonstrate the effectiveness of SAMGs via table-top exercises and drills.

Applicable to: All sites.

Timeline**:** Completion by end of December 2013.

A.3.2 Action:

Licensees of multi-unit NPPs should develop improved modelling of multi-unit plans in severe accident conditions, or demonstrate that the current simple modelling assumptions are adequate. This assessment should consider elements of HOP under accident conditions.

Action item(s):

A.3.2.1 An evaluation of the adequacy of existing modelling of severe accidents in multi-unit stations. The evaluation should provide a functional specification of any necessary improved models.

A.3.2.2 A plan and schedule for the development of improved modelling, including any necessary experimental support.

Applicable to: All sites (multi-unit accident conditions are not applicable to Point Lepreau and Gentilly-2).

Timeline: Completion by end of December 2012.

Part A2 – Enhancing emergency response

The CNSC Task Force also confirmed that the current emergency preparedness and response measures in Canada (both onsite and offsite) remain adequate. Nevertheless, the Task Force identified further improvements to be achieved through streamlining emergency preparedness between onsite and offsite authorities. These improvements should consider HOP, which is integral to design, analysis and procedural activities, and supports all levels of defence in depth (including accident management).

These improvements are described in the actions outlined below. Commission consideration will be sought for all measures required to strengthen interaction with provincial and federal emergency planning authorities and where legislation may be needed. The CNSC has no regulatory mandate to interact in these areas; nevertheless, the CNSC is committed to facilitating discussions and liaising with appropriate regulatory authorities to address the concerns expressed by the Task Force.

Recommendation 4 – Assess emergency plans (onsite)

Task Force recommendation

Licensees should assess emergency plans to ensure emergency response organizations will be capable of responding effectively in a severe event and/or multi-unit accident, and conduct sufficiently challenging emergency exercises based on them **(Actions A.4.1, A.4.2)**.

EAC recommendation 6

The EAC recommends that the CNSC examine the area of human and organizational factors to achieve a more complete understanding of lessons learned from the Fukushima crisis. **(This recommendation has been applied to Actions A.4.1, A.4.2.)**

CNSC staff actions

A.4.1 Action:

Licensees should evaluate and revise their emergency plans in regard to multi-unit accidents and severe external events. This activity should include an assessment of their minimum complement requirements to ensure their emergency response organizations will be capable of responding effectively to multi-unit accidents or to severe natural disasters. This assessment should consider elements of HOP under accident conditions.

Action item(s):

A.4.1.1 An evaluation of the adequacy of existing emergency plans and programs.

A.4.1.2 A plan and schedule to address any gaps identified in the evaluation.

Applicable to: All sites (multi-unit accident conditions are not applicable to Point Lepreau and Gentilly-2).

Timeline: Completion by end of December 2012.

A.4.2 Action:

Licensees should review their drill and exercise programs, to ensure that they are sufficiently challenging to test the performance of the emergency response organization under severe events and/or multi-unit accident conditions. This assessment should consider elements of HOP under accident conditions.

Action item(s):

A.4.2.1 A plan and schedule for the development of improved exercise program.

Applicable to: All sites (multi-unit accident conditions are not applicable to Point Lepreau and Gentilly-2).

Timeline: Completion by end of December 2012.

Recommendation 5 – Update emergency facilities and equipment

Task Force recommendation

Licensees should review and update their emergency facilities and equipment, in particular:

a) ensure operability of primary and backup emergency facilities and of all emergency response equipment that require electrical power and water **(Action A.5.1)**
b) formalize all arrangements and agreements for external support and document these in the applicable emergency plans and procedures **(Action A.5.2)**
c) verify or develop tools to provide offsite authorities with an estimate of the amount of radioactive material that may be released and the dose consequences, including the installation of automated real-time station boundary radiation monitoring systems with appropriate backup power **(Actions A.5.3, A.5.4)**

EAC recommendation 6

The EAC recommends that the CNSC examine the area of human and organizational factors to achieve a more complete understanding of lessons learned from the Fukushima crisis. **(This recommendation has been applied to Actions A.5.1, A.5.2.)**

CNSC staff actions

A.5.1 Action:

Licensees should review primary and alternate emergency facilities, and all emergency response equipment that requires electrical power to operate (e.g., electronic dosimeters, two-way radios), to make sure that appropriate backup power sources exist. The requirements and limitations should be documented in the applicable emergency plans and procedures. This assessment should consider elements of HOP under accident conditions.

Action item(s):

A.5.1.1 An evaluation of the adequacy of backup power for emergency facilities and equipment.
A.5.1.2 A plan and schedule to address any gaps identified.

Applicable to: All sites.

Timeline: Completion by end of December 2012.

A.5.2 Action:

Licensees should formalize all arrangements and agreements for external support, and should document these in the applicable emergency plans and procedures. This assessment should consider elements of HOP under accident conditions.

Action item(s):

A.5.2.1 Identify the external support and resources that may be required during an emergency.
A.5.2.2 Identify the external support and resource agreements that have been formalized and documented.
A.5.2.3 Confirm if any undocumented arrangements can be formalized.

Applicable to: All sites.

Timeline: Completed by end of December 2012.

A.5.3 Action:
Licensees should install automated real-time station boundary radiation monitoring systems with appropriate backup power and communications systems.

Action item(s):
A.5.3.1 Provide a project plan and installation schedule.

Applicable to: All sites.

Timeline: Completion by end of December 2012.

A.5.4 Action:
Licensees should develop source term estimation capability, including dose modelling tools.

Action item(s):
A.5.4.1 Provide source term and dose modelling tools specific to each NPP.

Applicable to: Hydro-Québec and NB Power.

Timeline: Completed by end of December 2012.

Recommendation 6 – Offsite emergency plans and programs

Task Force recommendation

Federal and provincial nuclear emergency planning authorities should undertake a review of their plans and supporting programs, such as **(Action 6.1)**:

a) ensuring plan revision activities are expedited and making regular full-scale exercises a priority
b) establishing a formal, transparent, national-level oversight process for offsite nuclear emergency plans, programs and performance
c) reviewing the planning basis of offsite arrangements in view of multi-unit accident scenarios
d) reviewing arrangements for protective action including resolving the issues pertaining to public alerting, validating the effectiveness of potassium iodide (KI) pill-stocking and distribution strategies and verifying, or developing the capability for predicting, offsite effects.

EAC recommendation 3

The EAC recommends that the CNSC work with other government departments to ensure better coordination and redefinition of departmental roles and responsibilities, should a nuclear accident occur in Canada, the United States or overseas. **(This recommendation has been applied to Action A.6.1.)**

EAC recommendation 4

The EAC recommends that the CNSC meet with its partner organizations and licensees to establish the frequency and extent of multi-level emergency exercises. **(This recommendation has been applied to Action A.6.1.)**

EAC recommendation 9

The EAC recommends that, as the Canadian nuclear safety regulator, the CNSC should play an active role in ensuring that emergency planning exercises with the United States are conducted regularly. **(This recommendation has been applied to Action A.6.1.)**

CNSC Staff Actions

A.6.1 Action:
CNSC staff will meet with provincial and federal nuclear emergency planning authorities, to ensure understanding of recommendations and findings.

Action item(s):
A.6.1.1 CNSC staff will participate in activities led by respective provincial and federal authorities, and initiate adequate CNSC regulatory framework or oversight measures to address recommendations.

Applicable to: All sites and federal and provincial emergency planning authorities.

Timeline: Completion by end of December 2013.

Part A3 – Improving regulatory framework and processes

The CNSC Task Force reviewed the CNSC regulatory framework and processes, and confirmed that the Canadian regulatory framework is strong and comprehensive. Nevertheless, the Task Force identified further improvements to existing regulations, supporting regulatory documents, and well as the licensing basis, which would strengthen the oversight of existing programs (or programs currently considered for potential new nuclear power plants). These are described in each of the actions outlined below.

Recommendation 7 – Class I Nuclear Facilities Regulations amendments

Task Force recommendation

The CNSC should initiate a formal process to amend the *Class I Nuclear Facilities Regulations* to require NPP licensees to submit offsite emergency plans with an application to construct or operate a nuclear power plant. **(Actions A.7.1, A.7.2)**

CNSC staff action

A.7.1 Action:
The CNSC will initiate a project to amend the *Class I Nuclear Facilities Regulations* to require submission of applicable provincial and municipal offsite emergency plans along with evidence to support how the licensees are meeting the requirements of those plans to the CNSC as part of the licence application or licence renewal process.

Action item(s):
A.7.1.1 The CNSC will prepare proposed amendments to the *Class I Nuclear Facilities Regulations* for consultation in *Canada Gazette Part I* and submit to the Commission for approval to proceed.
A.7.1.2 The CNSC will review results of consultation and prepare final amendments to the *Class I Nuclear Facilities Regulations* and propose them to the Commission for enactment.

Applicable to: CNSC staff.

Timeline: Completed by December 2013.

Recommendation 8 – Radiation Protection Regulations amendments

Task Force recommendation

The CNSC should amend the *Radiation Protection Regulations* to be more consistent with current international guidance and to describe in greater detail the regulatory requirements needed to address radiological hazards during the various phases of an emergency. **(Action A.8.1)**

CNSC staff action

A.8.1 Action:
The CNSC will initiate a project to amend the *Radiation Protection Regulations*, to introduce additional clarity on emergency dose limits for workers and to establish return-to-work criteria.

Action item(s):

A.8.1.1 The CNSC will prepare and consult on a discussion paper on potential amendments to the *Radiation* Protection *Regulations* which will include proposed amendments to the emergency provisions in the regulations.

A.8.1.2 The CNSC will prepare proposed amendments to the *Radiation Protection Regulations* for consultation in the *Canada Gazette Part I* and submit them to the Commission for approval to proceed.

A.8.1.3 The CNSC will review results of consultation and prepare final amendments to the *Radiation Protection Regulations* and propose them to the Commission for enactment.

Applicable to: CNSC staff.

Timeline: Completed by end of December 2013.

Recommendation 9 – Update regulatory document framework

Task Force recommendation

The CNSC should update the regulatory document framework through:

a) updating selected design-basis and beyond-design-basis requirements and expectations, including those for **(Action A.9.1)**:
   i) external hazards and the associated methodologies for assessment of magnitudes
   ii) probabilistic safety goals
   iii) complementary design features for both severe accident prevention and mitigation
   iv) passive safety features
   v) fuel transfer and storage
   vi) design features that would facilitate accident management
b) developing a dedicated regulatory document on accident management **(Action A.9.2)**
c) strengthening the suite of emergency preparedness regulatory documents **(Action A.9.3)**
d) reviewing applicable Canadian Standards Association standards **(Action A.9.4)**

EAC recommendation 7

The EAC recommends that the CNSC clarify its plans to address tornado hazards **(Action 9.1)**.

CNSC staff actions

A.9.1 Action:
The CNSC will initiate projects to amend applicable regulatory documents, in order to incorporate the findings of the CNSC Task Force for both existing and new nuclear power plants.

Action item(s):

A.9.1.1 The CNSC will adapt the proposed GD-310, *Guidance on Safety Analysis for Nuclear Power Plants*, prior to publishing it, to address the findings of the CNSC Task Force review findings.

A.9.1.2 The CNSC will prepare revisions to RD-337, *Requirements and Guidance for Design of New NPPs* and, following a public consultation period, submit them to the Commission for approval to publish.

A.9.1.3 The CNSC will prepare targeted amendments to specific regulatory documents and, following a public consultation period, submit them to the Commission for approval to publish. These include:

- RD-346, *Site Evaluation for New Nuclear Power Plants*
- S-294, *Probabilistic Safety Assessments for Nuclear Power Plants*
- S-296, *Environmental Protection Policies, Programs, and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills*
- RD-310, *Safety Analysis for Nuclear Power Plants*
- G-306, *Severe Accident Management Programs for Nuclear Reactors*

Applicable to: CNSC staff.

Timeline: Completed by end of December 2013.

A.9.2 Action:
The CNSC will initiate a project to develop a dedicated regulatory document on accident management.

Action item(s):

A.9.2.1 The CNSC will prepare a draft document on accident management and, following a period of public consultation, submit it to the Commission for approval to publish.

Applicable to: CNSC staff.

Timeline: Completed by end of December 2013.

A.9.3 Action:
The CNSC will initiate a project to develop a dedicated regulatory document on emergency management.

Action item(s):

A.9.3.1 The CNSC will prepare a draft regulatory document on emergency management, reviewing and incorporating existing information in G-225, *Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills*, and RD-353, *Testing the Implementation of Emergency Measures* and, following a period of public consultation, submit them to the Commission for approval to publish.

Applicable to: CNSC staff.

Timeline: Completed by end of December 2013.

A.9.4 Action:
The CNSC will support the review of Canadian Standards Association (CSA) Standards to take into account the lessons from the Fukushima Daiichi nuclear accident through its participation in the CSA Nuclear Strategic Steering Committee (NSSC).

Action item(s):
A.9.4.1 The CNSC will request the CSA to provide, within the proposed timeline:

1. identification of the issues that need to be addressed in the next review cycles for its Standards.

2. action and work plans to address the identified needs.

Applicable to: CNSC staff.

Timeline**:** Completed by end of December 2013.

Recommendation 10 – Amend power reactor operating licences (PROLs)

Task Force recommendation

The CNSC should amend all power reactor operating licences (PROLs) to include specific licence conditions, requiring implementation of accident management provisions, severe accident management and public information. **(Actions A.10.1, A.10.2)**

CNSC staff action

A.10.1 Action:
Require licensees to have programs for accident management, severe accident management and public communication.

Action item(s):
A.10.1.1 A Commission Member Document (CMD) will be produced for the February 2012 Commission meeting, requesting approval of a new PROL template that will include new licence conditions. The following wording is proposed:

"The licensee shall develop and implement operational guidance and adequate capabilities to deal with abnormal situations, emergencies, and accidents, including severe accidents and, where applicable, multi-unit events."

A licence condition will also be proposed, requiring licensees to implement and maintain a public information program that includes a proactive disclosure protocol, once RD/GD-99.3, *Public Information and Disclosure*, has been approved for publication (refer to Action 10.2 below for details).

Sections will be added to the NPP licence conditions handbook template, to clarify the compliance verification criteria for the new licence conditions.

A.10.1.2 The amendments to the existing PROLs will be added to comply with the updated template.

Applicable to: CNSC staff.

Timeline:
Item 1: Completion by February 1, 2012.
Item 2: Completion by end of December 2014.

A.10.2 Action:
The CNSC will continue to develop RD/GD-99.3, *Public Information and Disclosure*, and submit it to the Commission for approval.

Action item(s):
A.10.2.1 The CNSC will submit the updated draft RD/GD-99.3 to the Commission for approval to publish, at the February 2012 Commission meeting.
A.10.2.2 The amendments to existing PROLs will be consistent with the implementation timeline set out in Action 10.1.

Applicable to: CNSC staff.

Timeline: Completion by end of February 2012.

Recommendation 11 – Implementation of periodic safety reviews

Task Force recommendation

The CNSC should further enhance the regulatory oversight of nuclear power plants, through the implementation of a periodic safety review process **(Action A.11.1)**.

CNSC staff action

A.11.1 Action:
The CNSC will consider the development of a regulatory framework for the implementation of the periodic safety review process.

Action item(s):
A.11.1.1 A CMD seeking endorsement to proceed with the development of regulatory requirements for conducting periodic safety reviews by licensees is to be submitted for consideration by the Commission in Fall 2012, at a public Commission meeting.
A.11.1.2 Amendments to existing PROLs are anticipated to be completed by the end of December 2015, or as set out by the Commission.

Applicable to: CNSC staff.

Timeline:

Item 1: Completion by end of December 2012.
Item 2: Completion by end of December 2015.

Part A4 – Enhancing international collaboration

The need for greater cooperation among international regulators was also recognized by the CNSC Task Force, which recommended that the CNSC facilitate greater cooperation with international peers. The near-term initiatives undertaken by the CNSC to collaborate more closely with senior regulators of CANDU owner countries (in preparation for the Second Extraordinary Meeting of the Convention on Nuclear Safety) are consistent with actions outlined in the Task Force recommendations, and provide further opportunities for the CNSC to build consensus on proposed initiatives.

Recommendation 12 – Enhance collaboration with CANDU owner countries

Task Force recommendation

The CNSC should review memoranda of understanding with regulatory counterparts in countries with CANDU reactors to outline what support, if any, they would require from the CNSC during a nuclear emergency. **(Action A.12.1)**

EAC recommendation 1

The EAC recommends that the CNSC continue to work with regulators of other member states of the IAEA to ensure that the IRRS process is mandatory and transparent, and that the findings and recommendations are enforced. **(Action A.12.1)**

EAC recommendation 2

The EAC recommends that the CNSC work with its fellow regulators in convincing WANO members to share the results of their peer-review process to promote nuclear safety in all nations with nuclear power plants. **(Action A.12.1)**

CNSC staff action

A.12.1 Action:
The CNSC is to initiate discussions with CANDU senior regulators, to determine areas of interest where mutual support can be offered during a nuclear emergency.

Action item(s):
A.12.1.1 The CNSC, in collaboration with the IAEA and CANDU senior regulators, proposes a meeting in April 2012 in Vienna, Austria (in advance of national report submissions for peer review in May 2012), to establish a common platform for harmonization of future improvements arising from the lessons learned from their independent safety reviews.

Applicable to: CNSC staff.

Timeline: Completion by end of May 2012.

Recommendation 13 – Enhance international cooperation

Task Force recommendation

The CNSC should enhance cooperation with other nuclear regulators in addressing the lessons learned from the Fukushima Daiichi nuclear accident and thus further strengthen the capability to respond efficiently to any nuclear emergency. **(Action A.13.1)**

EAC recommendation 1

The EAC recommends that the CNSC continue to work with regulators of other member states of the IAEA to ensure that the IRRS process is mandatory and transparent, and that the findings and recommendations are enforced. **(This recommendation has been applied to Action A.13.1.)**

EAC recommendation 2

The EAC recommends that the CNSC work with its fellow regulators in convincing WANO members to share the results of their peer-review process, to promote nuclear safety in all nations with nuclear power plants. **(This recommendation has been applied to Action A.13.1.)**

EAC recommendation 3

The EAC recommends that the CNSC work with other government departments to ensure better coordination and redefinition of departmental roles and responsibilities should a nuclear accident occur in Canada, the United States or overseas. **(This recommendation has been applied to Action A.13.1.)**

EAC recommendation 9

The EAC recommends that, as the Canadian nuclear safety regulator, the CNSC should play an active role in ensuring that emergency planning exercises with the United States are conducted regularly. **(This recommendation has been applied to Action A.13.1.)**

CNSC staff action

A.13.1 Action:

Canada, as a signatory to the Convention on Nuclear Safety, is required to participate in triennial review meetings of the Convention and any extraordinary meeting that may be agreed to by contracting parties. The CNSC on behalf of Canada is responsible for coordinating the preparation and submission of the national reports for peer review and the participation of Canadian delegates at the review or extraordinary meetings. The CNSC in collaboration with industry and government stakeholders is to prepare a national report for peer review by contracting parties and to participate at the 2nd Extraordinary Meeting of the Convention on Nuclear Safety on the sharing of lessons learned and actions taken by contracting parties in response to the Fukushima Daiichi nuclear accident.

Action item(s):

A.13.1.1 Prepare a national report on lessons learned from the Fukushima Daiichi nuclear accident, consistent with the requirements established by contracting parties at the Fifth Review Meeting in April 2011. The national report is to be submitted to the IAEA Secretariat in May 2012, for peer review by the CNS states, and discussed at an Extraordinary Meeting of the Convention in Vienna, Austria, August 27–30, 2012.

Applicable to: CNSC staff.

Timeline: Completion by end of September 2012.

Annex B – Actions Related to Major Nuclear Facilities (Other Than NPPs)

Part B1 – Strengthening defence in depth

The actions described in this section are derived from CNSC staff review of licensee 12(2) submissions. The recommendations have been adapted to major nuclear facilities (other than NPPs). These are shown below together with their associated EAC and CNSC Fukushima Task Force recommendations.

The sites affected by these measures include: Chalk River Laboratories (including the National Research Universal [NRU] reactor), Slowpoke-2 reactors, the McMaster nuclear reactor, uranium processing facilities, nuclear substance processing facilities, waste management facilities, accelerators, as well as uranium mines and mills.

Recommendation 1 - Review facilities safety case

Review facilities' safety case (design of the facilities, internal and external credible events, facilities' safety features.

The following CNSC staff actions incorporate **EAC recommendation 5** and **Task Force recommendation 1,** applied in a graded risk-informed manner.

CNSC staff actions

B.1.1 Action:
Conduct a review of major nuclear facilities' design basis safety case.

Action item(s):
B.1.1.1 An evaluation of the design of the facilities, internal and external credible events, and the facilities' safety features.
B.1.1.2 Assessment of plant equipment and instrumentation, for potential upgrades.
B.1.1.3 A plan and schedule to address any gaps identified.

Applicable to:
B.1.1.1 and B.1.1.3 are applicable to all facilities.
B.1.1.2 is applicable only to Chalk River Laboratories (CRL).

Timeline:
B.1.1.1 and B.1.1.3 – completion by end of December 2014.
B1.1.2 – completion by end of December 2016 (coincident with licence expiry).

Recommendation 2 - Assessment of site-specific external hazards

Assessment of site-specific external hazards.

The following CNSC staff actions incorporate **Task Force recommendation 2,** applied in a graded risk-informed manner.

CNSC staff actions

B.2.1 Action:
Licensees to re-assess external events (including, but not limited to earthquake, floods, tornadoes, extreme weather events and fire), to demonstrate that consequences of events are within applicable limits.

Action item(s):
B.2.1.1 Re-evaluate the site-specific magnitudes of each external event to which the facility may be susceptible.
B.2.1.2 Evaluate measures in place to mitigate each external event. If gaps are identified, a corrective plan should be proposed.

Applicable to: All sites.

Timeline: Completion by end of December 2013 (except for CRL); CRL completion by December 2016 (coincident with licence expiry).

Recommendation 3 - Enhance modelling capabilities (NRU)

Enhance modelling capabilities - consideration of Severe Accident Management Guidelines (SAMG), for NRU only

The following CNSC staff actions incorporate **Task Force recommendation 3,** applied in a graded risk-informed manner.

CNSC staff actions

B.3.1 Action:
1. Licensees should develop and implement severe accident management guidelines (SAMGs) and associated procedures.
2. Licensees should fully implement a Severe Accident Management Program (SAMP), including training of personnel.

This assessment should consider elements of human and organizational performance (HOP) under accident conditions.

Action item(s):
B.3.1.1 Develop SAMGs and associated procedures for the NRU reactor.
B.3.1.2 Implement a SAMP, including training of personnel, for the NRU reactor.

Applicable to: CRL only.

Timeline: Completion by end of December 2016 (coincident with licence expiry).

Part B2 – Enhancing emergency response

The recommendations described in this section are derived from the *CNSC Fukushima Task Force Report* and have been adapted to major nuclear facilities other than NPPs.

The sites affected by these measures include: CRL (including the NRU reactor), Slowpoke-2 reactors, the McMaster nuclear reactor, uranium processing facilities, nuclear substance processing facilities, waste management facilities, accelerators, as well as uranium mines and mills.

Recommendation 4 - Assess emergency plans (onsite)

Assess emergency plans (onsite) - review of facilities' emergency response plans, including procedures, training and equipment.

The following CNSC staff actions incorporate **EAC recommendation 5** and **Task Force recommendation 4,** applied in a graded risk-informed manner.

CNSC staff actions

B.4.1 Action:
Licensees should evaluate and revise their emergency plans in regard to severe external events. Licensees should review their drill and exercise programs, to ensure that they are sufficiently challenging to test the performance of the emergency response organization under severe events. This assessment should consider elements of HOP under accident conditions.

Action item(s):
B.4.1.1 An evaluation of the adequacy of existing emergency plans and programs.
B.4.1.2 A plan and schedule to address any gaps identified in the evaluation.

Applicable to: All sites.

Timeline: Completion by end of December 2013 (except for CRL); CRL completion by December 2016 (coincident with licence expiry).

Recommendation 5 - Update emergency facilities and equipment (CRL)

Update emergency facilities and equipment - review and update equipment and design of site Emergency Operation Centre (Chalk River site only)

The following CNSC staff actions incorporate **Task Force recommendation 5,** applied in a graded risk-informed manner.

CNSC staff action

B.5.1 Action:
Licensees should review all emergency response equipment and (where applicable) emergency facilities, to make sure they are available, appropriate and sufficient, and are maintained adequately.

Action item(s):
B.5.1.1 An evaluation of the adequacy of emergency facilities and equipment.

B.5.1.2 A plan and schedule to address any gaps identified.

Applicable to: All sites.

Timeline: Completion by end of December 2013 (except for CRL); CRL completion by December 2016 (coincident with licence expiry).

Recommendation 6 - Offsite emergency plans and programs

Apply improvements to offsite response plans for NPPs to all relevant facilities in a graded manner

The following CNSC staff actions incorporate **Task Force recommendation 6,** applied in a graded risk-informed manner.

CNSC staff action

Federal and provincial plans related to offsite emergency plans and programs for nuclear facilities (other than NPPs) are managed by the same federal and provincial emergency management organizations responsible for offsite emergency plans and programs for NPPs (refer to A2 for details). Enhancements to these plans and programs are currently underway, through various initiatives by the CNSC and responsible emergency management authorities, and will be applied to non-NPPs in a graded approach.

Part B3 – Improving regulatory framework and processes

Recommendation 7 - Improve regulatory framework and processes

The improvement of regulatory framework and processes has not been assessed separately for major nuclear facilities other than NPPs. However, enhancements developed in the course of implementing related measures (identified in **Annex A** for NPPs) will be monitored by CNSC staff; applicable improvements to the regulatory framework and offsite response (as identified by the CNSC Task Force) will be applied in a graded manner to all relevant facilities.

Part B4 – Enhancing international collaboration

Recommendation 8 – Enhance international collaboration

Participation in:

- International meetings with the International Atomic Energy Agency, the Nuclear Energy Agency and the Committee on Nuclear Regulatory Activities to review: (1) national experiences in the conduct of lessons learned on research reactors following the events at Fukushima; and (2) the safety of fuel cycle facilities post-Fukushima
- Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

The following CNSC staff actions incorporate **Task Force recommendation 13,** applied in a graded risk-informed manner.

CNSC staff actions

B.13.1 Action:

Participation in international meetings with the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency (NEA) and the Committee on Nuclear Regulatory Activities (CNRA) to review national experiences in the conduct of lessons learned on nuclear facilities (other than NPPs) post-Fukushima.

Action item(s):

B.13.1.1 Participation in international meetings with the IAEA, NEA and the CNRA, to review national experiences in the conduct of lessons learned on research reactors following the events at Fukushima.

B.13.1.2 Participation in international meetings with the IAEA and NEA, to review the safety of fuel cycle facilities post-Fukushima.

B.13.1.3 Participation in the Fourth Review Meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Timeline: Completion by end of December 2012.

Annex C – Actions Related to Communication and Public Education

In its report, the EAC stressed the importance of communication and public education, and the need to provide complex and technical information to members of the public in clear, plain language and in an accessible manner, using various tools (including social media). The following section highlights several CNSC initiatives that were identified to enhance communications with stakeholders and the public.

The following CNSC staff actions incorporate **EAC recommendation 8**.

CNSC staff actions

The CNSC staff identified several program areas to enhance communications with stakeholders, strengthening readiness, and improving cooperation and ties with organizations involved in the dissemination of information related to nuclear safety. These include:

- CNSC Web site and social media
- crisis Web site
- educational initiatives
- media
- international participation
- extreme accident scenario video

CNSC Web site and social media

C.1.1 Action:
The CNSC to enhance social media tools through Facebook and YouTube.

Action item(s):
C.1.1.1 Continued development of CNSC Facebook page.
C.1.1.2 Launch of CNSC YouTube channel.

Applicable to: CNSC staff.

Timeline: Completion by December 2013.

C.1.2 Action:
To ensure the CNSC Web site provides information to the public in plain language, including information on the safety aspects of nuclear facilities and measures to deal with nuclear emergencies.

Action item(s):
C.1.2.1 Ensure regular Web updates on topics of interest to the general public and stakeholders, specifically including information on emergency response measures and radiation protection (ongoing).
C.1.2.2 Launch of new Web site, in accordance with the broader Government of Canada Web 2013 initiative.

Applicable to: CNSC staff.

Timeline: C.1.2.2 to be completed by December 2013.

Crisis Web site

C.1.3 Action:
The CNSC is to consider the development of a crisis Web site that can be activated in the event of a nuclear emergency in Canada.

Action item(s):
C.1.3.1 The CNSC is to develop a crisis Web site that will provide real-time information on the nature and evolution of a nuclear emergency. The site should provide precautionary measures and instructions for members of the public affected by the emergency, as well as information on the affected facility.

Applicable to: CNSC staff.

Timeline: Completion by December 2013.

Educational initiatives

C.1.4 Action:
The CNSC is to enhance the existing educational resources section on the CNSC Web site, by targeting a broader audience. CNSC Online is a Web-based educational tool that will present highly technical concepts (such as the nuclear fuel lifecycle and nuclear safety) in plain language to Canadians. Where practicable, this interactive tool will make effective use of animated graphics and illustrations.

Action item(s):
C.1.4.1 Continued development of educational resources to target a broader audience (ongoing).
C.1.4.2 Continued development of plain language educational tools, to facilitate the understanding by the public of highly technical subjects (such as the nuclear fuel lifecycle and nuclear safety).
C.1.4.3 Continued development of public information sessions to stakeholders in communities across the country, to present information and answer questions on how the nuclear industry is regulated (ongoing).
C.1.4.4 Where practicable, explore partnership opportunities to further disseminate information on nuclear, such as through the Canada Science and Technology Museum’s Energy Exhibit to promote nuclear safety (ongoing).

Applicable to: CNSC staff.

Timeline: C.1.4.2 to be completed by December 2013.

Media

C.1.5 Action:
The CNSC is to explore partnerships with science-based media organizations, and to provide media training programs for specialists and subject-matter experts (with greater emphasis on crisis communications) and convey information in plain language.

Action item(s):
C.1.5.1 The CNSC is to develop a plan for identifying and qualifying a cadre of specialists and subject-matter experts, and ensure that appropriate media relations training is received.
C.1.5.2 The CNSC is to proactively engage public information agencies (i.e., the Science Media Centre of Canada) to assist media in reporting technical and scientific issues.

Applicable to: CNSC staff.

Timeline: Completion by December 2013.

International participation

C.1.6 Action:
The CNSC is to enhance collaboration with international peers through active participation at various international forums to exchange communications best practices and lessons learned from the Fukushima crisis.

Action item(s):
C.1.6.1 CNSC staff to participate at the Nuclear Energy Agency's Crisis Communications Workshop in Madrid, Spain in May 2012.
C.1.6.2 CNSC staff to participate at the IAEA International Experts' Meeting on Enhancing Transparency and Communication Effectiveness in the Event of a Nuclear or Radiological Emergency in Vienna in, June 2012.

Applicable to: CNSC staff.

Timeline: Completion by December 2012.

Extreme accident scenario video

C.1.7 Action:
The CNSC is to develop a graphical representation to illustrate to the public the sequence of potential events during and immediately following an extreme accident at a Canadian nuclear power plant.

Action item(s):
C.1.7.1 The CNSC is to develop a video describing an extreme accident scenario at a Canadian nuclear power plant, along with the safety systems in place.

Applicable to: CNSC staff.

Timeline: Completion by December 2013.

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Canada's Nuclear Regulator

Reactor Facilities

Licence to Prepare Site and Site Evaluation for New Reactor Facilities

REGDOC-1.1.1

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Canadian Nuclear Safety Commission
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Preface

This regulatory document is part of the CNSC's Reactor Facilities series of regulatory documents, which also includes licence application guides for licences to construct, operate and decommission nuclear power plants. The full list of regulatory document series is included at the end of this document and can also be found on the CNSC's website.

Regulatory document REGDOC-1.1.1, *Licence to Prepare Site and Site Evaluation for New Reactor Facilities*, sets out requirements and guidance for site preparation and site evaluation. It also addresses requirements and guidance for a licence to prepare site. This document refers to both nuclear power plants and small reactor facilities as "reactor facilities". Its content also addresses the information needed for subsequent lifecycle phases of construction and operation.

This document replaces the previously published RD-346, *Site Evaluation for Nuclear Power Plants*. This regulatory document has revised the earlier RD-346 to:

- clarify requirements and guidance language
- expand scope to include small reactor facilities using a graded approach
- include site preparation requirements and guidance
- address the relevant Fukushima Task Force recommendations

REGDOC-1.1.1 updates RD-346 by incorporating lessons learned from the Fukushima nuclear event of March 2011. The updates were made to address findings from INFO-0824, *CNSC Fukushima Task Force Report*, and the subsequently issued action plans as applicable to RD-346. The changes focused on the need for robust characterization of the site to include:

- consideration of events to include multiple and simultaneous severe external events that could exceed the design basis
- multiple and simultaneous reactor accidents
- discussions around emergency planning and preparations for extreme events earlier in a project

REGDOC-1.1.1 is intended to form part of the licensing basis for a regulated facility or activity within the scope of the document. It is intended for inclusion in licences as either part of the conditions and safety and control measures in a licence, or as part of the safety and control measures to be described in a licence application and the documents needed to support that application.

For proposed new facilities: This document will be used to assess new licence applications for reactor facilities.

For existing facilities: The requirements contained in this document do not apply unless they have been included, in whole or in part, in the licence or licensing basis.

Guidance contained in this document exists to inform the applicant, to elaborate further on requirements or to provide direction to licensees and applicants on how to meet requirements. It also provides more information about how CNSC staff evaluate specific problems or data during their review of licence applications. Licensees are expected to review and consider guidance; should they choose not to follow it, they should explain how their chosen alternate approach meets regulatory requirements.

A graded approach, commensurate with risk, may be defined and used when applying the requirements and guidance contained in this regulatory document. The use of a graded approach is not a relaxation of requirements. With a graded approach, the application of requirements is commensurate with the risks and particular characteristics of the facility or activity.

An applicant or licensee may put forward a case to demonstrate that the intent of a requirement is addressed by other means and demonstrated with supportable evidence.

The requirements and guidance in this document are consistent with modern national and international practices addressing issues and elements that control and enhance nuclear safety. In particular, they establish a modern, risk-informed approach to the categorization of accidents – one that considers a full spectrum of possible events, including events of greatest consequence to the public.

Important note: Where referenced in a licence either directly or indirectly (such as through licensee-referenced documents), this document is part of the licensing basis for a regulated facility or activity.

The licensing basis sets the boundary conditions for acceptable performance at a regulated facility or activity, and establishes the basis for the CNSC's compliance program for that regulated facility or activity.

Where this document is part of the licensing basis, the word "shall" is used to express a requirement to be satisfied by the licensee or licence applicant. "Should" is used to express guidance or that which is advised. "May" is used to express an option or that which is advised or permissible within the limits of this regulatory document. "Can" is used to express possibility or capability.

Nothing contained in this document is to be construed as relieving any licensee from any other pertinent requirements. It is the licensee's responsibility to identify and comply with all applicable regulations and licence conditions.

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Government of Canada Gouvernement du Canada

Canada

Canadian Nuclear Safety Commission

RD-346: Site Evaluation for New Nuclear Power Plants

Preface

This regulatory document sets out the expectations of the Canadian Nuclear Safety Commission (CNSC) with respect to the evaluation of sites for new nuclear power plants (NPPs) before application is made for a *Licence to Prepare Site*, and before an environmental assessment (EA) determination is initiated.

This regulatory document does not address siting for other Class IA or IB facilities. Regulatory expectations pertaining to site preparation are also outside the scope of this document.

RD-346 represents the CNSC staff's adoption, or where applicable, adaptation of the principles set forth by the International Atomic Energy Agency (IAEA) in NS-R-3, *Site Evaluation for Nuclear Installations*. The scope of RD-346 goes beyond NS-R-3 in several aspects such as the protection of the environment, security of the site, and protection of prescribed information and equipment, which are not addressed in IAEA's NS-R-3.

Site evaluation is a process that should precede the submission of an application to prepare a site for the construction of a new NPP. RD-346 is written to serve the broader licensing needs under the *Nuclear Safety and Control Act* and the *Canadian Environmental Assessment Act*, and will facilitate a more effective and efficient regulatory review.

Similar to NS-R-3, RD-346 considers all licensing phases, because information from the site evaluation process feeds into the environmental assessment (EA), and the processes for reviewing an application for a *Licence to Prepare Site*, and other licence applications.

Nothing contained in this document is to be construed as relieving any applicant or licensee from requirements associated with conventional codes and standards. In particular, while RD-346 may assist a proponent in making a licence application, it is the licensee's responsibility to identify and comply with all applicable regulations and licence conditions.

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1.0 Purpose

The purpose of this regulatory document is to set out the expectations of the Canadian Nuclear Safety Commission (CNSC) with respect to the evaluation of sites for new nuclear power plants (NPPs or plants) before application is made for a *Licence to Prepare Site*, and before an environmental assessment (EA) determination is initiated.

2.0 Scope

This document provides high level guidance pertaining to site evaluation activities.

Site selection is not regulated under the *Nuclear Safety and Control Act* (NSCA), and is therefore not addressed in this document.

This regulatory document does not address siting for other Class IA or IB facilities.

The regulatory expectations pertaining to site preparation are outside the scope of this document. The information gathered during site evaluation may be used in the EA process, and may also feed into the NPP design process.

RD-346 represents the CNSC's adoption of the tenets set forth by the International Atomic Energy Agency (IAEA) in safety requirements document NS-R-3, *Site Evaluation for Nuclear Installations*, and the adaptation of those tenets to align with Canadian expectations. Some Canadian expectations, such as protection of the environment, security of the site, and protection of prescribed information and equipment, are not addressed in NS-R-3.

The IAEA guides that support NS-R-3 have also been adopted to support this document. These guides are included in the publications listed in the "Additional Information" section of this document.

3.0 Relevant Regulations

The provisions of the NSCA and the associated regulations that are relevant to this regulatory document can be separated into stipulations that relate to determination of site suitability and evaluation of licence applications.

3.1 NSCA and Associated Regulations

Data and analysis results from site evaluation may be used to satisfy the following aspects of the NSCA and associated regulations once the proponent decides to submit an application for a licence:

1. Paragraph 44(1)(*e*) of the NSCA provides that the Commission may make regulations respecting the location, design, construction, installation, operation, maintenance, modification, decommissioning, abandonment and disposal of a nuclear facility or part of a nuclear facility;
2. Paragraph 44(1)(*o*) of the NSCA provides that the Commission may establish requirements to be complied with by any person who locates, designs, constructs, installs, operates, maintains, modifies, decommissions or abandons a nuclear facility;
3. Paragraphs 3(*a*) through 3(*k*) of the *Class I Nuclear Facilities Regulations* provides that an application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain the following information in addition to the information required by paragraphs 3(*a*) through 3(*n*) of the *General Nuclear Safety and Control Regulations*:

    a. a description of the site of the activity to be licensed, including the location of any exclusion zone and any structures within that zone;
    b. plans showing the location, perimeter, areas, structures and systems of the nuclear facility;
    c. evidence that the applicant is the owner of the site or has authority from the owner of the site to carry on the activity to be licensed;
    d. the proposed quality assurance program for the activity to be licensed;
    e. the name, form, characteristics and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on;
    f. the proposed worker health and safety policies and procedures;
    g. the proposed environmental protection policies and procedures;
    h. the proposed effluent and environmental monitoring programs;
    i. if the application is in respect of a nuclear facility referred to in paragraph 2(b) of the *Nuclear Security Regulations*, the information required by section 3 of those Regulations;
    j. the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed; and
    k. the proposed plan for the decommissioning of the nuclear facility or of the site;

4. Paragraphs 4(*a*) through 4(*e*) of the *Class I Nuclear Facilities Regulations* provide that an application for a licence to prepare a site for a Class I nuclear facility shall contain the following information in addition to the information required by Section 3:

    a. a description of the site evaluation process and of the investigations and preparatory work that have been and will be done on the site and in the surrounding area;
    b. a description of the site's susceptibility to human activity and natural phenomena, including seismic events, tornadoes and floods;
    c. the proposed program to determine the environmental baseline characteristics of the site and the surrounding area;
    d. the proposed quality assurance program for the design of the nuclear facility; and
    e. the effects on the environment and the health and safety of persons that may result from the activity to be licensed, and the measures that will be taken to prevent or mitigate those effects.

3.2 Additional Regulations

Once a site has been selected and a project description has been submitted to the CNSC, an environmental assessment (EA) determination is performed as per Section 5 of the *Canadian Environmental Assessment Act* (CEAA). A complete project description is required to perform the EA determination.

The EA is triggered if the EA determination confirms that there is a project and a trigger, as identified, respectively, in Sections 2 and 5 of the CEAA. A trigger exists for the Commission if a licence will be issued under Section 24(2) of the NSCA, as per the

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Law List Regulations of the CEAA.

CEAA requirements should therefore be considered during the site evaluation process, because the EA will look at all proposed undertakings to be considered. As per
Section 14(3) of the CEAA, these include the preparation of the site.

3.3 Aboriginal Consultation

Canada has statutory, contractual, and common law obligations to consult with Aboriginal groups on the effects of proposed projects on established or potential Aboriginal rights. The common law duty to consult is based on judicial interpretation of the obligations of the Crown in the context of existing Aboriginal and treaty rights of the Aboriginal peoples of Canada, recognized and affirmed in Section 35 of the *Constitution Act* (1982).

The duty to consult by the CNSC arises when it has knowledge, real or constructive, of the potential existence of an Aboriginal right or title, and the CNSC contemplates conduct that might adversely affect the right or title.

Although this legal obligation does not extend to third parties such as industry proponents, early engagement with Aboriginal groups by the proponent can enhance relationships, promote trust, improve understanding of the project by the affected Aboriginal groups, and help the proponent to understand the interests of those in the affected region.

Aboriginal consultation is discussed in further detail in Section 12.0 of this document.

4.0 Overview

Information gathered during the site evaluation process may be used during the environmental assessment process, and will be reviewed by the CNSC during evaluation of all licence applications. The EA and licensing processes are outlined in CNSC information document INFO-0756, *Licensing Process for New Nuclear Power Plants in* Canada.

Site evaluation information may also feed into the NPP design process.

As the first step in establishing a new NPP, site evaluation takes into account all phases of the NPP life cycle, from site preparation to abandonment. In order to ensure that a thorough site evaluation is carried out, the proponent is expected to look at the NSCA, the CEAA, and this document.

Figure 4.1, describes where site evaluation fits within the initial stages of new NPP development.

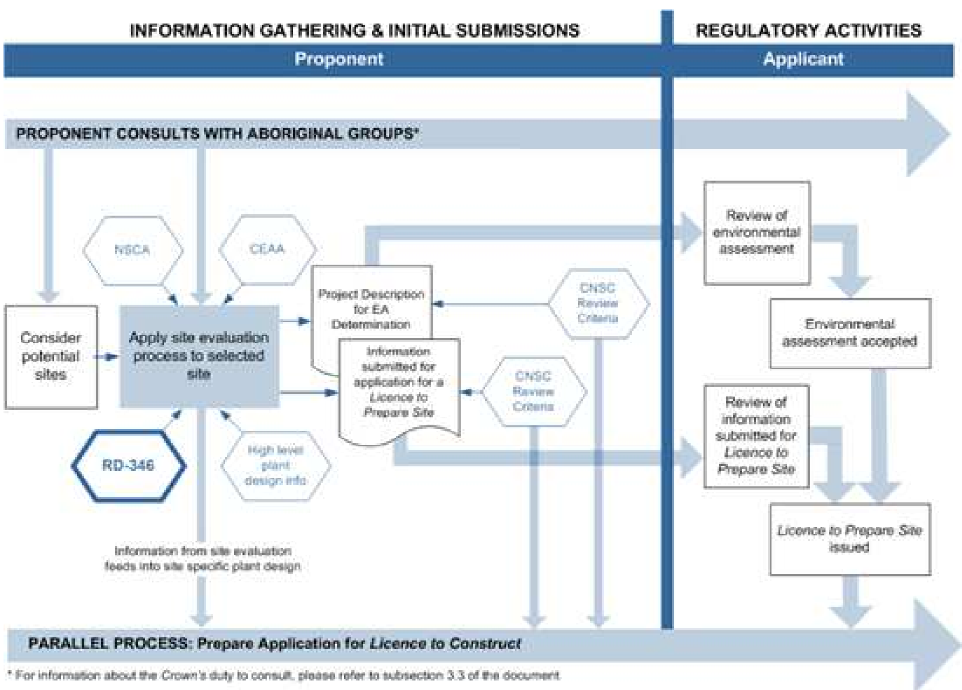

Figure 4.1: Site evaluation within the initial stages of NPP development

The process of evaluating the site involves conducting a site survey to identify one or more candidate sites, and then performing a detailed evaluation of those preferred sites to:

1. Minimize the effects of the proposed NPP on the environment;
2. Minimize the effects of the environment on the ability of the NPP to operate within the defined safe operating envelope; and

3. Identify mitigation strategies that may be needed to reduce risk to national security, the health and safety of persons, and the environment if the site is later selected for the proposed NPP.

One of the goals of the site evaluation process is to anticipate satisfying the requirements of the NSCA and associated regulations by yielding technical data that will be used in processes related to the design, construction, operation, and eventual decommissioning and abandonment of the NPP.

Site characteristics and the effects of external events are integral considerations in the site evaluation process for the following reasons:

1. They may be used in assessing the risks to both the plant and the environment, and in determining the mitigation strategies required to minimize those risks and their consequences;
2. Mitigation strategies feed into NPP site preparation and design through various safety assessment processes;
3. Site characteristics and associated risks feed into the Aboriginal and public consultation processes; and
4. Emergency preparedness and security needs can be anticipated to ensure adequate measures can be implemented at the appropriate licensing stages.

The degree of focus given to site characteristics and external events is dependent on their probability and severity. The amount of focus given to site characteristics is contingent on their ability to influence postulated events and contribute to an increased risk of adverse impact on the environment or on the health and safety of people, or to adversely affect the execution of emergency measures.

Detailed and methodical site evaluation is essential in preparing site mitigation strategies-including emergency response plans-that will adequately protect NPP personnel, the public, and the environment, from the effects of ionizing radiation and hazardous substances arising from licensed activities. Allowing for ongoing advances in technology and scientific knowledge with respect to nuclear safety, this document reflects the present IAEA consensus on what is expected in the site evaluation process.

It is expected that any inappropriate site will be rejected by the proponent prior to applying for a *Licence to Prepare Site*, without requiring CNSC involvement. Submission of site evaluation information on rejected sites is not expected either in future environmental assessments, or in future licensing phases under the NSCA.

Site evaluation takes the following considerations into account:

1. The population density, population distribution, and other characteristics of the protective zone, in so far as they may affect the implementation of emergency measures and the need to evaluate the risks to individuals and to the general population;
2. The technical basis for the safety and security analysis issues that will be included in the application for the *Licence to Prepare Site*;
3. Technical information for the *Project Description* and the *Description of the Existing Environment*, which will be included in the *Environmental Impact Statement* for the NPP (as per CEAA requirements for the EA);
4. Categorization and assessment of the characteristics of the natural and human environment in the region that may be affected by potential radiological or conventional impact associated with site preparation and construction, operational states, and accident conditions;
5. Predictions about the evolution of the natural and human environment in the region, particularly population growth and distribution, that may have a bearing on safety and security throughout the projected lifetime of the NPP;
6. Site suitability with respect to the storage and transport of input and output materials such as fresh and spent fuel and radioactive waste;
7. Information about non-radiological impact due to chemical or thermal releases, or other site activities such as damage to aquatic organisms from entrainment into cooling water intakes, or physical disruption of landscape and shoreline from site development, and the potential for explosion and the dispersion of chemical products;
8. As far as practicable, information about the potential for interactions between nuclear and conventional effluents, such as the combination of heat or chemicals with radioactive material in liquid effluents;
9. Predictions about the impact of the NPP on the population, including those that could lead to emergency conditions, with due consideration of relevant factors (e.g., population distribution, use of land and water, radiological impact of any other releases of radioactive material in the region, etc.); and
10. The hazards associated with natural and human-induced external events.

5.0 General Criteria for Site Evaluation

The main objective of site evaluation is to ensure that an NPP constructed at the site will not create an unreasonable risk to the public or to the environment. A systematic process for prioritizing the risks associated with site characteristics and external events is documented by the proponent and includes consideration of the synergy of multiple events and multiple effects of different activities on the site.

Evaluation of site suitability includes consideration of:

1. Site characteristics that could have an impact on the public or on the environment;

2. Population density, distribution, and other characteristics of the protective zone that may have an impact on the implementation of emergency measures or on the evaluation of risk to individuals, the general population, and the environment; and
3. The effects of natural or human-induced external events occurring in the environment of the site.

If the site evaluation indicates deficiencies for which design features, site protection measures, or administrative procedures cannot compensate, the site is deemed unacceptable by the proponent.

The site evaluation includes:

1. Evaluation against safety goals;
2. Consideration of evolving natural and human-induced factors;
3. Evaluation of the hazards associated with external events;
4. Determination of the potential effects of the NPP on the environment; and
5. Consideration of projected population growth in the vicinity of the site, and emergency planning that takes those projections into account.

The evaluation also takes into account the combined radiological and conventional effects of the site and the NPP on each other during normal and abnormal situations, based on both temporal (life cycle) and spatial (regional, local, and site) considerations.

5.1 Evaluation against Safety Goals

Proposed NPP designs are evaluated against applicable safety goals, taking into account the characteristics of the site, the risks associated with external hazards, and the potential impact of the NPP on the environment.

5.2 Consideration of the Evolution of Natural and Human-induced Factors

The evolution of natural and human-induced factors in the environment that may have a bearing on safety and security are evaluated across a time period that encompasses the projected lifetime of the NPP, with the understanding that different levels of evaluation and monitoring apply to the various phases of the plant lifetime.

5.3 Evaluation of Hazards Associated with External Events

The proposed site is examined with regard to the frequency and severity of external natural and human-induced events that could affect the safety and security of the proposed NPP.

A systematic approach for identifying and assessing the hazards associated with external events, including underlying rationale, is developed, documented, and implemented in an auditable fashion.

Each external natural and human-induced event is identified and assessed with the following considerations:

1. The potential direct and indirect effects of the event on the proposed NPP structures, systems, and components (SSCs), including those that could effect the safe operation of the NPP in both normal and abnormal operating states.
   a. direct effect-an earthquake resulting in a main steam line break, and
   b. indirect effect-a corrosive gas release from a nearby chemical plant degrading NPP safety system trip circuits via ventilation intakes;
2. The potential combined effects of external and human-induced events with normal and accidental releases from the proposed NPP that would exceed environmental limits or cause a significant adverse effect to occur; and
3. Effects that would influence the ability to successfully implement emergency plans.

Derivation of the hazards associated with external events includes consideration of the combined effects of these hazards with the ambient conditions (e.g., simultaneous aircraft crash and heavy snowstorm). Combined effects of external hazards can have significant impact on such facets of the proposed NPP as the implementation of emergency plans, accident mitigation, and contaminant pathway models.

The region assessed for each identified external event encompasses the environment that could be affected.

The evaluation considers foreseeable changes in land use for the projected lifetime of the NPP to assess and plan for mitigation of new external hazards introduced by change in land use.

Site-specific data is used to determine hazards, unless such data is unobtainable. In this case, data from similar regions that is sufficiently relevant to the region of interest, or data derived from appropriate and acceptable simulation techniques, may be used. Data from similar regions and from simulated findings may also be used to augment site-specific data.

Prehistoric, historic, and instrumentally recorded information, and records of the identified external events and their severity, is collected for the region and analyzed for reliability, accuracy, and completeness.

5.4 Determining the Potential Impact of the Site on the Environment

A number of considerations are taken into account in the early stages of site evaluation to minimize the potential impact of the site's interaction with the environment (i.e., moving, destroying, or substantially altering rare or sensitive habitats, biota, or areas of high economic value, etc.), including the structural, compositional, and functional components of its biodiversity.

Table 5.1 describes these considerations with respect to specific areas and activities that may be particularly sensitive to such interaction.

Table 5.1: Potential Impact-Considerations for Special Areas or Activities

Areas or Activities	Considerations
Habitats essential to maintaining the viability of valued ecosystem components (VECs), and designated protected habitats (national or provincial parks, preserves, etc.)	1) Assess and minimize any potential interaction with critical habitats or with individuals or species of conservation status; 2) Assess and minimize any potential for destruction or substantial alteration of breeding, nesting, or spawning habitats; and 3) Assess and minimize any potential for destruction or substantial alteration of other critical habitats to VECs, such as over-wintering, feeding, or nursery habitats.
Areas containing migratory routes of important species	1) Assess and minimize any potential for blockage or impairment of migration or movement corridors; this includes land areas, streams, creeks, rivers, and near shore areas of lakes and ponds that are used for breeding, spawning, or dispersion of reproductive products.
Areas of high biological production and their connecting links or buffer zones Certain habitats are extremely biologically productive, and therefore serve as important staging, feeding, and rearing grounds for numerous VECs	1) Assess and minimize any potential for compromising these natural heritage features, which may be site or region-specific, and may include woodlands, wetlands, meadows, valley lands, estuaries, and the shorelines of streams and lakes; and 2) Take into consideration that wetlands, salt marshes, mud flats, aquatic littoral zones, and offshore shoals may need buffer zones to protect areas of critical biodiversity functions from adverse effects such as contaminants and intrusions.

The future selection of the area of land allocated to the site will be balanced between the needs associated with facility construction, operation, and security, and those of the commercial and recreational uses of the land surrounding the site.

The site is also examined with respect to the risk from radiological and hazardous substances to the public and the environment, with the risks being kept as low as reasonably achievable. This includes the effects of thermal pollution on surrounding bodies of water, and the effects of long-term on-site radiological waste management.

The synergy of multiple events and multiple effects of several different activities, such as simultaneous oil spill and fire, is considered.

Contaminant (radiological and hazardous substances) pathway modeling incorporates atmospheric dispersion, surface water dispersion, and groundwater movement, as well as the associated abiotic and biotic environmental compartments.

Models used for dispersion and pathways analyses include site-specific, local, and regional topographic features and characteristics of the NPP, and take into account natural and human-induced events that may influence contaminant behaviour.

The pathways analyses take specific environmental and site characteristics into account, with special attention paid to the function of the biosphere in the accumulation and transport of radionuclides and hazardous substances.

To determine the potential contaminant impact on the environment, assessments of all releases are made under normal and abnormal conditions for all phases of the NPP life cycle.

Bounding scenarios involving modeling of potential effects from maximum possible releases are completed to establish the outer boundaries or worst case scenarios for the NPP. These bounding scenarios also contribute to the scenarios used for emergency planning.

Assessments of releases or disturbances associated with normal or routine operations are based on expected performance (e.g., average concentrations) and upper threshold bounding conditions, as well as possible pulse releases (high concentration with short exposure period) from anticipated operational occurrences (AOOs).

The proponent will be expected to conduct risk modeling when developing the *Environmental Impact Statement* during the environmental assessment. The estimates of releases and disturbances used in risk modeling will be confirmed during assessment of the construction licence application when the design and safety features of the NPP have been confirmed. The licensee re-evaluates risk modeling as operating experience is gained over the facility lifetime. CNSC staff then reviews re-evaluated risk models as necessary.

The locations of the NPP and of the subsidiary structures on the site are examined at a high level with the assistance of environmental modeling, and are situated in a manner that minimizes potential impact on the public and on the environment. This includes emission or effluent release points, and air or water intake structures.

5.5 Population and Emergency Planning Considerations

5.5.1 Exclusion Zone

The exclusion zone is defined in Section 1 of the *Class I Nuclear Facilities Regulations* as, "a parcel of land within or surrounding a nuclear facility on which there is no permanent dwelling and over which a licensee has the legal authority to exercise control."

5.5.2 Protective Zone

The protective zone is the area beyond the exclusion zone that needs to be considered with respect to implementing emergency measures. This includes consideration of such matters as population distribution and density, land and water usage, roadways, evacuation planning, and consequence analysis.

5.5.3 Planning Considerations

The evaluation takes the following population and emergency planning considerations into account to support achievement of the safety goals:

1. Population density and distribution within the protective zone, with particular focus on existing and projected population densities and distributions in the region including resident populations and transient populations-this data is kept up to date over the lifetime of the NPP;
2. Present and future use of land and resources;
3. Physical site characteristics that could impede the development and implementation of emergency plans;
4. Populations in the vicinity of the NPP that are difficult to evacuate or shelter (for example, schools, prisons, hospitals); and
5. Ability to maintain population and land-use activities in the protective zone at levels that will not impede implementation of the emergency plans.

5.5.4 Confirming Unimpeded Implementation of Emergency Plans

Prior to construction, the proponent confirms with the surrounding municipalities and the affected provinces, territories, foreign states, and neighbouring countries, that implementation of their respective emergency plans and related protective actions will not be compromised for the life cycle of the proposed site.

For example, if a hospital expansion is anticipated as part of a long term emergency plan, then discussions between the proponent and the municipality should begin at the site evaluation stage so that appropriate agreements are in place prior to construction.

Due to the time involved for this task, it is important that these discussions be initiated during the site evaluation phase. The CNSC will expect these agreements to be in place before a *Licence to Construct* will be granted.

5.6 Consideration of Future Life Extension Activities

A life extension project involves the replacement or refurbishment of major components, or substantial modifications to the plant, or both.

Anticipated power uprate projects are early plans to seek to use NPP design margins, and future operating efficiencies and experience, to increase NPP output capacity by some degree.

Power uprate projects may also require plant modernization activities in order to maintain compliance with the NSCA and associated regulations.

Where possible, the site evaluation considers the following potential effects of life extension and power uprate activities:

1. Increased NPP service life;
2. Additional conventional and radiological waste generated, as well as estimated resulting impact on handling, transport, and storage of waste;
3. Impact of external and human induced events on the life extension and power uprate project activities; and
4. Impact on security and emergency planning.

6.0 Gathering Baseline Data

A systematic process for gathering baseline data is documented and demonstrated by the proponent, and includes analyses of uncertainties.

Where possible, baseline data takes into account archeological, paleontological, and prehistoric data (including the oral history of aboriginal peoples), as well as historic and instrumentally recorded sources.

Baseline data is expected to be of sufficient sample size and duration to conduct hypothesis testing against post-commissioning (follow-up) monitoring data, with sufficient power to detect relevant effect sizes.

Baseline data is captured within auditable quality assurance programs.

6.1 Meteorological Data

A comprehensive site evaluation relies on understanding how meteorological phenomena may affect the site.

The evaluation therefore takes into account prehistoric, historic, and instrumentally recorded climate data sources that reflect the regional conditions, such as *Canadian Climate Normals*, published by the Canadian Weather Office.

Descriptions of basic meteorological variables include:

1. Regional topography;
2. Wind speed and direction;
3. Air temperature;
4. Precipitation;
5. Humidity;
6. Atmospheric pressure; and
7. Temperature inversions.

A program for meteorological measurements is typically prepared and carried out at or near the site with the use of instrumentation capable of measuring and recording the main meteorological variables at appropriate elevations, locations, and durations. This program initially provides data for site evaluation, and then provides ongoing data for use in revisions to basis documents in response to safety analysis results during future phases of the NPP life cycle.

6.2 Geological Data

Site evaluation includes a description of the structural geology in regional, local, and site scales.

The geotechnical properties of the overburden, including shear strength and liquefaction potential, are provided. The geotechnical properties support the assessment of slope stability and the bearing capacity of foundations under both static and dynamic conditions.

6.3 Geophysical Data

Seismotectonic data includes, without being limited to, information on prehistoric, historic, and instrumentally-recorded seismic activity in the region.

Information on geophysical hazards includes the influence of surface faults on seismic activity in the region.

6.4 Surface Water Data

The site evaluation describes surface water hydrology, including delineation of the drainage basins and available prehistoric, historic, and instrumentally-recorded hydrological data, such as water levels and flow rates.

A program of hydrological investigations is carried out using both deterministic and probabilistic approaches to permit the assessment of normal flow, flooding, and drought properties of water bodies, as well as the interactions between surface water and groundwater flow systems. This program includes predictions of changes to site surface water hydrology (flows and chemistry) that are expected from foreseeable changes in upstream land use.

Baseline surface water quality data is gathered and provided.

6.5 Groundwater Data

The site evaluation describes the groundwater hydrology of the environment, including the physical and geochemical properties of water-bearing formations (hydrogeological units) and their interactions with surface waters.

A program of hydrogeological investigations is carried out to permit the assessment of groundwater as well as radionuclide and other contaminant movement in the hydrogeological units. This program includes predictions of changes to site groundwater hydrology (flows and chemistry) that are expected to result from foreseeable changes in upstream land use or migration of existing contaminant plumes.

Baseline groundwater quality data is gathered and provided.

6.6 Biological Data

The biotic characteristics of the proposed site are identified and documented, taking into account the environmental considerations set out in Table 5.1, "Potential
Impact-Considerations for Special Areas or Activities." Documentation of the biota utilizing the habitat at the proposed site is documented, and includes descriptions of vegetation communities, birds, mammals, reptiles, fish, and invertebrate communities. This information is then used to:

1. Identify likely interactions between the project and the biota in the area;
2. Predict potential environmental effects;
3. Identify mitigation measures; and
4. Evaluate the significance of the residual effects once the mitigation measures are applied.

Biological data plays an important role in identifying VECs, which are used as the final receptors in pathways modeling.

6.7 Baseline Ambient Radioactivity and Pre-existing Hazardous Substances

The overburden and any bedrock to be removed are characterized with respect to both natural and anthropogenic sources to assess any conventional and radiological risks to health, safety, and the environment. Where an area on the site has received substantial contamination from previous nuclear or non-nuclear industrial activities, baseline characterization considers radionuclide and hazardous substance levels within biota of interest. The presence of contamination may result in the need for special measures to manage the removed overburden.

Prior to active commissioning of the nuclear installation under a *Licence to Operate,* the ambient radioactivity of the atmosphere, hydrosphere, lithosphere, and biota in the region will need to be assessed, including an assessment of ambient radionuclide activity levels in ingested water and food used in the human pathways modeling.

7.0 Evaluation of Natural External Events

The proponent is expected to develop, document, and implement a systematic approach for identifying all natural external events. The hazards described below are indicative of the types of natural external events to be considered:

1. Climate change;
2. Meteorological factors;
3. Surface water hazards;
4. Groundwater hazards;
5. Geotechnical hazards;
6. Geophysical hazards;
7. Biological hazards; and
8. Natural fire hazards.

7.1 Climate Change

The evaluation of natural external events considers potential climate change across the projected lifetime of the NPP.

Climate change can potentially influence all of the other natural external events. With respect to those indicated above, some examples of this influence are provided in Table 7.1.

Table 7.1: Potential Influence of Climate Change on Other Natural External Events

Natural External Event	Examples of Potential Influence of Climate Change

Meteorological factors	Averages and extremes of temperature, humidity, evaporation, high winds, abrasive dust and sand storms, precipitation, lightning
Surface water hazards	Water supply-magnitude and frequency of floods and droughts
Groundwater hazards	Groundwater levels, flow pattern and velocity change resulting from changes in surface water recharge and evaporation
Geotechnical hazards	Stabilities related to changes in permafrost, surface water, and groundwater flow systems
Geophysical hazards	Magnitude and frequency of earthquakes and landslides, etc., due to changing sea and lake levels and melting glaciers
Biological hazards	Biota population and distribution changes due to temperature and humidity changes
Natural fire hazards	Changes in temperature and vegetation cover

7.2 Meteorological Factors

7.2.1 Temperature and Humidity

The following potential factors are included in the assessment of temperature and humidity:

1. Effects of sudden or prolonged extreme temperatures on future plant SSCs that will be important to safety (e.g., cooling air intakes);
2. Effects of condensation and evaporation on future plant SSCs that will be important to safety (e.g., electronic components); and
3. Potential for temperature and humidity to affect releases from the NPP into the environment.

7.2.2 High Winds

The frequency and intensity of strong winds, including tornadoes and hurricanes, is assessed on the basis of historic and recorded data for the region.

The following potential factors are included in the assessment:

1. Wind and pressure-loading effects;
2. Wind-propelled missiles that could have an impact on SSCs, or that could render off-site power supplies unavailable;
3. Effects on emergency plan execution; and
4. Possibility of affecting releases from the NPP into the environment.

7.2.3 Abrasive Dust and Sand Storms

Assessment of the risk of dust and sand storms is made on the basis of historic and recorded data, and includes consideration of the following potential factors:

1. Abrasion or erosion of SSCs;
2. Impact on air or water intakes;
3. Effect of static electricity generation on electrical or electronic SSCs;
4. Impact on off-site power supplies to the site;
5. Effect on emergency plan execution; and
6. Possibility of affecting releases from the NPP into the environment.

7.2.4 Precipitation

All types of precipitation are assessed on the basis of historic and recorded data for the region. The assessment takes into account the potential effects on:

1. Structural loading, including acute impact from heavy precipitation such as hail;
2. Cooling air or water intakes;
3. Off-site power supplies to the site;
4. Dispersion of releases from the NPP through surface or groundwater;
5. Emergency plan execution; and
6. Possibility of affecting releases from the NPP into the environment.

7.2.5 Lightning

The frequency and severity of lightning is evaluated to determine potential impact on the NPP, including the influence of lightning events on the risks of natural fire hazards (as discussed in subsection 7.8).

7.3 Surface Water Hazards

7.3.1 Floods

The region is assessed to determine the potential for flooding due to natural causes that may affect the safety of the NPP (e.g., runoff from precipitation or snow melt, high tide, storm surge, seiche or wind waves, etc.). Prehistoric, historic, and instrumentally recorded data, both meteorological and hydrological, is collected and analyzed.

A suitable meteorological, seismic, and hydrological model is developed, taking the following factors into account:

1. Limits on data accuracy and quantity;
2. The length of the period over which the data was accumulated;
3. Possible combination of effects; and
4. All known past changes in relevant characteristics of the region.

The potential for tsunamis (known as seiche waves in inland lakes) is investigated, as is the potential for instability of a coastal area or river channel due to erosion or sedimentation. The potential for water accumulation resulting from temporary blockage of rivers upstream or downstream to cause flooding and associated phenomena at the proposed site is also examined.

Information relating to upstream water control structures is analyzed to determine whether the NPP will be able to withstand the effects of failure of one or more upstream structures.

7.3.2 Adequacy of Water Supply

Evaluation of water supplies to the site includes the following components:

1. Surface and groundwater sources;
2. Quantity and quality of water; and
3. Reliability and availability of supply.

The evaluation also includes consideration of the potential impact of:

1. Debris and fouling;
2. Additional water requirements for emergency cooling or process needs;
3. Effects on contamination transport;
4. Fluctuations in water temperature that could affect heat sinks; and
5. Effects on firefighting capability.

7.4 Groundwater Hazards

A program of hydrogeological investigations, based on groundwater probing, monitoring data, and numerical modeling, assesses the potential impact of the groundwater flow system on the NPP, such as:

1. Effects on the stability of the NPP's foundations; and
2. Effects on the integrity of the NPP's below-grade structures, such as fuel bays.

7.5 Geotechnical Hazards

Geological maps and other appropriate reference sources for the region are examined to determine the existence of natural features that could affect the surface and subsurface stability of the site.

The stability of the foundation material under dynamic, static, and seismic loading is assessed, with a detailed description of surface and subsurface conditions (including hydrogeochemical effects) being incorporated into a geotechnical investigation program for the purposes of hazard determination and mitigation. The investigation describes any potential site instability, such as collapse, subsidence, surface uplift, and liquefaction of the subsurface materials.

7.6 Geophysical Hazards

7.6.1 Seismic and Surface-faulting Hazards

A fault is considered capable if, on the basis of geological, geophysical, geodetic, or seismological data, one or more of the following conditions applies:

1. The fault shows evidence of past movement or movements of a recurring nature (significant deformations or dislocations) within such a period that is reasonable to infer that further movements at or near the surface could occur;
2. A structural relationship with a known capable fault has been demonstrated such that movement of one may cause movement of the other at or near the surface; and
3. The maximum potential seismic event associated with the seismogenic structure is sufficiently large and at such a depth that it is reasonable to infer that, in the geodynamic setting of the site, movement at or near the surface could occur.

The time-span for the assessment of capable faults is proportional to recurrence intervals of seismic events.

Seismotectonic evaluation is conducted for the region using geophysical data and information on geotechnical hazards. The effects of seismic events and capable faults on sub-surface contamination transport are also evaluated for the region.

7.6.2 Volcanism

An evaluation of all active volcanism in the region that could affect the safe operation of the NPP includes information on prehistoric, historic, and instrumentally recorded volcanic activity in the region. The evaluation also considers:

1. Characteristics of the volcanic source, such as seismic triggers, ash, and volatile gases;
2. Potential effects on ventilation systems;
3. Missiles that could have an impact on SSCs;
4. Potential abrasion or chemical impact on SSCs;
5. Effects on air and water intakes;
6. Effects of static electricity generation on electrical or electronic SSCs;
7. Effects on off-site power supplies to the site; and
8. Effects on emergency plan execution.

7.7 Biological Hazards

Site evaluation includes consideration of the biological phenomena that may pose a risk to the safe operation of the NPP.

Particular attention should be paid to biological phenomena that may pose a risk to cooling water systems. The potential for the colonization and excessive growth of algae, mussels, or clams within these systems, and the clogging of intake structures by large quantities of biological material such as aquatic plants, fishes, or jellyfish, are therefore considered.

The evaluation also considers the potential for unusual weather events to increase the risk of ventilation and cooling intake systems being clogged by biota. For example, flooding or large storm events can dislodge large biomasses of aquatic macrophytes that will foul the intake structures.

The potential for the rapid growth of pathogens in the ultimate heat sink and other elements of the cooling system poses a risk to both humans and non-humans, and is therefore considered in the evaluation.

The potential risk to human and non-human biota from biocides and other means of managing these biohazards is also evaluated.

7.8 Natural Fire Hazards

Natural fire hazards are assessed with respect to their potential risk to NPP safety.

8.0 Evaluation of External, Non-Malevolent, Human-Induced Events

The proponent is expected to develop, document, and implement a systematic approach to identifying all external, non-malevolent, human-induced events. Such events include, without being limited to:

1. Aircraft crashes;
2. Other transportation hazards;
3. Fires and explosions;
4. Chemical and radiological hazards; and
5. Electromagnetic interference hazards.

8.1 Aircraft Crashes

The potential for aircraft crashes on the site is assessed, taking into account the probable characteristics of future air traffic and aircraft. If the assessment reveals an unreasonable risk of an aircraft crash on the site, then an assessment of the associated hazards, including impact, fire, and explosion, is conducted. The potential effects on emergency plan execution, including effects on evacuation routes, are also considered.

8.2 Other Transportation Hazards

Present and proposed land and water transportation routes in the region are evaluated with respect to potential collisions with SSCs, generation of explosions, chemical and radiological hazards, and fires. The potential effects on emergency plan execution, including effects on evacuation routes, are also considered.

8.3 Fires and Explosions

All potential fire and explosion events in the region that could affect the safe operation of the NPP are evaluated, including:

1. Direction and force of pressure waves and their effects on SSCs and unprotected personnel;
2. Temperature effects on SSCs and unprotected personnel;
3. Potential secondary fires and explosions generated by the primary explosion or fire;
4. Release of volatile gases, asphyxiants, or chemicals that could affect safe function of SSCs or harm unprotected personnel;
5. Missiles that could have an impact on SSCs;
6. Effects that could render off-site power supplies unavailable; and
7. Potential effects on emergency plan execution.

8.4 Chemical and Radiological Hazards

All chemical and radiological hazards in the region that could affect the safe operation of the NPP are evaluated, with particular focus on:

1. Activities that involve the handling, processing, transport, and storage of materials with the potential for explosions, or the production of radioactive materials, volatile and reactive gases, or asphyxiants;
2. Effects of the above on SSCs and unprotected personnel, including estimates of overpressure, toxicity, and transport characteristics in air;
3. Secondary chemical interactions on SSCs; and
4. Potential effects on emergency plan execution.

8.5 Electromagnetic Interference Hazards

Electromagnetic emitters in the region are evaluated during normal and abnormal operations with respect to their potential to affects on the safe operation of the NPP.

Emitters include the following:

1. Telecommunications facilities, including military and civilian radar installations;
2. Particle accelerators or other research facilities utilizing large electromagnetic fields; and
3. High-voltage transmission lines, including the effects of solar storms on transmission.

8.6 Consideration of Future Connections to the Grid

The proponent is expected to confirm with the grid owner(s) that, with appropriate grid and plant mitigation measures in place, the location of the plant will not adversely affect the grid.

9.0 Security Considerations

Development of security-related physical protection objectives for new NPPs includes gathering information about the NPP's proposed siting location in order to study threats or issues presented by the geographical location and characteristics of the proposed site, including potential acts of terrorism. The findings from this study are compiled by the proponent in a *Site Selection Threat and Risk Assessment* (SStrA) report-this applies to new sites, and to new plants on existing sites.

At a very early stage, the SStrA report provides the basis for identifying physical protection requirements and proposed mitigation strategies to ensure that all security-related regulatory requirements are met. The SStrA also identifies security concerns that may render the site undesirable from a security perspective.

The SStrA includes comprehensive consideration of both physical protection concerns and transportation routes, as discussed in the following subsections.

The SStrA report is classified as prescribed information and protected from release under Access to Information/Freedom of Information requests on the basis of national security.

9.1 Physical Protection

The proposed physical protection requirements should ensure that the appropriate detection, delay, and response considerations are taken into account.

Physical protection design requirements are influenced by the site location. For example, NPPs located in a remote area bordered by a small population density may require different physical protection considerations than those that apply to NPPs located in a large urban area.

Site evaluation therefore addresses the physical dimensions of the NPP and its surrounding environment, including:

1. The topology of the area that can be considered a component of the overall security barrier design (such as line-of-sight view);
2. The proximity of various infrastructure elements that could adversely affect physical protection, such as a chemical plant that could release a noxious substance, a hydroelectric dam that could be accidentally or deliberately breached, resulting in flood, or an airport that provides significant flight traffic in the vicinity of the site;
3. Site boundaries;
4. Weather that could factor as a potential impediment to the operability of physical protection systems; and
5. Details pertaining to the establishment of a construction site, such as the positioning of perimeter fences, access and egress points, and storage of construction drawings.

9.1.1 Remote Areas

Remote sites are evaluated with respect to the anticipated time required to implement essential response services, including how long it will take off-site armed responders to reach the NPP. This aspect of the SStrA supports early identification of the need for establishing an on-site nuclear response force capability to ensure that a trained response group is in position during the construction phase of possible target sets, such as vital areas that are part of the NPP.

9.2 Transportation Routes

The transportation routes in the vicinity of the site are considered as part of the site evaluation to ensure that they are adequately taken into account during future site development activities. The routes to be considered include waterways, land routes, and airspace, as discussed below.

9.2.1 Waterways

The site evaluation includes assessment of all waterways in the vicinity of the site from the perspective of physical protection. For example, there may be a potential for a waterborne vehicle or its personnel or contents to be used in a manner that may pose a threat to the NPP (e.g., being laden with explosives) to disable operations, equipment, or systems in an act of sabotage that could have radiological implications.

9.2.2 Land Routes

All vehicular access land routes in proximity to the site, including rail lines, are assessed to determine the security threat they may pose to potential locations of future vital areas.

Where possible, the surrounding terrain may be considered as a natural barrier in reducing the risk from vehicle borne explosives. Where this is not possible, consideration is given to delineate areas from which land vehicles must be restricted.

9.2.3 Airspace

The SStrA considers the threats and risks associated with private and commercial airports, including associated flight pathways. This involves discussions with municipal, provincial, and federal governments to establish measures for deterring entry into airspace identified as being of "high risk" to the site.

10.0 Decommissioning

Site evaluation includes consideration of the effects and requirements of site decommissioning and abandonment activities, including:

1. Decommissioning of site preparation or construction activities;
2. Execution of a site restoration plan should the project be discontinued; and
3. Consideration of guidance contained in CNSC regulatory guide G-219, *Decommissioning Planning for Licensed Activities*.

11.0 Quality Assurance

Quality assurance (QA) for the site evaluation process is part of the overall management arrangements for the NPP. Site evaluation activities are initiated long before the NPP is established; however, it is expected that a QA program will be established at such a time that it can be applied to the site evaluation process.

The process of establishing site evaluation-related QA parameters involves technical and engineering analyses, along with judgments that require extensive experience and knowledge. In many cases, the parameters and analyses may not lend themselves to direct verification by inspections, tests, or other techniques that can be precisely defined and controlled. In these cases, evaluations are reviewed and verified by individuals or groups that are independent of those who did the work.

Feedback associated with experienced engineering judgment and expertise in geotechnical engineering is an important aspect of assuring the quality of the site evaluation process. For example, in the assessment of matters such as liquefaction potential and slope stability, the accuracy of the evaluation results depends heavily on insight into failures that have occurred in comparable situations. The information gathered from these assessments is documented and analyzed to provide evidence that similar failures will not occur.

A complete site evaluation QA program includes:

1. Procedures to control the effectiveness of assessments and engineering activities performed in the different stages of the site evaluation process;
2. Appropriate organization, planning, work control, personnel qualification and training, and activity verification and documentation, to ensure that the QA program is carried out as effectively as possible;
3. Records of all work carried out in the site evaluation process;
4. Documentation of the results of studies (including models and simulations) and investigations in sufficient detail to permit independent review; and
5. A report that documents the results of all site evaluation work, laboratory tests, and geotechnical analyses and evaluations.

These expectations apply to all activities that may influence safety, or that may contribute to the derivation of parameters that will ultimately contribute to the design basis for the site.

In addition, the QA program may be graded in accordance with the importance to safety of the individual evaluation activity under consideration.

12.0 Consultation

Early consultation is an important part of good governance, sound policy development, and decision-making. The proponent is therefore expected to demonstrate that consultation with the appropriate parties has been integrated into site evaluation activities.

Because of the constitutional obligations discussed in subsection 3.3, early consultation with Aboriginal groups is conducted separately from consultation with the general public.

However, in both cases, the proponent is expected to work with all stakeholders to establish:

1. The most appropriate methods by which to consult;
2. The objectives and expectations of the consultation process;
3. The means by which interested parties will be able to participate in the formulation and implementation of decisions; and
4. A dispute resolution mechanism that documents disputes and records efforts taken in their resolution.

Proponents are encouraged to thoroughly document the consultation process, and to include a summary of that process when submitting a project description to the CNSC. The summary is expected to include such information as:

1. A list of the stakeholders that were engaged and how they were identified;
2. The project information provided to the stakeholders;
3. A summary of issues raised; and
4. A description of how the proponent has already responded, or plans to respond, to any concerns raised.

12.1 Aboriginal Consultation

Aboriginal groups include communities of Indian, Inuit, and Métis peoples that hold or may hold Aboriginal or treaty rights under section 35 of the *Constitution Act, 1982.* Consultation with Aboriginal groups during site evaluation assists in the early identification of the potential impact that a new NPP would have on treaty and other Aboriginal rights if built on the site being evaluated. Proactive discussion of Aboriginal issues and concerns at the early stages of new NPP development (i.e., during site evaluation) before a project description is submitted to the CNSC can also facilitate a more effective and efficient regulatory review process, including environmental assessment and licensing. Proponents are therefore encouraged to engage Aboriginal groups as an integral part of the site evaluation process, before filing a project description for a new NPP with the CNSC.

There are many sources available to help identify Aboriginal groups in the region associated with the site that is under evaluation, and proponents are encouraged to contact regional or local Aboriginal organizations, as well as federal and provincial government sources, to identify the groups that could be expected to have an interest in the proposed project.

In addition, Natural Resources Canada possesses maps of treaties, comprehensive land claims, and Canada lands that may be useful, and Indian and Northern Affairs Canada maintains a database of all Aboriginal communities within Canada, including contact information.

12.2 Public Consultation

In keeping with best industry practices, the proponent is also expected to consult with stakeholders and the general public early in the site evaluation process, and before any substantive decisions are made.

The consultation process associated with site evaluation demonstrates involvement of stakeholders in good faith, openness, respect, and fairness, with a genuine desire to utilize the input received.

Glossary

Abbreviations

AOO
: anticipated operational occurrence

CEAA
: Canadian Environmental Assessment Act

CNSC
: Canadian Nuclear Safety Commission

DBA
: design basis accident

EA
: environmental assessment

IAEA
: International Atomic Energy Agency

NPP
: Nuclear power plant

NSCA
: Nuclear Safety and Control Act

SSCs
: Systems, structures, and components

SStrA
: site selection threat and risk assessment

VEC
: valued ecosystem component

Terminology

Abiotic
Refers to the non-living parts of the environment such as air, rock, soil, and water.

Anticipated operational occurrence (AOO)
An operational process deviating from normal operation that is expected to occur at least once during the operating lifetime of the nuclear power plant but which, in view of the appropriate design provisions, does not cause any significant damage to items important to safety nor lead to accident conditions.

Biotic
Refers to the living parts of the environment such as plants, animals and microorganisms.

Direct effect
An effect in which the cause-effect relationship has no intermediary effects.

Environment
The components of the earth, including:

1. Land, water and air, including all layers of the atmosphere;
2. All organic and inorganic matter and living organisms; and
3. The interacting natural systems that include components referred to in (1) and (2)

Environmental effect

1. any change that an activity, substance, equipment, or facility that is regulated by the CNSC may cause in the environment, including any effect of any such change: on health and socio-economic conditions; on physical and cultural heritage; on the current use of lands and resources for traditional purposes by aboriginal persons; or on any structure, site, or thing that is of historical, archaeological, paleontological, or architectural significance; and
2. any change to any activity, substance, equipment, or facility that the environment causes, whether any such change

occurs within or outside Canada.

External events
Events unconnected with the operation of a facility or activity that could have an effect on the safety of the facility or activity.

External hazards
An external hazard is an event that originates outside the site and whose effects on the nuclear power plant should be considered as potentially hazardous. Such events may be of natural or human-induced origin, and are identified and selected for design purposes during the site evaluation process. In some cases hazards originating on-site but outside the safety related buildings can be treated as external hazards, if the characteristics of the generated loads are similar to those caused by hazards originating outside the site.

Hazardous substance
A substance, other than a nuclear substance, that is used or produced in the course of carrying on a licensed activity and that may pose a risk to the environment or the health and safety of persons.

Indirect Effect
An effect in which the cause-effect relationship (e.g., between the project's impacts and the ultimate effect on a valued ecosystem components) has intermediary effects.

Malevolent act
An illegal action or an action that is committed with the intent of causing wrongful harm.

Management arrangements
The means by which an organization functions to achieve its objectives, including:

1. Physical elements, such as people, buildings, work areas, equipment, tools, etc.;
2. Intangible elements, such as roles and responsibilities, knowledge, skills and behaviour of the people, cultural norms, agreements, understandings, decision-making processes, etc.; and
3. The documentation that is essential to meeting the organization’s objectives.

Nuclear power plant
Any fission reactor installation constructed to generate electricity on a commercial scale. A nuclear power plant is a Class IA nuclear facility, as defined in the *Class I Nuclear Facilities Regulations*.

Nuclear power plant lifetime
The time between the granting of the *Licence to Prepare Site* and the granting of a *Licence to Abandon*.

Overburden
Any loose material that overlies bedrock.

Protective zone
The area beyond the exclusion zone that needs to be considered with respect to implementing emergency measures. This includes consideration of such matters as population distribution and density, land and water usage, roadways, and consequence and evacuation planning.

Region
A specific area to be studied; the spatial characteristics of a ‘region’ will vary for each hazard being studied. For example, the region being investigated for groundwater effects of an NPP may be substantially different from the region being investigated for effects due to atmospheric releases.

Risk
The product derived from the multiplication of the probability of a particular event by a parameter corresponding to the consequences of this event.

Seiche
An oscillation of an enclosed or semi-enclosed body of water in response to an atmospheric, oceanographic or seismic disturbing force. In the Great Lakes area, a seiche could mean any sudden rise in the water of a harbor or a lake, whether or not it is oscillatory.

Site
The area within the exclusion zone where the NPP and all associated support structures and systems are located.

Site personnel
All persons working in the site area of an authorized facility, either permanently or temporarily.

Siting
The process of selecting a suitable site for a facility, including appropriate assessment and definition of the related design bases.

Storm surge
Abnormal rise in sea level accompanying a hurricane or other intense storm.

Uprate
The action of increasing existing nuclear power plant's output capacity

Valued Ecosystem Components
VECs are selected from the abiotic and biotic information collected as part of the baseline characterization. They are ecosystem components or elements of the ecosystem considered to have scientific, cultural, economic, historical or aesthetic importance. They may be surrogate organisms rather than actual plant or animal species (e.g. a theoretical benthic feeding fish species), communities (e.g., benthic macroinvertebrate community) or specific species (i.e., endangered species), but may also include significant ecological features of the environment, such as wetlands.

Associated Documents

1. Class I Nuclear Facilities Regulations, SOR/2000-204

2. Decommissioning Planning for Licensed Activities, CNSC G-219, Canadian Nuclear Safety Commission, 2000

3. Ground Motion Determination for Seismic Qualification of CANDU Nuclear Power Plants, CAN3-N289.2-M81, Standards Council of Canada, Canada (reaffirmed 2008)

4. Licensing Process for New Nuclear Power Plants in Canada, CNSC INFO-0756, Canadian Nuclear Safety Commission, 2006

5. Life Extension of Nuclear Power Plants, CNSC RD-360, Canadian Nuclear Safety Commission, 2008

6. Nuclear Safety and Control Act, S.C.,1997, c.9

The following IAEA publications provide guidance to aspects of this regulatory document:

1. Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants, IAEA Safety Standards Series No.
NS-G-3.2, Vienna, 2002

2. Evaluation of Seismic Hazards for Nuclear Power Plants, IAEA Safety Standards Series No.
NS-G-3.3, Vienna, 2002

3. External Events Excluding Earthquakes in the Design of Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.5, Vienna, 2003

4. External Human Induced Events in Site Evaluation for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-3.1, Vienna, 2002

5. Flood Hazard for Nuclear Power Plants on Coastal and River Sites, IAEA Safety Standards Series No. NS-G-3.5, Vienna, 2007

6. Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants, IAEA Safety Standards, Series No.
NS-G-3.6, Vienna, 2005

7. Meteorological Events in Site Evaluation for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-3.4, Vienna, 2003

8. Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations: Code and Safety Guides Q1-Q14, IAEA Safety Series No. 50-C/SG-Q, Vienna, 1996

9. Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. NS-R-3, Vienna, 2003

10. The Safety of Nuclear Installations, IAEA Safety Series No. 110, Vienna, 1993

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Canadian Nuclear Safety Commission

RD-337: Design of New Nuclear Power Plants

Preface

This regulatory document sets out the expectations of the Canadian Nuclear Safety Commission (CNSC) concerning the design of new water-cooled nuclear power plants (NPPs or plants). It establishes a set of comprehensive design expectations that are risk-informed and align with accepted international codes and practices.

This document provides criteria pertaining to the safe design of new water-cooled NPPs, and offers examples of optimal design characteristics where applicable. All aspects of the design are taken into account, and multiple levels of defence are promoted in design considerations.

To the extent practicable, the guidance provided herein is technology-neutral with respect to water-cooled reactors.

RD-337 represents the CNSC's adoption of the principles set forth by the International Atomic Energy Agency (IAEA) in NS-R-1, *Safety of Nuclear Plants: Design*, and the adaptation of those principles to align with Canadian expectations. The scope of RD-337 goes beyond IAEA's NS-R-1 to address the interfaces between NPP design and other topics, such as environmental protection, radiation protection, ageing, human factors, security, safeguards, transportation, and accident and emergency response planning.

Similar to NS-R-1, RD-337 considers all licensing phases, because information from the design process feeds into the processes for reviewing an application for a *Licence to Construct* an NPP, and other licence applications.

Nothing contained in this document is to be construed as relieving any applicant or licensee from requirements associated with conventional codes and standards. In particular, while RD-337 may assist a proponent in making a licence application, it is the licensee's responsibility to identify and comply with all applicable regulations and licence conditions.

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1.0 Purpose

The purpose of this regulatory document is to set out the expectations of the Canadian Nuclear Safety Commission (CNSC) with respect to the design of new water-cooled nuclear power plants (NPPs or plants).

2.0 Scope

This document sets out CNSC expectations with respect to the design of new water-cooled NPPs, and provides examples of optimal design characteristics. All aspects of the design are taken into account, and multiple levels of defence are promoted in design considerations.

The information provided herein is intended to facilitate high quality design, and consistency with modern international codes and standards, for new water-cooled NPPs. It is recognized that specific technologies may use alternative approaches. If a design other than a water-cooled reactor is to be considered for licensing in Canada, the design is subject to the safety objectives, high level safety concepts and safety management expectations associated with this regulatory document. However, CNSC review of such a design will be undertaken on a case by case basis.

Conventional industrial safety is addressed only from a high-level perspective, with a focus on design considerations that are related to nuclear safety.

To the extent practicable, this document is technology-neutral with respect to water-cooled reactors, and includes direction concerning:

1. Establishing the safety goals and objectives for the design;
2. Utilizing safety principles in the design;
3. Applying safety management principles;
4. Designing systems, structures, and components;
5. Interfacing engineering aspects, plant features, facility layout; and
6. Integrating safety assessments into the design process.

To a large degree, this document represents the CNSC's adoption of the principles set forth in International Atomic Energy Agency (IAEA) document NS-R-1, *Safety of Nuclear Plants: Design*, and the adaptation of those principles to align with Canadian practices. The scope of NS-R-1 has been expanded to address the interfaces between NPP design and other topics, such as environmental protection, radiation protection, ageing, human factors, security, safeguards, transportation, and accident and emergency response planning.

3.0 Relevant Requirements

The provisions of the *Nuclear Safety and Control Act* (NSCA) and regulations that are relevant to this regulatory document include:

1. Subsection 24(4) of the NSCA prohibits the Commission from issuing, renewing, amending or replacing a licence, unless "in the opinion of the Commission, the applicant (*a*) is qualified to carry on the activity that the licence will authorize the licensee to carry on; and (*b*) will, in carrying on that activity, makes adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed";
2. Subsection 24(5) of the NSCA authorizes the Commission to include in a licence any term or condition that the Commission considers necessary for the purposes of the NSCA;
3. Paragraph 3(1)(*i*) of the *General Nuclear Safety and Control Regulations* stipulates that an application for a licence shall contain, in addition to other information, "…a description and the results of any test, analysis or calculation performed to substantiate the information included in the application";
4. Paragraph 12(1)(*f*) of the *General Nuclear Safety and Control Regulations* stipulates that every licensee shall, "…take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity";
5. Paragraph 5(*i*) of the *Class I Nuclear Facilities Regulations* stipulates that an application for a licence to construct a Class I nuclear facility shall contain, in addition to other information, information on, "…the effects on the environment

and the health and safety of persons that may result from the construction, operation and decommissioning of the nuclear facility…”;

6. Paragraph 6(*h*) of the *Class I Nuclear Facilities Regulations* stipulates that an application for a licence to operate a Class I nuclear facility shall contain, in addition to other information, information on, “…the effects on the environment and the health and safety of persons that may result from the operation and decommissioning of the nuclear facility…”;
7. Paragraph 7(*f*) of the *Class I Nuclear Facilities Regulations* stipulates that an application for a licence to decommission a Class I nuclear facility shall contain, in addition to other information, information on, “…the effects on the environment and the health and safety of persons that may result from the decommissioning and the measures that will be taken to prevent or mitigate those effects”; and
8. Other sections of the *Class I Nuclear Facilities Regulations*, as well as sections of the *Radiation Protection Regulations* and the *Nuclear Security Regulations* that pertain to the design of a new nuclear power plant.

4.0 Safety Objectives and Concepts

4.1 General Nuclear Safety Objective

In support of the NSCA and associated regulations, the CNSC endorses the objective established by the IAEA that NPPs be designed and operated in a manner that will protect individuals, society, and the environment from harm. This objective relies on the establishment and maintenance of effective defences against radiological hazards in NPPs.

The general nuclear safety objective is supported by two complementary safety objectives dealing with radiation protection and with the technical aspects of the design. The technical safety objective is interdependent with administrative and procedural measures that are taken to ensure defence against hazards due to ionizing radiation.

4.1.1 Radiation Protection Objective

The radiation protection objective is to provide that during normal operation, or during anticipated operational occurrences, radiation exposures within the NPP or due to any planned release of radioactive material from the NPP are kept below prescribed limits and as low as reasonably achievable (ALARA).

The design provides for the mitigation of the radiological consequences of any accidents.

4.1.2 Technical Safety Objectives

The technical safety objectives are to provide all reasonably practicable measures to prevent accidents in the NPP, and to mitigate the consequences of accidents if they do occur. This takes into account all possible accidents considered in the design, including those of very low probability.

With achievement of these objectives, any radiological consequences should be minor and below prescribed limits, and the likelihood of accidents with serious radiological consequences is expected to be extremely low.

4.2 Application of the Technical Safety Objectives

The NSCA and the technical safety objectives provide the basis for the following criteria and goals:

1. Dose acceptance criteria for events within the design basis; and
2. Safety goals for beyond design basis accidents.

Safety analyses are performed to confirm that these criteria and goals are met, to demonstrate effectiveness of measures for preventing accidents, and mitigating radiological consequences of accidents if they do occur.

4.2.1 Dose Acceptance Criteria

The committed whole-body dose for average members of the critical groups who are most at risk, at or beyond the site boundary is calculated in the deterministic safety analysis for a period of 30 days after the analyzed event.

This dose is less than or equal to the dose acceptance criteria of:

1. 0.5 millisievert for any anticipated operational occurrence (AOO); or
2. 20 millisieverts for any design basis accident (DBA).

4.2.2 Safety Goals

Qualitative Safety Goals

A limit is placed on the societal risks posed by nuclear power plant operation. For this purpose, the following two qualitative safety goals have been established:

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1. Individual members of the public are provided a level of protection from the consequences of nuclear power plant operation such that there is no significant additional risk to the life and health of individuals; and
2. Societal risks to life and health from nuclear power plant operation are comparable to or less than the risks of generating electricity by viable competing technologies, and should not significantly add to other societal risks.

Quantitative Application of the Safety Goals

For practical application, quantitative safety goals are established to achieve the intent of the qualitative safety goals. The three quantitative safety goals are:

1. Core damage frequency;
2. Small release frequency; and
3. Large release frequency.

A core damage accident results from a postulated initiating event (PIE) followed by failure of one or more safety system(s) or safety support system(s). Core damage frequency is a measure of the plant's accident preventive capabilities.

Small release frequency and large release frequency are measures of the plant's accident mitigative capabilities. They also represent measures of risk to society and to the environment due to the operation of a nuclear power plant.

Core Damage Frequency

The sum of frequencies of all event sequences that can lead to significant core degradation is less than 10^{-5} per reactor year.

Small Release Frequency

The sum of frequencies of all event sequences that can lead to a release to the environment of more than 10^{15} becquerel of iodine-131 is less than 10^{-5} per reactor year. A greater release may require temporary evacuation of the local population.

Large Release Frequency

The sum of frequencies of all event sequences that can lead to a release to the environment of more than 10^{14} becquerel of cesium-137 is less than 10^{-6} per reactor year. A greater release may require long term relocation of the local population.

4.2.3 Safety Analyses

To demonstrate achievement of the safety objectives, a comprehensive hazard analysis, a deterministic safety analysis, and a probabilistic safety assessment are carried out. These analyses identify all sources of exposure, in order to evaluate potential radiation doses to workers at the plant and to the public, and to evaluate potential effects on the environment.

The safety analyses examine plant performance for:

1. Normal operation;
2. Anticipated operational occurrences;
3. Design basis accidents; and
4. Beyond design basis accidents (BDBAs), including event sequences that may lead to a severe accident.

Based on these analyses, the capability of the design to withstand postulated initiating events (PIEs) and accidents can be confirmed, the effectiveness of the items important to safety can be demonstrated, and requirements for emergency response can be established. The results of the safety analyses are fed back into the design.

The safety analyses are discussed in further detail in Section 9.0.

4.2.4 Accident Mitigation and Management

The design includes provisions to limit radiation exposure in normal operation and AOOs to ALARA levels, and to minimize the likelihood of an accident that could lead to the loss of normal control of the source of radiation. However, given that there is a remaining probability that an accident may occur, measures are taken to mitigate the radiological consequences of accidents.

This includes such measures as:

1. Consideration of inherent safety features;
2. Incorporation of engineered design features;
3. Establishment by the operating organization of on-site accident management procedures; and
4. Establishment of off-site intervention measures by appropriate authorities.

The design applies the principle that plant states that could result in high radiation doses or radioactive releases have a very low frequency of occurrence, and plant states with significant frequency of occurrence have only minimal, if any, potential radiological consequences.

4.3 Safety Concepts

4.3.1 Defence-in-depth

The concept of defence-in-depth is applied to all organizational, behavioural, and design-related safety and security activities to ensure that they are subject to overlapping provisions. With the defence-in-depth approach, if a failure were to occur it will be detected and compensation made, or it would be corrected.

This concept is applied throughout the design process and operation of the plant to provide a series of levels of defence aimed at preventing accidents, and ensuring appropriate protection in the event that prevention fails.

The design provides all five levels of defence during normal operation; however, some relaxations may be specified for certain shutdown states. These levels are introduced in general terms below, and are discussed in greater detail in subsection 6.1.

Level One

The aim of the first level of defence is to prevent deviations from normal operation, and to prevent failures of systems, structures, and components (SSCs).

Level Two

The aim of the second level of defence is to detect and intercept deviations from normal operation in order to prevent AOOs from escalating to accident conditions, and to return the plant to a state of normal operation.

Level Three

The aim of the third level of defence is to minimize the consequences of accidents by providing inherent safety features, fail-safe design, additional equipment, and mitigating procedures.

Level Four

The aim of the fourth level of defence is to ensure that radioactive releases caused by severe accidents are kept as low as practicable.

Level Five

The aim of the fifth level of defence is to mitigate the radiological consequences of potential releases of radioactive materials that may result from accident conditions.

4.3.2 Consideration of Physical Barriers

An important aspect of implementing defence-in-depth in the NPP design is the provision of a series of physical barriers to confine radioactive material at specified locations.

4.3.3 Operational Limits and Conditions

Operational limits and conditions (OLCs) are the set of limits and conditions that can be monitored by or on behalf of the operator, and that can be controlled by the operator.

The OLCs are established to ensure that plants operate in accordance with design assumptions and intent (parameters and components), and include the limits within which the facility has been shown to be safe. The OLCs are documented in a manner that is readily accessible for control room personnel, with the roles and responsibilities clearly identified. Some OLCs may include combinations of automatic functions and actions by personnel.

Safe operation depends on personnel as well as equipment. OLCs therefore typically include:

1. Control system constraints and procedural constraints on important process variables;
2. Requirements for normal operation and AOOs, including shutdown states;
3. Actions to be taken and limitations to be observed by operating personnel;
4. Principal requirements for surveillance and corrective or compensatory actions; and
5. The limitations to be observed and the operational requirements to be met by SSCs in order that their intended functions, as assumed in the safety analysis, can be met.

The basis on which the OLCs are derived will be readily available in order to facilitate the ability of plant personnel to interpret, observe, and apply the OLCs.

5.0 Safety Management During Design

The NPP design:

1. Meets Canadian regulatory requirements;
2. Meets the design specifications, as confirmed by safety analysis;
3. Takes account of current safety practices;
4. Fulfills the requirements of an effective quality assurance program; and
5. Incorporates only those design changes that have been justified by technical and safety assessments.

The design process is carried out by technically qualified and appropriately trained staff at all levels, and includes such management arrangements as:

1. A clear division of responsibilities with corresponding lines of authority and communication;
2. Clear interfaces between the groups engaged in different parts of the design, and between designers, utilities, suppliers, builders, and contractors as appropriate;
3. Procedures that align with an established quality assurance program; and
4. A positive safety culture throughout all levels of the organization.

5.1 Design Authority

During the design phase, formal design authority typically rests with the organization that has overall responsibility for the design. Prior to plant start-up, this authority may be transferred to the operating organization.

The design authority may assign responsibility for the design of specific parts of the plant to other organizations, known as responsible designers. The tasks and functions of the design authority and any responsible designer need to be established in formal documentation; however, the overall responsibility remains with the design authority.

The applicant confirms that the design authority has achieved the following objectives during the design phase:

1. Established a knowledge base of all relevant aspects of the plant design and kept it up-to-date, while taking experience and research findings into account;
2. Ensured the availability of the design information that is needed for safe plant operation and maintenance;
3. Established the requisite security clearances and associated security measures to protect prescribed, designated, and classified material;
4. Maintained design configuration control;
5. Reviewed, verified, approved (or rejected), and documented design changes;
6. Established and controlled the necessary interfaces with responsible designers or other suppliers engaged in design work;
7. Ensured that the necessary engineering and scientific skills and knowledge have been maintained; and
8. Ensured that, with respect to individual design changes or multiple changes that may have significant interdependencies, the associated impact on safety has been properly assessed and understood.

5.2 Design Management

Appropriate design management is expected to achieve the following objectives:

1. SSCs important to safety meet their respective design requirements;
2. Due account is taken of the human capabilities and limitations of personnel;
3. Safety design information necessary for safe operation and maintenance of the plant and any subsequent plant modifications is preserved;
4. OLCs are provided for incorporation into the plant administrative and operational procedures;
5. The plant design facilitates maintenance throughout the life of the plant;
6. The results of the deterministic and probabilistic safety assessments are taken into account;
7. Due consideration is given to the prevention of accidents and mitigation of their consequences;
8. Generation of radioactive waste is limited to minimum practicable levels, in terms of both activity and volume;
9. A change control process is established to track design changes to provide configuration management during construction, commissioning, and operation; and
10. Physical protection systems are provided to address design basis threats.

5.3 Quality Assurance Program

A quality assurance program is established as part of the overall management arrangements by which the plant will function to achieve objectives. With respect to the plant design, this includes identifying all performance and assessment parameters for the design, as well as detailed plans for each SSC to ensure consistent quality of the design and the selected components.

The quality assurance program is such that the initial design, and any subsequent change or safety improvement, is carried out in accordance with established procedures that call on appropriate standards and codes, and that incorporate applicable requirements and design bases. Appropriate quality assurance also facilitates identification and control of design interfaces.

The adequacy of the design, including design tools and design inputs and outputs, are verified or validated by individuals or groups that are independent from those who originally performed the work. Verifications, validations, and approvals are completed before the detailed design is implemented.

5.4 Proven Engineering Practices

The design authority identifies the modern standards and codes that will be used for the plant design, and evaluates those standards and codes for applicability, adequacy, and sufficiency to the design of SSCs important to safety.

Where needed, codes and standards may be supplemented or modified to ensure that the final quality of the design is commensurate with the necessary safety functions.

SSCs important to safety are of proven designs, and are designed according to the standards and codes identified for the NPP.

Where a new SSC design, feature, or engineering practice is introduced, adequate safety is proven by a combination of supporting research and development programs, and by examination of relevant experience from similar applications. An adequate qualification program is established to verify that the new design meets all applicable safety expectations. New designs are tested before being brought into service, and are then monitored in service to verify that the expected behaviour is achieved.

The design authority establishes an adequate qualification program to verify that the new design meets all applicable safety design requirements.

In the selection of equipment, due attention is given to spurious operation and to unsafe failure modes (e.g., failure to trip when necessary). Where the design has to accommodate an SSC failure, preference is given to equipment that exhibits known and predictable modes of failure, and that facilitates repair or replacement.

5.5 Operational Experience and Safety Research

The NPP design draws on operational experience that has been gained in the nuclear industry, and on the results of relevant research programs.

5.6 Safety Assessment

Safety assessment is a systematic process applied throughout the design phase to ensure that the design meets all relevant safety requirements. This includes the requirements set by the operating organization and by regulatory authorities. The basis for the safety assessment is the data derived from the safety analysis, previous operational experience, results of supporting research, and proven engineering practices.

The safety assessment is part of the design process, with iteration between the design and analyses, and increases in scope and level of detail as the design process progresses.

Before the design is submitted, an independent peer review of the safety assessment is conducted by individuals or groups separate from those carrying out the design.

Safety assessment documentation identifies those aspects of operation, maintenance, and management that are important to safety. This documentation is maintained in a dynamic suite of documents to reflect changes in design as the plant evolves.

Safety assessment documentation is presented clearly and concisely, in a logical and understandable format, and will be made readily accessible to designers, operators, and the CNSC.

5.7 Design Documentation

The design documentation includes the following information:

1. Design description;
2. Design requirements;
3. System classifications;
4. Description of plant states;
5. Security system design, including a description of physical security barriers;
6. Operational limits and conditions;
7. Identification and categorization of initiating events;
8. Acceptance criteria and derived acceptance criteria;
9. Deterministic safety analysis;
10. Probabilistic safety assessment (PSA); and
11. Hazards analysis.

6.0 Safety Considerations

6.1 Application of Defence-in-depth

Defence-in-depth is achieved at the design phase through application of design provisions specific to the five levels of defence.

Level One

Achievement of defence-in-depth level one calls for conservative design and high-quality construction to provide confidence that plant failures and deviations from normal operations are minimized and accidents are prevented.

This entails careful attention to selection of appropriate design codes and materials, design procedures, equipment qualification, control of component fabrication and plant construction, and use of operational experience.

Level Two

Defence-in-depth level two is achieved by controlling plant behaviour during and following a PIE using both inherent and engineered design features to minimize or exclude uncontrolled transients to the extent possible.

Level Three

Achievement of defence-in-depth level three calls for provision of inherent safety features, fail safe design, engineered design features, and procedures that minimize the consequences of DBAs. These provisions are capable of leading the plant first to a controlled state, and then to a safe shutdown state, and maintaining at least one barrier for the confinement of radioactive material. Automatic activation of the engineered design features minimizes the need for operator actions in the early phase of a DBA.

Level Four

Defence-in-depth level four is achieved by providing equipment and procedures to manage accidents and mitigate their consequences as far as practicable.

Most importantly, adequate protection is provided for the confinement function by way of a robust containment design. This includes the use of complementary design features to prevent accident progression and to mitigate the consequences of selected severe accidents. The confinement function is further protected by severe accident management procedures.

Level Five

The design provides an adequately equipped emergency support centre, and plans for on-site and off-site emergency response.

6.1.1 Consideration of Physical Barriers

To ensure maintenance of the overall safety concept of defence-in-depth, the design provides multiple physical barriers to the uncontrolled release of radioactive materials to the environment. Such barriers include the fuel matrix, the fuel cladding, the reactor coolant pressure boundary, and the containment. In addition, the design provides for an exclusion zone.

To the extent practicable, the design therefore prevents:

1. Challenges to the integrity of physical barriers;
2. Failure of a barrier when challenged; and
3. Failure of a barrier as a consequence of failure of another barrier.

The design also allows for the fact that the existence of multiple levels of defence is not a sufficient basis for continued power operation in the absence of one defence level.

6.2 Safety Functions

The NPP design provides adequate means to:

1. Maintain the plant in a normal operational state;
2. Ensure the proper short-term response immediately following a PIE; and
3. Facilitate the management of the plant in and following any DBA, and in accident conditions beyond DBAs.

The following fundamental safety functions are available in normal operation, and during and following AOOs and DBAs:

1. Control of reactivity;
2. Removal of heat from the core;
3. Confinement of radioactive material;
4. Control of operational discharges and hazardous substances, as well as limitation of accidental releases; and
5. Monitoring of safety critical parameters to guide operator actions.

The above functions also facilitate response to BDBAs to the extent practicable.

SSCs necessary to fulfill safety functions following a PIE are identified. This approach identifies the need for such functions as reactor shutdown, emergency core cooling, containment, emergency heat removal, and power systems, etc.

6.3 Accident Prevention and Plant Safety Characteristics

The design applies the principles of defence-in-depth to minimize sensitivity to PIEs. Following a PIE, the plant is rendered safe by:

1. Inherent safety features;
2. Passive safety features, or action of control systems;
3. Action of safety systems; or
4. Specified procedural actions.

6.4 Radiation Protection and Acceptance Criteria

Achievement of the general nuclear safety objective (discussed in subsection 4.1) depends on all actual and potential sources of radiation being identified, and on provision being made to ensure that sources are kept under strict technical and administrative control.

Radiation doses to the public and to site personnel are to be as low as reasonably achievable. During normal operation, including maintenance and decommissioning, doses are regulated by the limits prescribed in the *Radiation Protection Regulations*.

The design includes provisions for the prevention and mitigation of radiation exposures resulting from DBAs and BDBAs.

The design also ensures that potential radiation doses to the public from AOOs and DBAs do not exceed dose acceptance criteria provided in subsection 4.2.1. The calculated overall risk to the public from all plant states meets the safety goals in subsection 4.2.2.

6.5 Exclusion Zone

The design includes adequate provision for an appropriate exclusion zone. The appropriateness of the exclusion zone is based on several factors, including (without being limited to):

1. Evacuation needs;
2. Land usage needs;
3. Security requirements; and
4. Environmental factors.

6.6 Facility Layout

The design takes into account the interfaces between the safety and security provisions of the NPP and other aspects of the facility layout, such as:

1. Access routes for normal operational actions and maintenance;
2. Access control to minimize radiation exposures;
3. Actions taken in response to internal or external events;
4. Egress routes;
5. Movement of hazardous substances, nuclear materials, and radioactive materials;
6. Movement of authorized and unauthorized personnel; and
7. Interaction of building and support functions.

It is likely that some design requirements associated with these factors will conflict with others in the determination of facility layout requirements. The design therefore reflects an assessment of options, demonstrating that an optimized configuration has been sought for the facility layout.

7.0 General Design Considerations

7.1 Classification of SSCs

The design authority classifies SSCs in a consistent and clearly defined classification scheme. The SSCs are then designed, constructed, and maintained such that their quality and reliability is commensurate with this classification.

In addition, all SSCs are identified as either important or not important to safety. The criteria for determining safety importance are based on:

1. Safety function(s) to be performed;
2. Consequence of failure;
3. Probability that the SSC will be called upon to perform the safety function; and
4. The time following a PIE at which the SSC will be called upon to operate, and the expected duration of that operation.

SSCs important to safety include:

1. Safety systems;
2. Complementary design features;
3. Safety support systems; and
4. Other SSCs whose failure may lead to safety concerns (e.g., process and control systems).

The design provides appropriately designed interfaces between SSCs of different classes to minimize the risk of an SSC less important to safety from adversely affecting the function or reliability of an SSC of greater importance.

7.2 Plant Design Envelope

The design authority establishes the plant design envelope, which comprises the design basis and complementary design features.

The design basis specifies the capabilities that are necessary for the plant in normal operation, AOOs, and DBAs.

Conservative design measures and sound engineering practices are to be applied in the design basis for normal operation, AOOs, and DBAs. This provides a high degree of assurance that no significant damage will occur to the reactor core, and that radiation doses will remain within established limits.

Complementary design features address the performance of the plant in BDBAs, including selected severe accidents.

7.3 Plant States

Plant states are grouped into the following four categories:

1. *Normal Operation*-operation within specified OLCs, including start-up, power operation, shutting down, shutdown, maintenance, testing, and refuelling;
2. *Anticipated Operational Occurrence*-a deviation from normal operation that is expected to occur once or several times during the operating lifetime of the NPP but which, in view of the appropriate design provisions, does not cause any significant damage to items important to safety, nor lead to accident conditions;
3. *Design Basis Accidents*-accident conditions for which an NPP is designed according to established design criteria, and for which damage to the fuel and the release of radioactive material are kept within regulated limits; and
4. *Beyond Design Basis Accidents*-accident conditions less frequent and more severe than a design basis accident. A BDBA may or may not involve core degradation.
   Acceptance criteria are assigned to each plant state, taking into account the expectation that frequent PIEs will have only minor or no radiological consequences, and events that may result in severe consequences are of extremely low probability.

7.3.1 Normal Operation

The design facilitates safe operation of the plant within a defined range of parameters, with an assumed availability of a minimum set of specified support features for safety systems.

The design minimizes the unavailability of safety systems. The design addresses the potential for accidents to occur when the availability of safety systems may be reduced, such as during shutdown, start-up, low power operation, refuelling, and maintenance.

The design establishes a set of requirements and limitations for safe normal operation, including:

1. Limits important to safety;
2. Constraints on control systems and procedures;
3. Plant maintenance, testing, and inspection requirements to ensure that SSCs function as intended, taking the ALARA principle into consideration; and
4. Clearly defined operating configurations, such as start-up, power production, shutdown, maintenance, testing, surveillance, and refuelling-these configurations include relevant operational restrictions in the event of safety system and safety support system outages.

These requirements and limitations, together with the results of safety analysis, form the basis for establishing the OLCs according to which the plant will be authorized to operate, as discussed in subsection 4.3.3 of this document.

7.3.2 Anticipated Operational Occurrences

The design includes provisions such that releases to the public following an AOO do not exceed the dose acceptance criteria.

The design also provides that, to the extent practicable, SSCs not involved in the initiation of an AOO will remain operable following the AOO.

The response of the plant to a wide range of AOOs allows safe operation or shutdown, if necessary, without the need to invoke provisions beyond defence-in-depth Level 1 or, at most, Level 2.

The facility layout is such that equipment is placed at the most suitable location to ensure its immediate availability when operator intervention is required, allowing for safe and timely access during an AOO.

7.3.3 Design Basis Accidents

The set of design basis accidents sets the boundary conditions according to which SSCs important to safety are designed.

The design is such that releases to the public following a DBA will not exceed the dose acceptance criteria.

In order to prevent progression to a more severe condition that may threaten the next barrier, the design includes provision to automatically initiate the necessary safety systems where prompt and reliable action is required in response to a PIE.

Provision is also made to support timely detection of, and manual response to, conditions where prompt action is not necessary. This includes such responses as manual initiation of systems or other operator actions.

The design takes into account operator actions that may be necessary to diagnose the state of the plant and to put it into a stable long-term shutdown condition in a timely manner. Such operator actions are facilitated by the provision of adequate instrumentation to monitor plant status, and controls for manual operation of equipment.

Any equipment necessary for manual response and recovery processes is placed at the most suitable location to allow safe and timely worker access when needed.

7.3.4 Beyond Design Basis Accidents

The design authority identifies credible BDBAs, based on operational experience, engineering judgment, and the results of analysis and research. This includes events leading to significant core degradation (severe accidents), particularly those events that challenge containment.

Complementary design features are then considered with the goal of preventing identified BDBA scenarios, and mitigating their consequences if they do occur.

Complementary design features include design or procedural considerations, or both, and are based on a combination of phenomenological models, engineering judgments, and probabilistic methods.

The design identifies the rules and practices that have been applied to the complementary design features. These rules and practices do not necessarily need to incorporate the same degree of conservatism as those applied to the design basis.

The design identifies a radiological and combustible gas accident source term for use in the specification of the complementary design features for BDBAs. This source term is referred to as the reference source term, and is based on a set of representative core damage accidents established by the design authority.

In the case of multi-unit plants, the use of available support from other units is relied upon only if it can be established that the safe operation of the other units is not compromised.

To the extent practicable, the design provides biological shielding of appropriate composition and thickness to protect operational personnel during BDBAs, including severe accidents.

Severe Accidents

The design should be balanced such that no particular design feature or event makes a dominant contribution to the frequency of severe accidents, taking uncertainties into account.

Early in the design process, the various potential barriers to core degradation are identified, and features that can be incorporated to halt core degradation at those barriers are considered.

The design also identifies the equipment to be used in the management of severe accidents. A reasonable level of confidence that this equipment will perform as intended in the case of a severe accident is demonstrated by environmental, fire, and seismic assessments.

Particular attention is placed on the prevention of potential containment bypass in accidents involving significant core degradation.

Consideration is given to the plant's full design capabilities, including the possible use of safety, non-safety, and temporary systems, beyond their originally intended function. This applies to any system that can be shown with a reasonable degree of assurance to be able to function in the environmental conditions expected during a severe accident.

Containment maintains its role as a leak-tight barrier for a period that allows sufficient time for the implementation of off-site emergency procedures following the onset of core damage. Containment also prevents uncontrolled releases of radioactivity after this period.

The design authority establishes initial severe accident management guidelines, taking into account the plant design features and the understanding of accident progression and associated phenomena.

The design considers prevention of recriticality following severe accidents.

7.4 Postulated Initiating Events Considered in the Design

Postulated initiating events can lead to AOO or accident conditions, and include credible failures or malfunctions of SSCs, as well as operator errors, common-cause internal hazards, and external hazards.

7.4.1 Internal Hazards

SSCs important to safety are designed and located in a manner that minimizes the probability and effects of fires and explosions caused by external or internal events.

The plant design takes into account the potential for internal hazards, such as flooding, missile generation, pipe whip, jet impact, fire, smoke, and combustion by-products, or release of fluid from failed systems or from other installations on the site. Appropriate preventive and mitigation measures are provided to ensure that nuclear safety is not compromised.

The design considers the possible interaction of external and internal events, such as external events initiating internal fires or floods that may lead to the generation of missiles.

Where two fluid systems operating at different pressures are interconnected, failure of the interconnection is considered. Either both withstand the higher pressure, or provision is made so that the pressure of the system operating at the lower pressure will not be exceeded.

7.4.2 External Hazards

The design considers all natural and human-induced external events that may be linked with significant radiological risk. The subset of external events that the plant is designed to withstand is selected, and design basis events are determined from this subset.

Various interactions between the plant and the environment, such as population in the surrounding area, meteorology, hydrology, geology and seismology are identified during the site evaluation and environmental assessment processes. These interactions are taken into account in determining the design basis for the NPP.

Applicable natural external hazards include such events as earthquakes, droughts, floods, high winds, tornadoes, tsunami, and extreme meteorological conditions. Human-induced external events include those that are identified in the site evaluation, such as potential aircraft crashes, ship collisions, and terrorist activities.

7.4.3 Combinations of Events

Combinations of randomly occurring individual events that could credibly lead to AOOs, DBAs, or BDBAs are considered in the design. Such combinations are identified early in the design phase, and are confirmed using a systematic approach.

Events that may result from other events, such as a flood following an earthquake, are considered to be part of the original PIE.

7.5 Design Rules and Limits

The design authority specifies the engineering design rules for all SSCs. These rules comply with appropriate accepted engineering practices.

The design also identifies SSCs to which design limits are applicable. These design limits are specified for normal operation, AOOs, and DBAs.

7.6 Design for Reliability

All SSCs important to safety are designed with sufficient quality and reliability to meet the design limits. A reliability analysis is performed for each of these SSCs.

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Where possible, the design provides for testing to demonstrate that these reliability requirements will be met during operation.

The safety systems and their support systems are designed to ensure that the probability of a safety system failure on demand from all causes is lower than 10^{-3}.

The reliability model for each system uses realistic failure criteria and best estimate failure rates, considering the anticipated demand on the system from PIEs.

Design for reliability includes consideration of mission times for SSCs important to safety.

The design takes into account the availability of off-site services upon which the safety of the plant and protection of the public may depend, such as the electricity supply and external emergency response services.

7.6.1 Common-cause Failures

Failure of a number of devices or components to perform their functions may occur as a result of a single specific event or cause. Common-cause failures may also occur when multiple components of the same type fail at the same time. This may be caused by such occurrences as a change in ambient conditions, saturation of signals, repeated maintenance error or design deficiency.

The potential for common-cause failures of items important to safety is considered in determining where to apply the principles of diversity, separation, and independence to achieve the necessary reliability. Such failures may simultaneously affect a number of different items important to safety. The event or cause may be a design deficiency, a manufacturing deficiency, an operating or maintenance error, a natural phenomenon, a human-induced event, or an unintended cascading effect from any other operation or failure within the plant.

The design provides sufficient physical separation between redundant divisions of safety support systems and process systems. This applies to equipment and to routing of the following items:

1. Electrical cables for power and control of equipment;
2. Piping for service water for the cooling of fuel and process equipment; and
3. Tubing and piping for compressed air or hydraulic drives for control equipment.

Where physical separation is not possible, safety support system equipment may share physical space. In such cases, the reasons for the lack of separation and justification for the space sharing arrangement is explained in the design documentation.

Where space sharing is necessary, services for safety and for other important process systems are arranged in a manner that incorporates the following considerations:

1. A safety system designed to act as backup is not located in the same space as the primary safety system; and
2. If a safety system and a process system must share space, then the associated safety functions are also provided by another safety system to counter the possibility of failures in the process system.

The design provides effective protection against common-cause events where sufficient physical separation among individual services or groups of services does not exist. The design authority assesses the effectiveness of specified physical separation or protective measures against common-cause events.

Diversity is applied to redundant systems or components that perform the same safety function by incorporating different attributes into the systems or components. Such attributes include different principles of operation, different physical variables, different conditions of operation, or production by different manufacturers.

It is important that any diversity used actually achieves the desired increase in reliability. For example, to reduce the potential for common-cause failures, the application of diversity is examined for any similarity in materials, components, and manufacturing processes, or subtle similarities in operating principles or common support features. If diverse components or systems are used, there should be a reasonable assurance that such additions are of overall benefit, taking into account associated disadvantages such as the extra complication in operational, maintenance, and test procedures, or the consequent use of equipment of lower reliability.

7.6.2 Single Failure Criterion

All safety groups function in the presence of a single failure. The single failure criterion requires that each safety group perform all safety functions required for a PIE in the presence of any single component failure, and:

1. All failures caused by that single failure;
2. All identifiable but non-detectable failures, including those in the non-tested components; and
3. All failures and spurious system actions that cause (or are caused by) the PIE.

Each safety group is able to perform the required safety functions under the worst permissible systems configuration, taking into account such considerations as maintenance, testing, inspection and repair, and equipment outage.

Analysis of all possible single failures, and all associated consequential failures, is conducted for each element of each safety group until all safety groups have been considered.

Unintended actions and failure of passive components are considered as two of the modes of failure of a safety group.

The single failure is assumed to occur prior to the PIE, or at any time during the mission time for which the safety group is required to function following the PIE. Passive components may be exempt from this expectation.

Exemptions for passive components apply only to those components that are designed and manufactured to high standards of quality, that are adequately inspected and maintained in service, and that remain unaffected by the PIE. Design documentation includes analytical justification of such exemptions, taking loads and environmental conditions into account, as well as the total period of time after the PIE for which the functioning of the component is necessary.

Check valves are active components if they must change state following a PIE.

Exceptions to the single failure criterion are infrequent, and clearly justified.

7.6.3 Fail-safe Design

The principle of fail-safe design is applied to the design of SSCs important to safety. To the greatest extent practicable, application of this principle enables plant systems to pass into a safe state if a system or component fails, with no necessity for any action to be taken.

7.6.4 Allowance for Equipment Outages

The design includes provisions for adequate redundancy, reliability, and effectiveness, to allow for online maintenance and online testing of systems important to safety, except where these activities are not possible due to access control restrictions.

The design considers the time allowed for each equipment outage and the respective response actions.

7.6.5 Shared Systems

In cases where a system performs both process functions and safety functions, the following design considerations apply:

1. The process and safety functions are not required or credited at the same time;
2. If the process function is operating, and a PIE in that system is postulated, it can be shown that all essential safety functions of the system that are required to mitigate the PIE are unaffected;
3. The system is designed to the standards of the function of higher importance with respect to safety;
4. If the process function is used intermittently, then the availability of the safety function after each use, and its continued ability to meet expectations, can be demonstrated by testing; and
5. The expectations for instrumentation sharing are met.

Shared Instrumentation for Safety Systems

Instrumentation is not typically shared between safety systems.

Where justified, there may be sharing between a safety system and a non-safety system (such as a process or control system).

Reliability and effectiveness of a safety system will not be impaired by normal operation, by partial or complete failure in other systems, or by any cross-link generated by the proposed sharing.

The design includes provisions to ensure that the sharing of instruments does not result in an increased frequency in demand on the safety system during operation.

The design provides for periodic testing of the entire channel of instrumentation logic, from sensing device to actuating device.

If the design includes sharing of instrumentation between a safety system and a non-safety system, then the following expectations apply:

1. Sharing is limited to the sensing devices and their pre-amplifiers or amplifiers as needed to get the signal to the point of processing;
2. The signal from each sensing device is electrically isolated so that failures cannot be propagated from one system to the other; and
3. Isolation devices between systems of different safety importance are always associated with the system classified as being of greater importance to safety.

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Sharing of SSCs between Reactors

SSCs important to safety are typically not shared between two or more reactors.

In exceptional cases when SSCs are shared between two or more reactors, such sharing excludes safety systems and turbine generator buildings that contain high-pressure steam and feedwater systems.

If sharing of SSCs between reactors is arranged, then the following expectations apply:

1. All safety requirements are met for all reactors during normal operation, AOOs, and DBAs; and
2. In the event of an accident involving one of the reactors, orderly shutdown, cool down, and removal of residual heat is achievable for the other reactor(s).

When an NPP is under construction adjacent to an operating plant, and sharing of SSCs between reactors has been justified, the availability of the SSCs and their capacity to meet all safety requirements for the operating units is assessed during the construction phase.

7.7 Pressure-retaining SSCs

All pressure-retaining SSCs are protected against overpressure conditions, and are classified, designed, fabricated, erected, inspected, and tested in accordance with established standards.

All pressure-retaining SSCs of the reactor coolant system and auxiliaries are designed with an appropriate safety margin to ensure that the pressure boundary will not be breached, and that fuel design limits will not be exceeded in normal operation, AOOs, or DBA conditions.

The design minimizes the likelihood of flaws in pressure boundaries. This includes timely detection of flaws in pressure boundaries important to safety in a manner that supports leak-before-break detection capability.

Unless otherwise justified, all pressure boundary SSCs are designed to withstand static and dynamic loads anticipated in normal operation, AOOs, and DBAs.

SSC design includes protection against postulated pipe ruptures, unless otherwise justified.

The operation of pressure relief devices does not lead to unacceptable releases of radioactive material from the plant.

Adequate isolation is provided at the interfaces between the reactor coolant system (RCS) and connecting systems operating at lower pressures to prevent the overpressure of such systems and possible loss of coolant accidents. Consideration is given to the characteristics and importance of the isolation and its reliability targets. Isolation devices are either closed or close automatically on demand. The response time and speed of closure are in accordance with the acceptance criteria defined for postulated initiating events.

All pressure boundary piping and vessels are separated from electrical and control systems to the greatest extent practicable.

Pressure-retaining components whose failure will affect nuclear safety are designed to permit inspection of their pressure boundaries throughout the design life. If full inspection is not achievable, then it is augmented by indirect methods such as a program of surveillance of reference components. Leak detection is an acceptable method when the SSC is leak-before-break qualified.

7.8 Equipment Environmental Qualification

The design provides an equipment environmental qualification program. Development and implementation of this program ensures that the following functions are carried out in post-accident conditions:

1. The reactor is safely shut down and kept in a safe shutdown state during and following AOOs and DBAs;
2. Residual heat is removed from the reactor after shutdown, and also during and following AOOs and DBAs;
3. Potential for release of radioactive material from the plant is limited, and the resulting dose to the public from AOOs and DBAs is kept within prescribed limits; and
4. Post-accident conditions are monitored to indicate whether the above functions are being carried out.

The environmental conditions to be accounted for include those expected during normal operation, and those arising from AOOs and DBAs. Operational data and applicable design assist analysis tools, such as the probabilistic safety assessment, are used to determine the envelope of environmental conditions.

Equipment qualification also includes consideration of any unusual environmental conditions that can reasonably be anticipated, and that could arise during normal operation or AOOs (such as periodic testing of the containment leak rate).

Equipment credited to operate during BDBA and severe accident states is assessed for its capacity to perform its intended function under the expected environmental conditions. A justifiable extrapolation of equipment behaviour may be used to provide assurance of operability, and is typically based on design specifications, environmental qualification testing, or other considerations.

7.9 Instrumentation and Control

7.9.1 General Considerations

The design includes provision of instrumentation to monitor plant variables and systems over the respective ranges for normal operation, AOOs, DBAs, and BDBAs, in order to ensure that adequate information can be obtained on plant status.

This includes instrumentation for measuring variables that can affect the fission process, the integrity of the reactor core, the reactor cooling systems, and containment, as well as instrumentation for obtaining any information on the plant that is necessary for its reliable and safe operation.

The design is such that the safety systems and any necessary support systems can be reliably and independently operated, either automatically or manually, when necessary.

The design also includes the capability to trend and automatically record measurement of any derived parameters that are important to safety.

Instrumentation is adequate for measuring plant parameters for emergency response purposes.

The design includes reliable controls to maintain variables within specified operational ranges.

The design minimizes the likelihood of operator action defeating the effectiveness of safety and control systems in normal operation and AOOs, without negating correct operator actions following a DBA.

System control interlocks are designed to minimize the likelihood of inadvertent manual or automatic override, and to provide for situations when it is necessary to override interlocks to use equipment in a non-standard way.

Various safety actions are automated so that operator action is not necessary within a justified period of time from the onset of AOOs or DBAs. In addition, appropriate information is available to the operator to confirm the safety action.

7.9.2 Use of Computer-based Systems or Equipment

Appropriate standards and codes for the development, testing, and maintenance of computer hardware and software are applied to the design of systems or equipment important to safety that are controlled by computer. These standards and codes are implemented throughout the life cycle of the system or equipment, particularly during the software development cycle.

A top-down software development process is used to facilitate verification and validation activities. This approach includes verification at each step of the development process to demonstrate that the respective product is correct, and validation to demonstrate that the resulting computer-based system or equipment meets its functional and performance requirements.

If software provided by a third-party vendor is used in systems or equipment important to safety, then the software-and any subsequent release of the software-is developed, inspected, and tested in accordance with standards of a category commensurate with the safety function provided by the given system or equipment.

The software development process, including control, testing, and commissioning of design changes, as well as the results of independent assessment of that process, is reviewable and systematically documented in the design documentation.

Where a function important to safety is computer-based, the following expectations apply:

1. Functions not essential to safety are separate from and shown not to impact the safety function;
2. The safety function is normally executed in processors separate from software that implements other functions, such as control, monitoring, and display;
3. The expectations associated with diversity apply to computer-based systems that perform similar safety functions-the choice of diversity type is justified;
4. The design incorporates fail-safe and fault tolerance features, and the additional complexity ensuing from these features results in an overall gain in safety;
5. The design provides protection against physical attack, intentional and non-intentional intrusion, fraud, viruses, and other malicious threats; and
6. The design provides for effective detection, location, and diagnosis of failures in order to facilitate timely repair or replacement of equipment or software.

7.9.3 Post-accident Instrumentation

Instrumentation and recording equipment is such that essential information is available to support plant procedures during and following accidents by:

1. Indicating plant status;
2. Identifying the locations of radioactive material;
3. Supporting estimation of quantities of radioactive material;
4. Recording vital plant parameters; and
5. Facilitating decisions in accident management.

7.10 Safety Support Systems

Safety support systems provide services such as electrical, compressed air, and water to systems important to safety. The safety support systems ensure that the fundamental safety functions are available in all plant states, including normal operation, AOO, DBA and, to the extent practicable, BDBA states.

Where normal services are provided from external sources, backup safety support systems are also available on the site.

The design incorporates emergency safety support systems to cope with the possibility of loss of normal service and, where applicable, concurrent loss of backup systems.

The systems that provide normal services, backup services and emergency services have:

1. Sufficient capacity to meet the load requirements of the systems that perform the fundamental safety functions; and
2. Availability and reliability that is commensurate with the systems to which they supply the service.

The emergency support systems:

1. Are independent of normal and backup systems;
2. Provide continuity of the service until long term (normal or backup) service is re-established;
3. Have a capacity margin that allows for future increases in demand; and
4. Are testable under design load conditions.

7.11 Guaranteed Shutdown State

The design authority defines the guaranteed shutdown state (GSS) that will support safe maintenance activities of the NPP.

The design provides two independent means of preventing recriticality from any pathway or mechanism during the GSS.

The shutdown margin for GSS is such that the core will remain subcritical for any credible changes in the core configuration and reactivity addition. Where possible, this is achieved without operator intervention.

7.12 Fire Safety

The design of the NPP, including that of external buildings and SSCs integral to plant operation, includes provisions for fire safety.

7.12.1 General Provisions

Suitable incorporation of operational procedures, redundant SSCs, physical barriers, spatial separation, fire protection systems, and design for fail-safe operation achieves the following general objectives:

1. Prevents the initiation of fires;
2. Limits the propagation and effects of fires that do occur by
    a. quickly detecting and suppressing fires to limit damage, and
    b. confining the spread of fires and fire by-products that have not been extinguished;
3. Prevents loss of redundancy in safety and safety support systems;
4. Provides assurance of safe shutdown;
5. Ensures that monitoring of critical safety parameters remains available;
6. Prevents exposure, uncontrolled release, or unacceptable dispersion of hazardous substances, nuclear material, or radioactive material, due to fires;
7. Prevents the detrimental effects of event mitigation efforts, both inside and outside of containment; and
8. Ensures structural sufficiency and stability in the event of fire.

Buildings or structures are constructed using non-combustible or fire retardant and heat resistant material.

Fire is considered an internal hazard. The essential safety functions are therefore available during a fire.

Fire suppression systems are designed and located such that rupture, or spurious or inadvertent operation, will not significantly impair the capability of SSCs important to safety.

7.12.2 Safety to Life

The design provides protection to workers and the public from event sequences initiated by fire or explosion in accordance with established radiological, toxicological, and human factors criteria. With this protection:

1. Persons not intimate with the initial event (including the public, occupants, and emergency responders) are protected from injury and loss of life; and
2. Persons intimate with the initial event have a decreased risk of injury or death.

The following design provisions demonstrate that the above life safety objectives have been achieved:

1. Effective and reliable means of fire detection in all areas;
2. Effective and reliable means of emergency notification, including the nature of the emergency and protective actions to be taken;
3. Multiple and separate safe egress routes from any area;
4. Easily accessible exits;
5. Effective and reliable identification and illumination of egress routes and exits;
6. Sufficient exiting capacity for the number of workers (taking into account the emergency movement of crowds);
7. Protection of workers from fires and fire by-products (i.e., combustion products, smoke, heat, etc.) during egress and in areas of refuge;
8. Protection of workers performing plant control and mitigation functions during or following a fire;
9. Adequate supporting infrastructure (lighting, access, etc.) for workers to perform emergency response, plant control, and mitigation activities during or following a fire;
10. Sufficient structural integrity and stability of buildings and structures to ensure safety of workers and emergency responders during and after a fire; and
11. Protection of workers from the release or dispersion of hazardous substances, radioactive material, or nuclear material as a result of fire.

7.12.3 Environmental Protection and Nuclear Safety

The design minimizes the release and dispersion of hazardous substances or radioactive material to the environment, and minimizes the impact of any releases or dispersions, including those resulting from fire.

7.13 Seismic Qualification

The seismic qualification of all SSCs aligns with the requirements of Canadian national-or equivalent-standards.

The design includes instrumentation for monitoring seismic activity at the site for the life of the plant.

7.13.1 Seismic Design and Classification

The design authority identifies SSCs important to safety that are credited to withstand a design basis earthquake (DBE), and ensures that they are qualified accordingly. This applies to:

1. SSCs whose failure could directly or indirectly cause an accident leading to core damage;
2. SSCs restricting the release of radioactive material to the environment;
3. SSCs that assure the subcriticality of stored nuclear material; and
4. SSCs such as radioactive waste tanks containing radioactive material that, if released, would exceed regulatory dose limits.

The design of these SSCs also meets the DBE criteria to maintain all essential attributes, such as pressure boundary integrity, leak-tightness, operability, and proper position in the event of a DBE.

The design provides that no substantive damage to these SSCs will be caused by the failure of any other SSC under DBE conditions.

Seismic fragility levels should be evaluated for SSCs important to safety by analysis or, where possible, by testing.

7.14 In-service Testing, Maintenance, Repair, Inspection, and Monitoring

In order to maintain the NPP within the boundaries of the design, the SSCs important to safety are calibrated, tested, maintained and repaired (or replaced), inspected, and monitored over the lifetime of the plant.

These activities are performed to standards commensurate with the importance of the respective safety functions of the SSCs, with no significant reduction in system availability or undue exposure of the site personnel to radiation.

SSCs that have shorter service lifetimes than the plant lifetime are identified and described in the design documentation.

In cases where SSCs important to safety cannot be designed to support the desirable testing, inspection, or monitoring schedules, the following approach is taken:

1. Other proven alternative methods, such as surveillance of reference items or use of verified and validated calculation methods, are specified; or
2. Conservative safety margins are applied, or other appropriate precautions are taken, to compensate for possible unanticipated failures.

Details of alternate approaches to SSC monitoring are provided in the design documentation.

The design provides facilities for monitoring chemical conditions of fluids, and of metallic and non-metallic materials. In addition, the means for adding or modifying the chemical constituents of fluid streams are specified.

The design also considers the needs for related testing when specifying the commissioning requirements for the plant.

7.15 Civil Structures

7.15.1 Design

The NPP design specifies the required performance for the safety functions of the civil structures under normal operation and accident conditions.

Civil structures important to safety are designed and located so as to minimize the probabilities and effects of internal hazards such as fire, explosion, smoke, flooding, missile generation, pipe whip, jet impact, or release of fluid due to pipe breaks.

External events such as earthquakes, floods, high winds, tornadoes, tsunamis, and extreme meteorological conditions are considered in the design of civil structures.

Settlement analysis and evaluation of soil capacity includes consideration of the effects of fluctuating ground water on the foundations, and identification and evaluation of potential liquefiable soil strata and slope failure.

Civil structures are designed to meet the serviceability, strength, and stability requirements for all possible load combinations under normal operation, AOO, and DBA conditions, and in the event of external hazards. The serviceability considerations include, without being limited to, deflection, vibration, permanent deformation, cracking, and settlement.

The design specifications also define all loads and load combinations, with due consideration given to concurrence probability and loading time history.

Environmental effects are considered in the design of civil structures and the selection of construction materials. The choice of construction material is commensurate with the designed service life and potential life extension of the plant.

The plant safety assessment includes structural analyses for all civil structures important to safety.

7.15.2 Surveillance

The design enables implementation of periodic inspection programs for structures related to nuclear safety to verify as-constructed conditions.

The design also facilitates monitoring in-service for degradations that may compromise the intended design function of the structures.

In particular, the design permits monitoring of foundation settling.

Pressure and leak testing is conducted on applicable structures to demonstrate that the respective design parameters comply with requirements.

The design facilitates routine inspection of sea, lake, and river flood defences and demonstrates fitness for service.

7.15.3 Lifting of Large Loads

The lifting of large and heavy loads, particularly those containing radioactive material, is considered in the NPP design. This includes identification of the large loads, and situations where they need to be lifted over areas of the plant that are critical to safety. The design of all cranes and lifting devices therefore needs to incorporate large margins, appropriate interlocks, and other safety features to accommodate the lifting of large loads.

7.16 Commissioning

All plant systems are designed such that, to the greatest extent practicable, tests of the equipment can be performed to confirm that design requirements have been achieved prior to the first criticality.

7.17 Ageing and Wear

The design considers the effects of ageing and wear on SSCs. For SSCs important to safety, this consideration includes:

1. An assessment of design margins, taking into account all known ageing and wear mechanisms and potential degradation in normal operation, including the effects of testing and maintenance processes; and
2. Provisions for monitoring, testing, sampling, and inspecting SSCs to assess ageing mechanisms, verify predictions, and identify unanticipated behaviours or degradation that may occur during operation as a result of ageing and wear.

7.18 Control of Foreign Material

The design provides for exclusion and removal of all foreign material and corrosion products that may have an impact on safety.

7.19 Transport and Packaging for Fuel and Radioactive Waste

NPP design incorporates appropriate features to facilitate transport and handling of new fuel, used fuel, and radioactive waste. Related considerations include facility access, as well as lifting and packaging capabilities.

7.20 Escape Routes and Means of Communication

The design provides a sufficient number of safe escape routes that will be available in all plant states, including seismic events. These routes are identified with clear and durable signage, emergency lighting, ventilation and other building services essential to their safe use.

Escape routes are subject to the relevant Canadian requirements for radiation zoning, fire protection, industrial safety, and plant security, which include assurance of the ability to escape from containment regardless of the pressure in containment.

Suitable alarm systems and means of communication are available at all times to warn and instruct all persons in the plant and on the site.

The design ensures that diverse methods of communication are available within the NPP and in the immediate vicinity, and also to off-site agencies, in accordance with the emergency response plan.

7.21 Human Factors

The design includes a human factors engineering program plan.

Relevant and proven systematic analysis techniques are used to address human factors issues within the design process.

Human factors considerations:

1. Reduce the likelihood of human error as far reasonably achievable;
2. Provide means for identifying the occurrence of human error, and methods by which to recover from such error; and
3. Mitigate the consequences of error.

The human factors engineering program also facilitates the interface between the operating personnel and the plant by promoting attention to plant layout and procedures, maintenance, inspection, training, and the application of ergonomic principles to the design of working areas and working environments.

Appropriate and clear distinction between the functions assigned to operating personnel and those assigned to automatic systems is facilitated by systematic consideration of human factors and the human-machine interface. This consideration continues in an iterative way throughout the entire design process.

The human-machine interfaces in the main control room, the secondary control room, the emergency support centre, and in the plant, provide operators with necessary and appropriate information in a usable format that is compatible with the necessary decision and action times.

Human factors verification and validation plans are established for all appropriate stages of the design process to confirm that the design adequately accommodates all necessary operator actions.

To assist in the establishment of design criteria for information display and controls, each operator is considered to have dual roles-that of a systems manager, including responsibility for accident management, and that of an equipment operator. Verification and validation activities are comprehensive, such that the design conforms to human factors design principles and meets usability requirements.

The design identifies the type of information that facilitates an operator’s ability to readily:

1. Assess the general state of the plant, whether in normal operating, AOO, or DBA states;

2. Confirm that the designed automatic safety actions are being carried out; and
3. Determine the appropriate operator-initiated safety actions to be taken.

The design provides the type of information that enables an individual in an equipment operator role to identify the parameters associated with individual plant systems and equipment, and to confirm that the necessary safety actions can be initiated safely.

Design goals include promoting the success of operator action with due regard for the time available for response, the physical environment to be expected, and the associated psychological demands made on the operator.

The need for operator intervention on a short time scale is kept to a minimum. Where such intervention is necessary, the following conditions apply:

1. The information necessary for the operator to make the decision to act is presented simply and unambiguously;
2. The operator has sufficient time to make a decision and to act; and
3. Following an event, the physical environment is acceptable in the main control room or in the secondary control room, and in the access route to the secondary control room.

7.22 Robustness against Malevolent Acts

The design provides physical features such as protection against design basis threats (DBTs), in accordance with the requirements of the *Nuclear Security Regulations*.

7.22.1 Design Principles

The design is such that the NPP and any other on-site facilities with potential to release large amounts of radioactive material or energy are protected against malevolent acts.

Threats from credible malevolent acts are referred to as DBTs. More severe but unlikely threats are referred to as beyond design basis threats (BDBTs). Both types of threats are considered in the design.

Threats identified as DBTs have credible attributes and characteristics of a potential insider or external adversaries, who might attempt unauthorized removal of nuclear material or sabotage against which a physical protection system is designed and evaluated.

BDBTs are threats too unlikely to warrant incorporation into the design basis, but for which the consequences are assessed in order to establish means of mitigation to the extent practicable.

Consistent with the concept of defence-in-depth, the design provides multiple barriers for protection against malevolent acts, including physical protection systems, engineered safety provisions, and measures for post-event management, as appropriate. The failure of a preceding barrier should not compromise the integrity and effectiveness of subsequent barriers.

7.22.2 Design Methods

The design authority develops a methodology for assessing the challenges imposed by DBTs and evaluating the capabilities for meeting these challenges (e.g., as identified in an initial threat and risk assessment). The methodology applies conservative design measures and sound engineering practices.

The plant design considers the role of structures, pathways, equipment, and instrumentation in providing detection, delay, and response to threats.

Vital areas are identified and are taken into account in the design and verification of robustness. For vital areas, the design should allow enough delay for effective intervention by the on-site or off-site response force, taking structures, detection, and assessment into account. These areas should be protected from inadvertent damage during the carrying out of defensive actions.

The design provides appropriate means for access control and detection, and for minimizing the number of access and egress points to protected areas. Such points include storm sewers, culverts, service piping, and cable routing that could be used to gain access to the facility.

The design also considers the placement of civil utilities to minimize access requirements for such activities as repair and maintenance, in order to reduce threats to the protected area and vital areas.

The design authority also develops a methodology for assessing the challenges associated with BDBTs. This methodology is applied to determine the margins available for shutdown and for containment of radioactivity. Significant degradation of engineering means may be permitted.

7.22.3 Acceptance Criteria

All safety system functions and capabilities continue to be available for DBTs.

The design provides for the ongoing availability of fundamental safety functions during BDBTs; these provisions will depend on the severity of the threat.

For more severe events there is a safe shutdown path that comprises at least one means of:

1. Reactor shutdown;
2. Fuel cooling; and
3. Retention of radioactivity from the reactor.

There should be sufficient structural integrity to protect important systems. Two such success paths are identified where practical.

For extreme events, there is at least one means of reactor shutdown and core cooling. Degradation of the containment barrier may allow the release of radioactive material; however, the degradation should be limited with the goal that the dose acceptance criteria are not exceeded. In these cases, the response includes on-site and off-site emergency measures.

7.23 Safeguards

NPP design is subject to the obligations arising from Canada's international agreements, and to requirements pertaining to safeguards and non-proliferation.

The design and the design process ensure compliance with the obligations arising from the safeguards agreement between Canada and the IAEA. In general, these features are associated with the permanent installation of safeguards equipment and the provision of services required for ongoing operation of that equipment.

7.24 Decommissioning

Future plant decommissioning and dismantling activities are taken into account, such that:

1. Materials are selected for the construction and fabrication of plant components and structures with the purpose of minimizing eventual quantities of radioactive waste and assisting decontamination;
2. Plant layout is designed to facilitate access for decommissioning or dismantling activities; and
3. Consideration is given to the future potential requirements for storage of radioactive waste generated as a result of new facilities being built, or existing facilities being expanded.

8.0 System-Specific Expectations

8.1 Reactor Core

The design provides protection against deformations to reactor structures that have the potential to adversely affect the behaviour of the core or associated systems.

The reactor core and associated structures and cooling systems:

1. Withstand static and dynamic loading, including thermal expansion and contraction;
2. Withstand vibration (such as flow-induced and acoustic vibration);
3. Ensure chemical compatibility;
4. Meet thermal material limits; and
5. Meet radiation damage limits.

The reactor core design facilitates the application of a guaranteed shutdown state as described in subsection 7.11.

The design of the core is such that:

1. The fission chain reaction is controlled during normal operation and AOOs; and
2. The maximum degree of positive reactivity and its maximum rate of increase by insertion in normal operation, AOOs, and DBAs are limited so that no resultant failure of the reactor pressure boundary will occur, cooling capability will be maintained, and no significant damage will occur to the reactor core.

The shutdown margin for all shutdown states is such that the core will remain subcritical for any credible changes in the core configuration and reactivity addition.

If operator intervention is required to keep the reactor in a shutdown state, the feasibility, timeliness, and effectiveness of such intervention is demonstrated.

8.1.1 Fuel Elements and Assemblies

Fuel assembly design includes all components in the assembly, such as the fuel matrix, cladding, spacers, support plates, movable rods inside the assembly, etc. The fuel assembly design also identifies all interfacing systems.

Fuel assemblies and the associated components are designed to withstand the anticipated irradiation and environmental conditions in the reactor core, and all processes of deterioration that can occur in normal operation and AOOs. At the design stage, consideration is given to long-term storage of irradiated fuel assemblies after discharge from the reactor.

Fuel design limits are established to include, as a minimum, limits on fuel power or temperature, limits on fuel burn-up, and limits on the leakage of fission products in the reactor cooling system. The design limits reflect the importance of preserving the cladding and fuel matrix, as these are the first barriers to fission product release.

The design accounts for all known degradation mechanisms, with allowance being made for uncertainties in data, calculations, and fuel fabrication.

Fuel assemblies are designed to permit adequate inspection of their structures and component parts prior to and following irradiation.

In DBAs, the fuel assembly and its component parts remain in position with no distortion that would prevent effective post-accident core cooling or interfere with the actions of reactivity control devices or mechanisms. The acceptance criteria for the fuel for DBAs are consistent with these expectations.

The expectations for reactor and fuel assembly design apply in the event of changes in fuel management strategy or in operating conditions over the lifetime of the plant.

Fuel design and design limits reflect a verified and auditable knowledge base. The fuel is qualified for operation, either through experience with the same type of fuel in other reactors, or through a program of experimental testing and analysis, to ensure that fuel assembly requirements are met.

8.1.2 Control System

The design provides the means for detecting levels and distributions of neutron flux. This applies to neutron flux in all regions of the core during normal operation (including after shutdown and during and after refuelling states), and during AOOs.

The reactor core control system detects and intercepts deviations from normal operation with the goal of preventing AOOs from escalating to accident conditions.

Adequate means are provided to maintain both bulk and spatial power distributions within a predetermined range.

The reactor control mechanisms limit the positive reactivity insertion rate to a level required to control reactivity changes and power manoeuvring.

The control system, combined with the inherent characteristics of the reactor and the selected operating limits and conditions, minimize the need for shutdown action.

The control system and the inherent reactor characteristics keep all critical reactor parameters within the specified limits for a wide range of AOOs.

8.2 Reactor Coolant System

The design provides the reactor coolant system and its associated components and auxiliary systems with sufficient margin to ensure that the appropriate design limits of the reactor coolant pressure boundary are not exceeded in normal operation, AOOs, or DBAs.

The design ensures that the operation of pressure relief devices will not lead to unacceptable releases of radioactive material from the plant, even in DBAs. The reactor coolant system is fitted with isolation devices to limit any loss of radioactive coolant outside containment.

The material used in the fabrication of the component parts is selected so as to minimize activation of the material.

Plant states in which components of the pressure boundary could exhibit brittle behaviour should be avoided.

The design reflects consideration of all conditions of the boundary material in normal operation (including maintenance and testing), AOOs, and DBAs, as well as expected end-of-life properties affected by ageing mechanisms, the rate of deterioration, and the initial state of the components.

The design of the moving components contained inside the reactor coolant pressure boundary, such as pump impellers and valve parts, minimizes the likelihood of failure and associated consequential damage to other items of the reactor coolant system. This applies to normal operation, AOOs, and DBAs, with allowance for deterioration that may occur in service.

The design provides a system capable of detecting and monitoring leakage from the reactor coolant system.

8.2.1 In-service Pressure Boundary Inspection

The components of the reactor coolant pressure boundary are designed, manufactured, and arranged in a manner that permits adequate inspections and tests of the boundary throughout the lifetime of the plant.

The design also facilitates surveillance in order to determine the metallurgical conditions of materials for which metallurgical changes are anticipated.

8.2.2 Inventory

Taking volumetric changes and leakage into account, the design provides control of coolant inventory and pressure to ensure that specified design limits are not exceeded in normal operation. This expectation extends to the provision of adequate capacity (flow rate and storage volumes) in the systems performing this function.

The inventory in the reactor coolant system and its associated systems are sufficient to support cool down from hot operating conditions to zero power cold conditions without the need for transfer from any other systems.

8.2.3 Cleanup

The design provides for adequate removal of radioactive substances from the reactor coolant, including activated corrosion products and fission products leaking from the fuel.

8.2.4 Removal of Residual Heat from Reactor Core

The design provides a means (i.e., backup) of removing residual heat from the reactor for all conditions of the RCS. The backup is independent of the configuration in use.

The means of removing residual heat meets reliability requirements on the assumptions of a single failure and the loss of off-site power, by incorporating suitable redundancy, diversity, and independence. Interconnections and isolation capabilities have a degree of reliability that is commensurate with system design requirements.

Heat removal is at a rate that prevents the specified design limits of the fuel and the reactor coolant pressure boundary from being exceeded.

If a residual heat removal system is required when the RCS is hot and pressurized, it can be initiated at the normal operating conditions of the RCS.

8.3 Steam Supply System

8.3.1 Steam Lines

The steam piping up to and including the turbine generator governor valves and, where applicable, the steam generators, allow sufficient margin to ensure that the appropriate design limits of the pressure boundary are not exceeded in normal operation, AOOs, or DBAs. This provision takes into account the operation of control and safety systems.

The main steam isolation valves (MSIVs) will be installed in each of the steam lines leading to the turbine, and located as close as practicable to the containment structure.

Where MSIVs are credited with preventing steam flow into containment, they are capable of closing under the conditions for which they will be credited.

Where MSIVs provide a containment barrier, they meet the containment requirements that apply to those conditions for which they are credited.

The MSIVs are testable.

Steam lines up to and including the first isolation valve and, where applicable, steam generators, are qualified to withstand a design basis earthquake.

8.3.2 Steam and Feedwater System Piping and Vessels

All piping and vessels are typically separated from electrical and control systems to the extent practicable.

The auxiliary feedwater, boiler pressure control, and other auxiliary systems, prevent the escalation of AOOs to accident conditions.

8.3.3 Turbine Generators

The design provides over-speed protection systems for the turbine generators to minimize the probability of turbine disk failure leading to generation of missiles.

The axes of the turbine generators are to be oriented in such a manner as to minimize the potential for any missiles that result from a turbine break-up striking the containment, or striking other SSCs important to safety.

8.4 Means of Shutdown

The design provides means of reactor shutdown capable of reducing reactor power to a low value, and maintaining that power for the required duration, when the reactor power control system and the inherent characteristics are insufficient or incapable of maintaining reactor power within the requirements of the OLCs.

The design includes two separate, independent, and diverse means of shutting down the reactor.

At least one means of shutdown is independently capable of quickly rendering the nuclear reactor subcritical from normal operation, in AOOs, and in DBAs by an adequate margin, on the assumption of a single failure. For this means of shutdown, a transient recriticality may be permitted in exceptional circumstances if the specified fuel and component limits are not exceeded.

At least one means of shutdown is independently capable of rendering the reactor subcritical from normal operation, in AOOs, and in DBAs, and maintaining the reactor subcritical by an adequate margin and with high reliability for even the most reactive conditions of the core.

Redundancy is provided in the fast-acting means of shutdown if, in the event that the credited means of reactivity control fails during any AOO or DBA, inherent core characteristics are unable to maintain the reactor within specified limits.

While resetting the means of shutdown, the maximum degree of positive reactivity and the maximum rate of increase are within the capacity of the reactor control system.

To improve reliability, stored energy should be used in shutdown actuation.

The effectiveness of the means of shutdown (i.e., speed of action and shutdown margin) is such that specified limits are not exceeded, and the possibility of recriticality or reactivity excursion following a PIE is minimized.

8.4.1 Reactor Trip Parameters

The design authority specifies derived acceptance criteria for reactor trip parameter effectiveness for all AOOs and DBAs, and performs a safety analysis to demonstrate the effectiveness of the means of shutdown.

For each credited means of shutdown, the design specifies a direct trip parameter to initiate reactor shutdown for all AOOs and DBAs in time to meet the respective derived acceptance criteria. Where a direct trip parameter does not exist for a given credited means, there are two diverse trip parameters specified for that means.

For all AOOs and DBAs, there are at least two diverse trip parameters unless it can be shown that failure to trip will not lead to unacceptable consequences.

There is no gap in trip coverage for any operating condition (i.e., power, temperature, etc.) within the OLCs. This is ensured by providing additional trip parameters if necessary. A different level of effectiveness may be acceptable for the additional trip parameters.

The extent of trip coverage provided by all available parameters is documented for the entire spectrum of failures for each set of PIEs.

An assessment of the accuracy and the potential failure modes of the trip parameters is provided in the design documentation.

8.4.2 Reliability

The design permits ongoing demonstration that each means of shutdown is being operated and maintained in a manner that ensures continued adherence to reliability and effectiveness requirements.

Periodic testing of the systems and their components is scheduled at a frequency commensurate with applicable requirements.

8.4.3 Monitoring and Operator Action

Once automatic shutdown is initiated, it is impossible for an operator to prevent its actuation.

The need for manual shutdown actuation is minimized.

The means for monitoring shutdown status and manual actuation is provided in the main control room.

8.5 Emergency Core Cooling System

All water-cooled nuclear power reactors are to be equipped with an emergency core cooling system (ECCS). The function of this safety system is to transfer heat from the reactor core following a loss of reactor coolant that exceeds makeup capability. All equipment required for correct operation of the ECCS is considered part of the system or its safety support system(s).

Safety support systems include systems that supply electrical power or cooling water to equipment used in the operation of the ECCS, and are subject to all relevant requirements and expectations.

The design considers the effect on core reactivity of the mixing of ECCS water with reactor coolant water, including possible mixing due to in-leakage.

The ECCS meets the following criteria for all DBAs involving loss of coolant:

1. All fuel in the reactor and all fuel assemblies are kept in a configuration such that continued removal of the residual heat produced by the fuel can be maintained; and
2. A continued cooling flow (recovery flow) is supplied to prevent further damage to the fuel after adequate cooling of the fuel is re-established by the ECCS.

The ECCS recovery flow path is such that impediment to the recovery of coolant following a loss of coolant accident by debris or other material is avoided.

Maintenance and reliability testing that is conducted when ECCS availability is required can be carried out without a reduction in the effectiveness of the system below the OLCs.

In the event of an accident when injection of emergency coolant is required, it is not readily possible for an operator to prevent the injection from taking place.

All ECCS components that may contain radioactive material are to be located inside containment or in an extension of containment.

ECCS piping in an extension of containment that could contain radioactivity from the reactor core is subject to the following expectations:

1. As a piping extension to containment, it meets the requirements for metal penetrations of containment;
2. All piping and components of the ECCS recovery flow path piping that are open to the containment atmosphere are designed for a pressure greater than the containment design pressure;
3. All ECCS recovery flow paths are housed in a confinement structure that prevents leakage of radioactivity to the environment and to adjacent structures; and
4. This housing includes detection capability for leakage of radioactivity, and the capability to either return the radioactivity to the flow path, or to collect the radioactivity and store or process it in a system designed for this purpose.

Intermediate or secondary cooling piping loops have leak detection, whether the ECCS recovery system is inside or outside of containment, with the leak detection being such that on detection of radioactivity from the ECCS recovery flow, the loops can be isolated as per the requirements for containment isolation.

Inadvertent operation of all or part of the ECCS will have no detrimental effect on plant safety.

8.6 Containment

8.6.1 General Requirements

Each nuclear power reactor is installed within a containment structure to minimize the release of radioactive materials to the environment during normal operation, AOOs, and DBAs. Containment also assists in mitigating the consequences of BDBAs.

The containment system is designed for all AOOs and DBAs, and also considers BDBAs, including severe accident conditions.

The containment is a safety system and includes complementary design features, both of which are subject to the respective design expectations provided in this regulatory document.

The design includes a clearly defined continuous leak-tight containment envelope, the boundaries of which are defined for all conditions that could exist in the operation or maintenance of the reactor, or following an accident.

All piping that is part of the main or backup reactor coolant systems is entirely within the main containment structure, or in a containment extension.

The containment design incorporates systems to assist in controlling internal pressure and the release of radioactive material to the environment following an accident.

The containment includes at least the following subsystems:

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1. The containment structure and related components;
2. Equipment required to isolate the containment envelope and maintain its completeness and continuity following an accident;
3. Equipment required to reduce the pressure and temperature of the containment and reduce the concentration of free radioactive material within the containment envelope; and
4. Equipment required for limiting the release of radioactive material from the containment envelope following an accident.

When the containment design includes the use of compressed air or non-condensable gas systems in response to a DBA, the autonomy of the compressed air system is demonstrated. In the event of a loss of compressed air, containment isolation valves fail in their safe state.

The design authority identifies where and when the containment boundary is credited for providing shielding for people and equipment.

8.6.2 Strength of the Containment Structure

The strength of the containment structure provides sufficient margins of safety based on potential internal overpressures, underpressures, temperatures, dynamic effects such as missile generation, and reaction-forces anticipated to result in the event of DBAs. Application of strength margins applies to access openings, penetrations, and isolation valves, and to the containment heat removal system.

The margins reflect:

1. Effects of other potential energy sources, such as possible chemical reactions and radiolytic reactions;
2. Limited experience and experimental data available for defining accident phenomena and containment responses; and
3. Conservatism of the calculation model and input parameters.

The positive and negative design pressures within each part of the containment boundary include the highest and lowest pressures that could be generated in the respective parts as a result of any DBA.

The containment structure protects systems and equipment important to safety in order to preserve safety functions for the plant.

The design supports maintenance of full functionality following a DBE of all parts of the containment system credited in the safety analysis.

The seismic design of the concrete containment structure has an elastic response when subjected to seismic ground motions. The special detailing of reinforcement allows the structure to possess ductility and energy-absorbing capacity which permits inelastic deformation without failure.

8.6.3 Capability for Pressure Tests

The containment structure is subject to pressure testing at a specified pressure to demonstrate structural integrity. Testing is conducted before plant operation commences and throughout the plant’s lifetime.

8.6.4 Leakage

Leakage Rate Limits

The safety leakage rate limit assures that:

1. Normal operation release limits are met; and
2. AOOs and DBAs will not result in exceeding dose acceptance criteria.

The design leakage rate limit is:

1. Below the safety leakage rate limit;
2. As low as is practicably attainable; and
3. Consistent with state-of-the-art design practices.

Test Acceptance Leakage Rate Limits

A test acceptance leakage rate provides the maximum rate acceptable under actual measurement tests. Test acceptance leakage rate limits are established for the entire containment system, and for individual components that can contribute significantly to leakage.

Leak Rate Testing

The containment structure and the equipment and components affecting the leak tightness of the containment system are designed to allow leak rate testing:

1. For commissioning, at the containment design pressure; and
2. Over the service lifetime of the reactor, either at the containment design pressure or at reduced pressures that permit estimation of the leakage rate at the containment design pressure.

To the extent practicable, penetrations are to be designed to allow individual testing of each penetration.

The design is expected to provide for ready and reliable detection of any significant breach of the containment envelope.

8.6.5 Containment Penetrations

The number of penetrations through the containment will be kept to a minimum.

All containment penetrations are subject to the same design expectations as the containment structure itself, and are to be protected from reaction forces stemming from pipe movement or accidental loads, such as those due to missiles, jet forces, and pipe whip.

All penetrations are designed to allow for periodic inspection.

If resilient seals such as elastomeric seals, electrical cable penetrations, or expansion bellows are used with penetrations, they have the capacity for leak testing at the containment design pressure. To demonstrate continued integrity over the lifetime of the plant, this capacity supports testing that is independent of determining the leak rate of the containment as a whole.

8.6.6 Containment Isolation

Each line of the reactor coolant pressure boundary that penetrates the containment, or that is connected directly to the containment atmosphere, is to be automatically and reliably sealable. This provision is essential to maintaining the leak tightness of the containment in the event of an accident, and preventing radioactive releases to the environment that exceed prescribed limits.

Automatic isolation valves are positioned to provide the greatest safety upon loss of actuating power.

Piping systems that penetrate the containment system have isolation devices with redundancy, reliability, and performance capabilities that reflect the importance of isolating the various types of piping systems. Alternative types of isolation may be used where justification is provided.

Where manual isolation valves are used, they have locking or continuous monitoring capability.

Reactor Coolant System Auxiliaries that Penetrate Containment

Each auxiliary line that is connected to the reactor coolant pressure boundary, and that penetrates the containment structure, includes two isolation valves in series. The valves are normally arranged with one inside and one outside the containment structure.

Where the valves provide isolation of the heat transport system during normal operation, both valves are normally in the closed position.

Systems directly connected to the reactor coolant system that may be open during normal operation are subject to the same isolation expectations as the normally closed system, with the exception that manual isolating valves inside the containment structure will not be used. At least one of the two isolation valves is either automatic or powered, and operable from the main and secondary control rooms.

For any piping outside of containment that could contain radioactivity from the reactor core, the following expectations apply:

1. Design parameters are the same as those for a piping extension to containment, and are subject to the requirements for metal penetrations of containment;
2. All piping and components that are open to the containment atmosphere are designed for a pressure greater than the containment design pressure;
3. The piping and components are housed in a confinement structure that prevents leakage of radioactivity to the environment and to adjacent structures; and
4. This housing includes detection capability for leakage of radioactivity and the capability to return the radioactivity to the flow path.

Systems Connected to Containment Atmosphere

Each line that connects directly to the containment atmosphere, that penetrates the containment structure and is not part of a closed system, is to be provided with two isolation barriers that meet the following expectations:

1. Two automatic isolation valves in series for lines that may be open to the containment atmosphere;

2. Two closed isolation valves in series for lines that are normally closed to the containment atmosphere; and
3. The line up to and including the second valve is part of the containment envelope.

Closed Systems

All closed piping service systems have at least one single isolation valve on each line penetrating the containment, with the valve being located outside of, but as close as practicable to, the containment structure.

Where failure of a closed loop is assumed to be a PIE or the result of a PIE, the isolations for reactor coolant system auxiliaries apply.

Closed piping service systems inside or outside the containment structure that form part of the containment envelope need no further isolation if:

1. They meet the applicable service piping standards and codes; and
2. They can be continuously monitored for leaks.

8.6.7 Containment Air Locks

Personnel access to the containment is through airlocks that are equipped with doors that are interlocked to ensure that at least one of the doors is closed during normal operation, AOOs, and DBAs.

Where provision is made for entry of personnel for surveillance or maintenance purposes during normal operation, the design specifies provisions for personnel safety, including emergency egress. This expectation also applies to equipment air locks.

8.6.8 Internal Structures of the Containment

The design provides for ample flow routes between separate compartments inside the containment. The openings between compartments are to be large enough to prevent significant pressure differentials that may cause damage to load bearing and safety systems during AOOs and DBAs.

The design of internal structures considers any hydrogen control strategy, and assists in the effectiveness of that strategy.

8.6.9 Containment Pressure and Energy Management

The design enables heat removal and pressure reduction in the reactor containment in all plant states. Systems designed for this purpose are considered part of the containment system, and are capable of:

1. Minimizing the pressure-assisted release of fission products to the environment;
2. Preserving containment integrity; and
3. Preserving required leak tightness.

8.6.10 Control and Cleanup of the Containment Atmosphere

The design provides systems to control the release of fission products, hydrogen, oxygen, and other substances into the reactor containment as necessary, to:

1. Reduce the amount of fission products that might be released to the environment during an accident; and
2. Prevent deflagration or detonation that could jeopardize the integrity or leak tightness of the containment.

The design also:

1. Supports isolation of all sources of compressed air and other non-condensable gases into the containment atmosphere following an accident;
2. Ensures that, in the case of ingress of non-condensable gas resulting from a PIE, containment pressure will not exceed the design limit; and
3. Provides isolation of compressed air sources to prevent any bypass of containment.

8.6.11 Coverings, Coatings, and Materials

The coverings and coatings for components and structures within the containment are carefully selected, and their methods of application specified to ensure fulfillment of their safety functions. The primary objective of this expectation is to minimize interference with other safety functions or accident mitigation systems in the event of deterioration of coverings and coatings. In addition, the choice of materials inside containment takes into account the impact on post-accident containment conditions, including fission product behaviour, acidity, equipment fouling, radiolysis, fires, and other factors that may affect containment performance and integrity, and fission product release.

8.6.12 Severe Accidents

Following onset of core damage, the containment boundary should be capable of contributing to the reduction of radioactivity releases to allow sufficient time for the implementation of off-site emergency procedures. This expectation applies to a representative set of severe accidents.

Damage to the containment structure is limited to prevent uncontrolled releases of radioactivity, and to maintain the integrity of structures that support internal components.

The ability of the containment system to withstand loads associated with severe accidents is demonstrated in design documentation, and includes the following considerations:

1. Various heat sources, including residual heat, metal-water reactions, combustion of gases, and standing flames;
2. Pressure control;
3. Control of combustible gases;
4. Sources of non-condensable gases;
5. Control of radioactive material leakage;
6. Effectiveness of isolation devices;
7. Functionality and leak tightness of air locks and containment penetrations; and
8. Effects of the accident on the integrity and functionality of internal structures.

The design authority should consider incorporation of complementary design features that will:

1. Prevent a containment melt-through or failure due to the thermal impact of the core debris;
2. Facilitate cooling of the core debris; and
3. Minimize generation of non-condensable gases and radioactive products.

8.7 Heat Transfer to an Ultimate Heat Sink

The design includes systems for transferring residual heat from SSCs important to safety to an ultimate heat sink. This function is subject to very high levels of reliability during normal operation, AOOs, and DBAs. All systems that contribute to the transport of heat by conveying heat, providing power, or supplying fluids to the heat transport systems, are therefore designed in accordance with the importance of their contribution to the function of heat transfer as a whole.

Natural phenomena and human-induced events are taken into account in the design of heat transfer systems, and in the choice of diversity and redundancy, both in the ultimate heat sinks and in the storage systems from which fluids for heat transfer are supplied.

The design extends the capability to transfer residual heat from the core to an ultimate heat sink so that, in the event of a severe accident:

1. Acceptable conditions can be maintained in SSCs;
2. Radioactive materials can be confined; and
3. Releases to the environment can be limited.

8.8 Emergency Heat Removal System

The design includes an emergency heat removal system (EHRS) which provides for removal of residual heat in order to meet fuel design limits and reactor coolant boundary condition limits.

If the design of the plant is such that the EHRS is required to mitigate the consequences of a DBA, then the EHRS is designed as a safety system.

Correct operation of the EHRS equipment following an accident is not dependent on power supplies from the electrical grid or from the turbine generators associated with any reactor unit that is located on the same site as the reactor involved in the accident.

Where water is required for the EHRS, it comes from a source that is independent of normal supplies.

The design supports maintenance and reliability testing without a reduction in system effectiveness below that required by the OLCs.

As far as practicable, inadvertent operation of the EHRS, or of part of the EHRS, will not have a detrimental effect on plant safety.

If the fire water supply or system components are interconnected to the EHRS, operation of one does not impair operation of the other.

8.9 Emergency Power Supply

The emergency power supply (EPS) system has sufficient capacity and reliability, within a specified mission time, to provide the necessary power to maintain the plant in a safe state and ensure nuclear safety in the event of all DBAs. These expectations are met following a common-cause loss of off-site power where this may occur as a result of a PIE, and in the presence of a single failure in the EPS.

The EPS system has sufficient capacity and capability, within a specified mission time, to support severe accident management actions.

The EPS system includes appropriate control, monitoring and testing facilities.

The emergency power supply:

1. Is initiated either automatically or manually following the DBAs as determined by the nuclear safety requirements of the plant; and
2. Can be tested under load conditions representing full load demand.

8.10 Control Facilities

8.10.1 Main Control Room

The design provides for a main control room (MCR) from which the plant can be safely operated, and from which measures can be taken to maintain the plant in a safe state or to bring it back into such a state after the onset of AOOs, DBAs, and, to the extent practicable, following BDBAs.

The design identifies events both internal and external to the MCR that may pose a direct threat to its continued operation, and provides practicable measures to minimize the effects of these events.

The safety functions initiated by automatic control logic in response to an accident can also be initiated manually from the main and secondary control rooms.

The layout of the controls and instrumentation, and the mode and format used to present information, provide operating personnel with an adequate overall picture of the status and performance of the plant and provide the necessary information to support operator actions.

The design of the MCR is such that appropriate lighting levels and thermal environment are maintained, and noise levels are minimized to applicable standards and codes.

The design of the MCR takes ergonomic factors into account to provide both physical and visual accessibility to controls and displays, without adverse impact on health and comfort. This includes hardwired display panels as well as computerized displays, with the aim of making these displays as user friendly as possible.

Cabling for the instrumentation and control equipment in the MCR is arranged such that a fire in the secondary control room cannot disable the equipment in the MCR.

The design provides visual and, if appropriate, audible indications of plant states and processes that have deviated from normal operation and that could affect safety.

The design also allows for the display of information needed to monitor the effects of the automatic actions of all control, safety, and safety support system.

The MCR is to be provided with secure communication channels to the emergency support centre and to off-site emergency response organizations, and to allow for extended operating periods.

Safety Parameter Display System

The MCR contains a safety parameter display system that presents sufficient information on safety-critical parameters for the diagnosis and mitigation of DBAs and BDBAs, including severe accidents.

The safety parameter display system has the following capabilities:

1. Display safety critical parameters within the full range expected in normal operation and during accidents;
2. Track data trends;
3. Indicate when process or safety limits are being approached or exceeded; and
4. Display the status of safety systems.

The safety parameter display system is designed and installed such that the same information is made available in a secure manner to the emergency support centre.

The safety parameter display system is integrated and harmonized with the overall control room human-system interface design.

8.10.2 Secondary Control Room

The design provides a secondary control room (SCR) that is physically and electrically separate from the MCR, and from which the plant can be placed and kept in a safe shutdown state when the ability to perform essential safety functions from the MCR is lost.

The design identifies all events that may pose a direct threat to the continued operation of the MCR and the SCR. The design of the MCR and the SCR are such that no event can simultaneously affect both control rooms to the extent that the essential safety functions cannot be performed.

For any PIE, at least one control room is habitable, and is accessible by means of a qualified route.

Instrumentation, control equipment, and displays are available in the SCR, so that the essential safety functions can be performed, essential plant variables can be monitored, and operator actions are supported.

Safety functions initiated by automatic control logic in response to an accident can also be initiated manually from both the MCR and the SCR.

The design of the SCR ensures that appropriate lighting levels and thermal environment are maintained, and noise levels align with applicable standards and codes.

Ergonomic factors apply to the design of the SCR to ensure physical and visual accessibility in relation to controls and displays, without adverse impact on health and comfort. These include hardwired display panels as well as computerized displays that are as user friendly as possible.

Cabling for the instrumentation and control equipment in the SCR is such that a fire in the main control room cannot disable the equipment in the SCR.

The SCR is equipped with a safety parameter display system similar to that in the MCR. As a minimum, this display system provides the information required to facilitate the management of the reactor when the MCR is uninhabitable.

The SCR is to be provided with secure communication channels to the emergency support centre and to off-site emergency response organizations.

The SCR allows for extended operating periods.

8.10.3 Emergency Support Centre

The design provides for an emergency support centre that is separate from the plant control rooms, for use by the emergency support staff in the event of an emergency.

The emergency support centre design ensures that appropriate lighting levels and thermal environment are maintained, and that noise levels are minimized to applicable standards and codes.

The emergency support centre includes a safety parameter display system similar to those in the MCR and in the SCR.

Information about the radiological conditions in the plant and its immediate surroundings, and about meteorological conditions in the vicinity of the plant, is to be accessible from the emergency support centre.

The emergency support centre includes secure means of communication with the MCR, the SCR, and other important points in the plant, and with on-site and off-site emergency response organizations.

The design ensures that the emergency support centre:

1. Includes provisions to protect occupants over protracted periods from the hazards resulting from a severe accident; and
2. Is equipped with adequate facilities to allow extended operating periods.

8.10.4 Equipment Requirements for Accident Conditions

If operator action is required for actuation of any safety system or safety support system equipment, all of the following expectations apply:

1. There are clear, well-defined, validated, and readily available operating procedures that identify the necessary actions;
2. There is instrumentation in the control rooms to provide clear and unambiguous indication of the necessity for operator action;
3. Following indication of the necessity for operator action inside the MCR, there is at least 15 minutes available before the operator action is required; and
4. Following indication of the necessity for operator action outside the MCR, there is a minimum of 30 minutes available before the operator action is required.

Alternative action times may be used if justified, making due allowance for the complexity of the action to be taken, and for the time needed for such activities as the diagnosing the event and accessing to the remote station.

For automatically initiated safety systems and control logic actions, the design facilitates backup manual initiation from inside the appropriate control room.

8.11 Waste Treatment and Control

The design includes provisions to treat liquid and gaseous effluents in a manner that will keep the quantities and concentrations of discharged contaminants within prescribed limits, and that will support application of the ALARA principle.

The design also includes adequate provision for the safe on-site handling and storage of radioactive and non-radioactive wastes for a period of time consistent with options for off-site management or disposal.

8.11.1 Control of Liquid Releases to the Environment

To ensure that emissions and concentrations remain within prescribed limits, the design includes suitable means for controlling liquid releases to the environment in a manner that conforms to the ALARA principle.

This includes a liquid waste management system of sufficient capacity to collect, hold, mix, pump, test, treat, and sample liquid waste before discharge, taking expected waste and accidental spills or discharges into account.

8.11.2 Control of Airborne Material within the Plant

The design includes gaseous waste management systems capable of:

1. Controlling all gaseous contaminants so as to conform to the ALARA principle and ensure that concentrations remain within prescribed limits;
2. Collecting all potentially active gases, vapours, and airborne particulates for monitoring;
3. Passing all potentially active gases, vapours, and airborne particulates through pre-filters, absolute filters, charcoal filters, or high efficiency particulate air filters where applicable; and
4. Delaying releases of potential sources of noble gases by way of an off-gas system of sufficient capacity.

The design provides a ventilation system with an appropriate filtration system capable of:

1. Preventing unacceptable dispersion of all airborne contaminants within the plant;
2. Reducing the concentration of airborne radioactive substances to levels compatible with the need for access to each particular area;
3. Keeping the level of airborne radioactive substances in the plant below prescribed limits, applying the ALARA principle in normal operation; and
4. Ventilating rooms containing inert or noxious gases without impairing the capability to control radioactive releases.

8.11.3 Control of Gaseous Releases to the Environment

The ventilation system includes filtration that will:

1. Control the release of gaseous contaminants and hazardous substances to the environment;
2. Ensure conformation to the ALARA principle; and
3. Maintain airborne contaminants within prescribed limits.

The filtration system reliably achieves the necessary retention factors under the expected prevailing conditions, and is designed in a manner that facilitates appropriate efficiency testing.

8.12 Fuel Handling and Storage

8.12.1 Handling and Storage of Non-irradiated Fuel

The design of the fuel handling and storage systems for non-irradiated fuel:

1. Ensures nuclear criticality safety by
    a. maintaining an approved subcriticality margin by physical means or processes, preferably by the use of geometrically safe configurations, under both normal and credible abnormal conditions,
    b. minimizing on-site consequences to personnel of postulated criticality accidents, and
    c. mitigating off-site consequences of postulated criticality accidents;
2. Permits appropriate maintenance, periodic inspection, and testing of components important to safety;
3. Permits inspection of non-irradiated fuel;
4. Prevents loss of or damage to the fuel; and

5. Meets Canada's safeguards requirements for recording and reporting accountancy data, and for monitoring flows and inventories related to non-irradiated fuel containing fissile material.

8.12.2 Handling and Storage of Irradiated Fuel

The design of the handling and storage systems for irradiated fuel:

1. Ensures nuclear criticality safety by
   a. maintaining an approved subcriticality margin by physical means or processes, preferably by the use of geometrically safe configurations, under both normal and credible abnormal conditions,
   b. minimizing on-site consequences to personnel of postulated criticality accidents, and
   c. mitigating off-site consequences of postulated criticality accidents;
2. Permits adequate heat removal under normal operation, AOOs, and DBAs;
3. Permits inspection of irradiated fuel;
4. Permits periodic inspection and testing of components important to safety;
5. Prevents the dropping of used fuel in transit;
6. Prevents unacceptable handling stresses on fuel elements or fuel assemblies;
7. Prevents the inadvertent dropping of heavy objects and equipment on fuel assemblies;
8. Permits inspection and safe storage of suspect or damaged fuel elements or fuel assemblies;
9. Provides proper means for radiation protection;
10. Adequately identifies individual fuel modules;
11. Facilitates maintenance and decommissioning of the fuel storage and handling facilities;
12. Facilitates decontamination of fuel handling and storage areas and equipment when necessary;
13. Ensures implementation of adequate operating and accounting procedures to prevent loss of fuel;
14. Includes measures to prevent a direct threat or sabotage to irradiated fuel; and
15. Meets Canada's safeguards requirements for recording and reporting accountancy data, and for monitoring flows and inventories related to irradiated fuel containing fissile material.

A design for a water pool used for fuel storage is expected to include provisions for:

1. Controlling the chemistry and activity of any water in which irradiated fuel is handled or stored;
2. Monitoring and controlling the water level in the fuel storage pool;
3. Detecting leakage; and
4. Preventing the pool from emptying in the event of a pipe break.

8.12.3 Detection of Failed Fuel

The design provides a means for allowing reliable detection of fuel defects in the reactor, and subsequent removal of failed fuel if action levels are exceeded.

8.13 Radiation Protection

The design and layout of the plant make suitable provision to minimize exposure and contamination from all sources. This includes the adequate design of SSCs to:

1. Control access to the plant;
2. Minimize exposure during maintenance and inspection;
3. Provide shielding from direct and scattered radiation;
4. Provide ventilation and filtering to control airborne radioactive materials;
5. Limit the activation of corrosion products by proper specification of materials;
6. Minimize the spread of active material;
7. Monitor radiation levels; and
8. Provide suitable decontamination facilities.

8.13.1 Design for Radiation Protection

The shielding design prevents radiation levels in operating areas from exceeding the prescribed limits. This includes provision of appropriate permanent layout and shielding of SSCs containing radioactive materials, and the use of temporary shielding for maintenance and inspection work.

To minimize radiation exposure, the plant layout provides for efficient operation, inspection, maintenance, and replacement. In addition, the design limits the amount of activated material and its build-up.

The design accounts for frequently occupied locations, and supports the need for human access to locations and equipment.

Access routes are shielded where needed.

The design enables operator access for actions credited for post-accident conditions.

Adequate protection is provided against exposure to radiation and radioactive contamination in accident conditions in those parts of the facility to which access is required.

8.13.2 Access and Movement Control

The plant layout and procedures control access to radiation areas and areas of potential contamination.

The design minimizes the movement of radioactive materials and the spread of contamination, and to provide appropriate decontamination facilities for personnel.

8.13.3 Monitoring

Equipment is provided to ensure that there is adequate radiation monitoring in normal operation, AOOs, and DBAs.

Stationary alarming dose rate meters are therefore provided:

1. For monitoring the local radiation dose rate at places routinely occupied by operating personnel;
2. Where the changes in radiation levels may be such that access may be limited for periods of time;
3. To indicate the general radiation level at appropriate locations in the event of DBAs and, as far as practicable, severe accidents; and
4. To give sufficient information in the control room or at the appropriate control position to enable plant personnel to initiate corrective actions when necessary.

Monitors are to be provided for measuring the activity of radioactive substances in the atmosphere:

1. For areas routinely occupied by personnel;
2. For areas where the levels of activity of airborne radioactive materials may, on occasion, be expected to necessitate protective measures; and
3. To give an indication in the control room, or in other appropriate locations, of when a high concentration of radionuclides is detected.

Facilities are provided for monitoring individual doses to and contamination of personnel.

Stationary equipment and laboratory facilities are to be provided to determine the concentration of selected radionuclides in fluid process systems as appropriate, and in gas and liquid samples taken from plant systems or the environment.

Stationary equipment is provided for monitoring the effluents prior to or during discharge to the environment.

8.13.4 Sources

The design provides for:

1. Appropriate disposal of radioactive materials, either to on-site storage or through removal from the site;
2. Reduction in the quantity and concentration of radioactive materials produced;
3. Control of dispersal within the plant;
4. Control of releases to the environment;
5. Decontamination facilities for equipment, and for handling any radioactive waste arising from decontamination activities; and
6. Minimization of radioactive waste generation.

8.13.5 Monitoring Environmental Impact

The design provides the means for monitoring radiological releases to the environment in the vicinity of the plant, with particular reference to:

1. Pathways to the human population, including the food-chain;
2. The radiological impact, if any, on local ecosystems;
3. The possible accumulation of radioactive materials in the environment; and
4. The possibility of any unauthorized discharge routes.

9.0 Safety Analysis

9.1 General

A safety analysis of the plant design includes hazards analysis, deterministic safety analysis, and probabilistic safety assessment techniques. The safety analysis demonstrates achievement of all levels of defence-in-depth, and confirms that the design is capable of meeting the applicable expectations, dose acceptance criteria, and safety goals.

The first step of each part of the safety analysis is to identify PIEs using a systematic methodology such as failure modes and effects analysis. PIE identification considers both direct and indirect events.

9.2 Analysis Objectives

The safety analysis is iterative with the design process, and results in two reports: a preliminary safety analysis report, and a final safety analysis report.

The preliminary safety analysis assists in the establishment of the design-basis requirements for the items important to safety, and demonstrates whether the plant design meets applicable expectations.

The final safety analysis:

1. Reflects the as-built plant;
2. Demonstrates that the design can withstand and effectively respond to identified PIEs;
3. Demonstrates the effectiveness of the safety systems and safety support systems;
4. Derives the OLCs for the plant, including
    a. operational limits and set points important to safety, and
    b. allowable operating configurations, and constraints for operational procedures;
5. Establishes requirements for emergency response and accident management;
6. Determines post-accident environmental conditions, including radiation fields and worker doses, to confirm that operators are able to carry out the actions credited in the analysis;
7. Confirms that the dose and derived acceptance criteria are met for all AOOs and DBAs; and
8. Demonstrates that all safety goals have been met.

9.3 Hazards Analysis

Hazards analysis is the process of collecting and evaluating information about the NPP to identify the associated hazards and determine those that are significant and must be addressed. A hazards analysis demonstrates the ability of the design to effectively respond to credible common-cause events.

As discussed in Section 9.1, the first step of the hazards analysis is to identify PIEs. For each common-cause PIE, the hazards analysis then identifies:

1. Applicable acceptance criteria (i.e., the success path criteria);
2. The hazardous materials in the plant and at the plant site;
3. All qualified mitigating SSCs credited during and following the event-all non-qualified safety or safety support systems are assumed to fail, except in cases where their continued operation would result in more severe consequences;
4. Operator actions and operating procedures for the event; and
5. Plant or operating procedure parameters for which the event is limiting.

The hazards analysis confirms that:

1. The plant design incorporates sufficient diversity and separation to cope with credible common-cause events;
2. Credited SSCs are qualified to survive and function during and following credible common-cause events, as applicable; and
3. The following criteria are met
    a. the plant can be brought to a safe shutdown state,
    b. the integrity of the fuel in the reactor core can be maintained,
    c. the integrity of the reactor coolant pressure boundary and containment can be maintained, and
    d. safety-critical parameters can be monitored by the operator.

The hazards analysis report includes the findings of the analysis and the basis for those findings. This report also:

1. Includes a general description of the physical characteristics of the plant that outlines the prevention and protection systems to be provided;
2. Includes the list of safe shutdown equipment;
3. Defines and describes the characteristics associated with hazards for all areas that contain hazardous materials;
4. Describes the performance criteria for detection systems, alarm systems, and mitigation systems, including requirements such as seismic or environmental qualification;
5. Describes the control and operating room areas and the protection systems provided for these areas, including additional facilities for maintenance and operating personnel;
6. Describes the operator actions and operating procedures of importance to the given analysis;
7. Identifies the plant parameters for which the event is limiting;
8. Explains the inspection, testing, and maintenance parameters needed to protect system integrity; and

9. Defines the emergency planning and coordination requirements for effective mitigation, including any necessary measures to compensate for the failure or inoperability of any active or passive protection system or feature.

9.4 Deterministic Safety Analysis

The purpose of the deterministic safety analysis is to:

1. Confirm that OLCs comply with the assumptions and intent of the design for normal operation of the plant;
2. Characterize the events that are appropriate for the plant site and design;
3. Analyze and evaluate event sequences that result from failure of SSCs;
4. Compare the results of the analysis with dose acceptance criteria and design limits;
5. Establish and confirm the design basis; and
6. Demonstrate that AOOs and DBAs can be managed by automatic response of safety systems in combination with prescribed operator actions.

The expectations for the deterministic safety analysis are provided in CNSC regulatory document RD-310, *Safety Analysis for Nuclear Power Plants*.

9.5 Probabilistic Safety Assessment

The purpose of the probabilistic safety assessment is to:

1. Identify accident scenarios with the potential for significant core degradation;
2. Demonstrate that a balanced design has been achieved such that no particular design feature or event makes a dominant contribution to the frequency of severe accidents, taking uncertainties into account;
3. Provide probability assessments for the occurrence of core damage states and major off-site releases;
4. Identify systems for which design improvements or modifications to operating procedures could reduce the probability of severe accidents or mitigate their consequences; and
5. Assess the adequacy of plant accident management and emergency procedures.

The PSA is conducted in accordance with the requirements specified in CNSC regulatory standard S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*.

10.0 Environmental Protection and Mitigation

10.1 Design for Environmental Protection

The design makes adequate provision to protect the environment and to mitigate the impact of the NPP on the environment. A review of the design confirms that this provision has been met.

A systematic approach is used to assess the potential bio-physical environmental effects of the NPP on the environment, and the effects of the environment on the NPP.

10.2 Release of Nuclear and Hazardous Substances

The design demonstrates through process, monitoring, control, prevention, and mitigation measures, that the releases of nuclear and hazardous substances will conform to the ALARA principle.

The life cycle assessment identifies various sources of nuclear and hazardous substances in design, operation, and decommissioning, along with their possible environmental impacts on human and non-human biota.

Some of the factors that are considered include:

1. Resource requirements for the NPP, such as fuel, energy, and water;
2. Depletion of ground and surface water resources;
3. Contamination of air, soil, and water resources;
4. Nuclear and hazardous substances used
5. Types of waste generated-gaseous, liquid and solid;
6. Quantities of waste generated;
7. Impact of cooling water intake on entrainment and impingement; and
8. Impact of water output on the thermal regime of the receiving environment.

Technological options are considered in establishing design objectives for controlling and monitoring releases during start-up, normal operation, shutdown, and potential abnormal and emergency situations. Appropriate limits are included in the plant OLCs.

Technological options for the design of cooling water systems should consider a closed-cycle technology in order to minimize adverse environmental impact on aquatic biota.

11.0 Alternative Approaches

The expectations in this regulatory document are intended to be technology neutral for water-cooled reactor designs. It is recognized that specific technologies may use alternative approaches.

The CNSC will consider alternative approaches to the expectations in this document where:

1. The alternative approach would result in an equivalent or superior level of safety;
2. Application of the expectations in this document conflicts with other rules or requirements;
3. Application of the expectations in this document would not serve the underlying purpose, or is not necessary to achieve the underlying purpose; or
4. Application of the expectations in this document would result in undue hardship or other costs that significantly exceed those contemplated when the regulatory document was adopted.

Any alternative approach should demonstrate equivalence to the outcomes associated with the use of the expectations set out in this regulatory document.

Glossary

Abbreviations

ALARA
: as low as reasonably achievable

AOO
: anticipated operational occurrence

BDBA
: beyond design basis accident

BDBT
: beyond design basis threat

CNSC
: Canadian Nuclear Safety Commission

DBA
: design basis accident

DBE
: design basis earthquake

DBT
: design basis threat

ECCS
: emergency core cooling system

EHRS
: emergency heat removal system

EPS
: emergency power supply

GSS
: guaranteed shutdown state

IAEA
: International Atomic Energy Agency

MCR
: main control room

MSIV
: main steam isolation valve

NPP
: nuclear power plant

NSCA
: *Nuclear Safety and Control Act*

OLC
: operational limits and conditions

PIE
: postulated initiating event

PSA
: probabilistic safety assessment

RCS
: reactor coolant system

SCR
: secondary control room

SSCs

structures, systems, and components

Terminology

Accident
Any unintended event, including operating errors, equipment failures or other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.
Note: For the purposes of this document, accidents include design basis accidents and beyond design basis accidents. Accidents exclude anticipated operational occurrences, which have negligible consequences from the perspective of protection or safety.

Anticipated operational occurrence
An operational process deviating from normal operation which is expected to occur at least once during the operating lifetime of a facility but which, in view of the appropriate design provisions, does not cause any significant damage to items important to safety or lead to accident conditions.

Best estimate
Unbiased estimate obtained by the use of a mathematical model or calculation method to realistically predict plant behaviour and important parameters.

Combustion
A chemical process that involves oxidation sufficient to produce heat or light.

Common-cause failure
A concurrent failure of two or more structures, systems or components due to a single specific event or cause, such as natural phenomena (earthquakes, tornadoes, floods, etc.), design deficiency, manufacturing flaws, operation and maintenance errors, human-induced destructive events and others.

Commissioning
A process of activities intended to demonstrate that installed systems, structures, and components and equipment perform in accordance with their specifications and design intent before they are put into service.

Complementary design feature
A design feature outside of the design basis envelope that is introduced to cope with beyond design basis accidents, including severe accidents.

Confinement
A continuous boundary without openings or penetrations (such as windows) that prevents the transport of gases or particulates out of the enclosed space.

Containment
A confinement structure designed to maintain confinement at both high temperature and pressures and for which isolation valving on penetrations is permitted.

Conservatism
Use of assumptions, based on experience or indirect information, about a phenomena or behaviour of a system being at or near the limit of expectation, which increases safety margins or makes predictions regarding consequences more severe than if best-estimate assumptions had been made.

Core damage
Core degradation resulting from event sequences more severe than design basis accidents.

Crediting
Assuming the correct operation of an SSC, or correct operator action, as part of an analysis.

Critical groups
A group of members of the public that is reasonably homogeneous with respect to its exposure for a given radiation source, and is typical of individuals receiving the highest effective dose or equivalent dose (as applicable) from the given source.

Design basis threat
A set of malevolent acts that the CNSC considers possible.

Deterministic safety analysis
Analysis of plant responses to an event performed using predetermined rules and assumptions (e.g., those concerning the initial plant state, availability and performance of the plant systems, and operator actions). Deterministic analyses can use either conservative or best estimate methods.

Direct trip parameter
A value based on direct measurement of a specific challenge to the derived acceptance criteria and, if applicable, a direct measure of the event.

Diversity
The presence of two or more redundant systems or components to perform an identified function, where the different systems or components have different attributes so as to reduce the possibility of common-cause failure.

Environment
The components of the Earth, including:

1. Land, water, and air, including all layers of the atmosphere;
2. All organic and inorganic matter and living organisms; and
3. Interacting natural systems that include components referred to in (1) and (2).

Exclusion zone
Pursuant to Section 1 of the *Class I Nuclear Facilities Regulations*, a parcel of land within or surrounding a nuclear facility on which there is no permanent dwelling and over which a licensee has the legal authority to exercise control.

External event
Any event that proceeds from the environment external to a nuclear power plant, and can cause failure of structures, systems and components.
Note: External events include, but are not limited to, earthquakes, floods, and hurricanes.

Fail-safe design
Design whose most probable failure modes do not result in a reduction of safety.

Fire
A process of combustion characterized by heat emission and accompanied by smoke or flame, or both.

Heat sink
A system or component that provides a path for heat-transfer from a source such as heat generated in the fuel, to a large heat absorbing medium.

Human factors
Factors that influence human performance as it relates to the safety of the nuclear power plant, including activities during design, construction, and commissioning, operation, maintenance and decommissioning phases.

Independent systems
Systems that do not share any components.

Internal event
An event internal to the nuclear power plant that results from human error or failure in a system, structure, or component.

Jet impact
The potential internal hazard associated with high pressure fluid released from a pressure-retaining component.

Leak-before-break
A situation where leakage from a flaw is detected during normal operation, allowing the reactor to be shut down and depressurized before the flaw grows to the critical size for rupture.

Malevolent act
An illegal action or an action that is committed with the intent of causing wrongful harm.

Management arrangements
The means by which an organization functions to achieve its objectives, including:

1. Physical elements, such as people, buildings, work areas, equipment, tools, etc.;
2. Intangible elements, such as roles and responsibilities, knowledge, skills and behaviour of the people, cultural norms, agreements, understandings, decision-making processes, etc.; and
3. The documentation that is essential to meeting the organization’s objectives.

Missile generation
The internal hazard associated with the sudden high-speed propulsion of debris.

Mission time
The duration of time within which a system or component is required to operate or be available to operate and fulfill its function following an event.

Normal operation

Operation of a nuclear power plant within specified operational limits and conditions including start-up, power operation, shutting down, shutdown, maintenance, testing and refuelling.

Nuclear power plant
Any fission reactor installation constructed to generate electricity on a commercial scale. A nuclear power plant is a Class IA nuclear facility, as defined in the *Class I Nuclear Facilities Regulations*.

Plant state
A configuration of nuclear power plant components, including the physical and thermodynamic states of the materials and the process fluids in them.
Note: For the purpose of this document a plant is said to be in one of the following states: normal operation, anticipated operational occurrence, design basis accident, or beyond design basis accident (severe accidents are a subset of the beyond design basis state).

Postulated initiating event
An event identified in the design as leading to either an anticipated operational occurrence or accident conditions. This means that a postulated initiating event is not necessarily an accident itself; rather it is the event that initiates a sequence that may lead to an operational occurrence, a design basis accident, or a beyond design basis accident, depending on the additional failures that occur.

Practicable
Technically feasible and justifiable while taking cost-benefit considerations into account.

Pressure boundary
A boundary of any pressure-retaining vessel, system, or component of a nuclear or non-nuclear system.

Probabilistic safety assessment
A comprehensive and integrated assessment of the safety of the nuclear power plant that, by considering the initial plant state and the probability, progression, and consequences of equipment failures and operator response, derives numerical estimates of a consistent measure of the safety of the plant. Such assessments are most useful in assessing the relative level of safety.

Process
Set of interrelated activities that transform inputs into outputs.

Process system
A system whose primary function is to support (or contribute to) the production of steam or electricity.

Proven design
A design of a component(s) can be proven either by showing compliance with accepted engineering standards, or by a history of experience, or by test, or some combination of these. New component(s) are "proven" by performing a number of acceptance and demonstration tests that show the component(s) meets pre-defined criteria.

Residual heat
The sum of heat originating from radioactive decay, fission in the fuel in the shutdown state, and the heat stored in reactor related structures, systems and components.

Risk significant system
Any plant system whose failure to meet design and performance specifications could result in unreasonable risk to the health and safety of persons, to national security, or to the environment.

Safeguards
A system of international inspections and other verification activities undertaken by the IAEA in order to evaluate, on an annual basis, Canada's compliance with its obligations pursuant to the safeguards agreements between Canada and the IAEA.

Safety analysis
Analysis by means of appropriate analytical tools that establishes and confirms the design basis for the items important to safety; and ensures that the overall plant design is capable of meeting the acceptance criteria for each plant state.

Safety culture
The characteristics of the work environment, such as values, rules and common understandings, that influence employee perceptions and attitudes about the importance that the organization places on safety.

Safety group
Assembly of structures, systems and components designated to perform all actions required for a particular postulated initiating event to ensure that the specified limits for AOOs and DBAs are not exceeded. It may include certain safety and safety support systems, and any interacting process system.

Safety support system
A system designed to support the operation of one or more safety systems.

Safety system
A system provided to ensure the safe shutdown of the reactor or the residual heat removal from the core, or to limit the consequences of anticipated operational occurrences and design basis accidents.

Severe accident
A beyond design basis accident that involves significant core degradation.

Single failure
A failure that results in the loss of capability of a system or component to perform its intended function(s) and any consequential failure(s) that result from it.

Shutdown state
Characterized by subcriticality of the reactor. At shutdown, automatic actuation of safety systems could be blocked and support systems may remain in abnormal configurations.

Structures, systems and components
A general term encompassing all of the elements (items) of a facility or activity which contribute to protection and safety, except human factors.

Structures are the passive elements: buildings, vessels, shielding, etc. A system comprises several components, assembled in such a way as to perform a specific (active) function. A component is a discrete element of a system. Examples are wires, transistors, integrated circuits, motors, relays, solenoids, pipes, fittings, pumps, tanks and valves, etc.

Trip parameter
A measurement of a variable that is used to trigger a safety system action when the trip parameter set point is reached.

Trip parameter set point
Trip parameter value at which activation of a safety system is triggered.

Ultimate heat sink
A medium to which the residual heat can always be transferred, even if all other means of removing the heat have been lost or are insufficient. This medium is normally a body of water or the atmosphere.

Usability
The extent to which a product can be used by specified users, to achieve specified goals, with effectiveness, efficiency, and satisfaction in a specified context of use.

Vital area
An area containing equipment, systems, or devices the sabotage of which could directly or indirectly lead to unacceptable radiological consequences.

Associated Documents

The following legislation and regulations are relevant to this document:

1. *Class I Nuclear Facilities Regulations*, SOR/2000-204

2. *General Nuclear Safety and Control Regulations*, SOR/2000-202

3. *Nuclear Safety and Control Act*, S.C.,1997, c.9

4. *Nuclear Security Regulations*, SOR/2000-209

5. *Radiation Protection Regulations*, SOR/2000-203

The following documents provide additional information pertaining to nuclear power plant design:

1. *Design Guide for Basic and Intermediate Level Radioisotope Laboratories*, R-52 rev-1, Atomic Energy Control Board, 1991

2. *Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills,* G-225, Canadian Nuclear Safety Commission, 2001

3. *Engineering Safety Aspects of the Protection of Nuclear Power Plant Against Sabotage*, International Atomic Energy Agency, Nuclear Security Series No. 4, 2007

4. *Entry to Protected and Inner Areas*, G-205, Canadian Nuclear Safety Commission, 2003

5. *Human Factors Engineering Program Plans*, G-276, Canadian Nuclear Safety Commission, 2003

6. *Human Factors Verification and Validation Plans*, G-278, Canadian Nuclear Safety Commission, 2003

7. Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable (ALARA)", G-129 rev-1, Canadian Nuclear Safety Commission, 2004

8. Nuclear Emergency Management, P-325, Canadian Nuclear Safety Commission, 2006

9. Probabilistic Safety Assessment (PSA) for Nuclear Power Plants,S-294, Canadian Nuclear Safety Commission, 2005

10. Reliability Programs for Nuclear Power Plants, S-98 rev-1, Canadian Nuclear Safety Commission, 2005

11. Safety Analysis for Nuclear Power Plants, RD-310, Canadian Nuclear Safety Commission, 2008

12. Safety of Nuclear Plants: Design, IAEA Safety Standard Series NS-R-1, International Atomic Energy Agency, Vienna, 2000

13. Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities, G-274, Canadian Nuclear Safety Commission, 2003

14. Severe Accident Management Programs for Nuclear Reactors, G-306, Canadian Nuclear Safety Commission, 2006

15. Transportation Security Plans for Category I, II or III Nuclear Material, G-208, Canadian Nuclear Safety Commission, 2003

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Canada's Nuclear Regulator

CNSC CCSN 70 YEARS • 70 ANS

Canadian National Report for the Convention on Nuclear Safety

Seventh Report
August 2016

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

Canadian National Report for the Convention on Nuclear Safety – Seventh Report

In conformance with article 5 of the *Convention on Nuclear Safety*

Executive Summary

This seventh Canadian report demonstrates how Canada continued to meet its obligations under the terms of the *Convention on Nuclear Safety* (CNS) during the reporting period from April 2013 to March 2016. During this period, Canada effectively maintained and, in many cases, enhanced its measures to meet its obligations under the CNS. Enabled by a modern and robust legislative framework, these measures – which focus on the health and safety of persons and the protection of the environment – are implemented by Canada's nuclear regulator, licensees of nuclear power plants (NPPs), and other government institutions and industry stakeholders. Canada remains fully committed to the principles and implementation of the CNS by undertaking continuous improvements to maintain the highest level of safety of nuclear power reactors in Canada and around the world.

Nineteen Canada Deuterium Uranium (CANDU) reactors were operating in Canada during the reporting period and three reactors were in safe storage.

Nuclear-related activities at NPPs in Canada are governed by robust, modern legislation, with appropriate and well-defined powers to ensure the NPPs remain safe. The most important legislation is the *Nuclear Safety and Control Act* (NSCA), which is complemented by regulations and other regulatory instruments. Canada's nuclear regulator, the Canadian Nuclear Safety Commission (CNSC), is mature and well established. A system of licensing is in place to control activity related to NPPs and to protect the health and safety of persons, the environment, and national security. To further enhance this system, the CNSC continued its licence reform project and during the reporting period, all existing NPPs had streamlined operating licences and accompanying licence condition handbooks (LCHs) that clarify the regulatory requirements and expectations and facilitate increased regulatory effectiveness and efficiency.

With the 2015 publication of CNSC regulatory document REGDOC-2.3.3, *Periodic Safety Reviews*, and its implementation to the licensing basis of Canadian NPPs, licensees will begin to perform periodic safety reviews (PSRs) for future licence renewals. This closes the one remaining open recommendation from the 2009 Integrated Regulatory Review Service (IRRS) mission to Canada.

The CNSC has a comprehensive program to assure compliance with the regulatory framework and monitor the safety performance of the NPPs. The CNSC continued to enhance the compliance program for operating NPPs during the reporting period.

A comprehensive set of graduated enforcement tools are available to the CNSC to address non-compliances. One of the tools introduced during the previous reporting period, administrative monetary penalties (AMPs), was further developed during the reporting period with the publication of the *Administrative Monetary Penalties Regulations (Canadian Nuclear Safety*

Commission) and CNSC regulatory document REGDOC-3.5.2, *Administrative Monetary Penalties*, *Version 2*. This tool has been used to enhance the CNSC's effectiveness and flexibility in enforcement.

The CNSC's regulatory framework and processes feature a high degree of openness and transparency. The CNSC continued to foster openness and transparency during the reporting period – for example, through its Participant Funding Program, which facilitates the participation of eligible intervenors in the decision-making process and by issuing discussion papers and soliciting early public feedback on potential regulatory changes.

The Canadian regulatory framework, which is largely non-prescriptive, is continuously updated and aligned with international standards. Renewals of operating licences for NPPs are used to introduce new standards and requirements that the licensees actively implement.

Canada's nuclear industry has an excellent safety record. During the reporting period, NPP licensees fulfilled the basic responsibilities for safety as required by the NSCA, regulations, and the NPP operating licences. The licensees also addressed any safety issues that arose to keep the risk at reasonable levels – and continued to give safety a high priority at every level of their organizations.

None of the safety-significant events that occurred at Canadian NPPs during the reporting period posed a significant threat to persons or the environment. For example, there were no serious process failures at any NPP during the reporting period. The licensees' efforts to address operational events were effective in correcting any deficiencies and preventing recurrence.

During the reporting period, all Canadian NPPs operated with acceptable safety margins and acceptable levels of defence in depth. The maximum annual worker doses at NPPs were below annual dose limits, and all radiological releases from NPPs were very low – below 1 percent of derived release limits. The CNSC's ratings of NPP safety performance confirmed that regulatory requirements and performance expectations in all 14 of its safety and control areas were met or exceeded at all NPPs during the reporting period.

The 2015 *Vienna Declaration on Nuclear Safety* (VDNS) was adopted by Contracting Parties to the CNS. The declaration provides principles for the implementation of the objective of the *Convention on Nuclear Safety* to prevent accidents and mitigate radiological consequences. Canada has demonstrated its fulfillment of the VDNS principles through the activities of the CNSC and its licensees in all aspects of operating NPP facilities. Specifically, the principles of the VDNS have been achieved through the following means:

- The national regulatory framework for siting, design, and construction of NPPs aligns with the International Atomic Energy Agency (IAEA) safety standards, which themselves have been demonstrated to fulfill the principles of the VDNS.
- The designs of Canada's NPPs include features that prevent accidents and mitigate impacts should an accident occur. In addition, actions by the CNSC and licensees have strengthened defence in depth and enhanced emergency response.
- Licensees have implemented updated safety analyses and safety analysis reports that align with the requirements in revised CNSC regulatory documents. Also, licensees are meeting the safety goals associated with probabilistic safety assessments (PSAs).
- Integrated safety reviews for the refurbishment of specific NPPs have been completed. The introduction of PSRs for 10-year operating licences will enhance the systematic adoption of safety improvements at existing NPPs.

During the reporting period, the CNSC and Canadian nuclear industry addressed the six specific CNS challenges that were identified for Canada at the Sixth Review Meeting:

Challenge C-1	Complete the implementation of the *CNSC Integrated Action Plan* in response to the Fukushima accident
Challenge C-2	Enhance probabilistic safety assessment (PSA) to consider multi-units and to consider irradiated fuel bays (spent fuel bays)
Challenge C-3	Establish guidelines for the return of evacuees post-accident and to confirm public acceptability of it
Challenge C-4	Invite an IAEA emergency preparedness review (EPREV) mission
Challenge C-5	Update emergency operational interventional guidelines and protective measures for the public during and following major and radiological events
Challenge C-6	Transition to decommissioning approach

The following steps were taken to address the six challenges.

Canadian NPP licensees completed the Fukushima action items (FAIs) by December 31, 2015, as specified in the CNSC Action Plan. The FAIs address safety improvements aimed at strengthening defence in depth, and enhancing onsite emergency response. The CNSC completed enhancements to its regulatory documents and is amending its regulations to address lessons learned from Fukushima.

The CNSC published regulatory document REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, in May 2014, which introduced new requirements related to multi-units, irradiated fuel bays, and re-evaluation of site-specific external initiating events. REGDOC-2.4.2 will be included in the licensing basis for NPP licensees as their operating licences are renewed. All licensees are expected to be fully compliant by 2020. Full-scope PSAs are either completed or the licensees are making acceptable progress towards completion. The licensees are developing a safety goal framework and pilot application of a whole-site PSA methodology.

With respect to guidelines for the post-accident return of evacuees, the CNSC is collaborating with Health Canada to develop a discussion paper on a proposed regulatory document that will address this topic. The discussion paper is targeted for publication in the fall of 2016 and the goal is to publish the regulatory document during the next reporting period.

Health Canada continues to work with stakeholders to implement the lessons learned from the 2014 Exercise Unified Response, with a planned completion date of mid-2016 for federal-level actions. Health Canada and the CNSC have initiated planning for a future EPREV mission and an invitation for an EPREV mission is expected during the next reporting period.

Health Canada is updating the draft *Canadian Guidelines for Protective Actions during a Nuclear Emergency*. It will be released by mid-2016 for final consultation with federal, provincial, municipal and non-governmental organizations.

The CNSC established a licensing strategy for decommissioning NPPs in the context of the 2016 licence renewal for Gentilly-2. The licence application from Hydro-Québec is to replace the current licence with a 10-year power reactor decommissioning licence. Hydro-Québec is expected to continue activities related to the preparation for the decommissioning of Gentilly-2 and CNSC is providing oversight, adapting its compliance program to the decommissioning phase.

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and evaluating the conservatism of, and correcting inconsistencies in, the safety analyses. The main activities of the program have included:

- performance of pilot studies for specific analyses
- production of a guideline for application of derived acceptance criteria to safety analysis
- performance of pilot studies of Darlington loss-of-reactivity control, Bruce A loss of flow and Point Lepreau safety report dose assessment
- gap assessments for the set of analyses in the safety analysis report, followed by the necessary actions to address such gaps
- overall improvement of the safety analysis report

The lessons learned from the pilot studies are being used to update a COG document that provides guidance for deterministic safety analysis and, in particular, for the implementation of REGDOC-2.4.1.

The activities undertaken as part of the safety analysis improvement program are chosen, in part, to address the CANDU safety issues described in subsection 14(i)(g). For example, the pilot study of the Darlington loss-of-reactivity control addressed one of the Category 3 CANDU safety issues related to non-large-break loss-of-coolant accident (non-LBLOCA). In that work, OPG integrated modern and validated coupled thermal hydraulic and reactor physics tools and classified events into the categories of anticipated operational occurrences, design-basis accidents and BDBAs.

Details on the work each licensee is undertaking to implement REGDOC-2.4.1 are provided in annex 14(i)(c).

Fire safety assessment

Each facility has revised its fire safety assessment (which involves a fire hazard assessment and fire safe shutdown analysis) in accordance with the CSA standard N293-07, *Fire Protection for CANDU Nuclear Power Plants*, which is part of the licensing basis for all NPPs. CNSC staff members have reviewed and accepted the revised fire safety assessments. NPP licensees have implemented modifications or provided corrective action plans to address recommendations arising from the revised assessments. The recommendations identified in the fire safety assessments are not considered to be risk significant. The implemented and proposed modifications will enhance fire protection at Canada’s NPPs.

The CSA Group issued a new edition of the standard N293 standard during the reporting period. The updated standard, N293-12, *Fire Protection for CANDU Nuclear Power Plants*, provides clarifications to content and additional guidance on achieving compliance in the case of performance-based designs. It does not include any new requirements that would negate or requires revisions to the approved fire safety assessments.

14 (i) (d) Probabilistic safety assessments

A PSA is a comprehensive and integrated assessment of the safety of an NPP that considers the probability, progression and consequences of equipment failures or transient conditions to derive numerical estimates that provide a consistent measure of safety. There are three levels of PSAs:

- A **Level 1 PSA** identifies and quantifies the sequences of events that may lead to the loss of core structural integrity and massive fuel failures.
- A **Level 2 PSA** starts from the Level 1 results and analyzes the containment behaviour, evaluates the radionuclides released from the failed fuel and quantifies the releases to the environment.
- A **Level 3 PSA** starts from the Level 2 results and analyzes the distribution of radionuclides in the environment, evaluating the resulting effect on public health.

The main objectives of the PSA are to:

- provide a systematic analysis that gives confidence that the design will comply with the fundamental safety objectives
- demonstrate that a balanced design has been achieved
- provide confidence that small changes of conditions that may lead to a catastrophic increase in the severity of consequences (i.e., cliff-edge effects) will be prevented
- assess the probabilities of occurrence for severe core damage states and the risks of major radioactive releases to the environment
- assess the probabilities of occurrence and the consequences of site-specific external hazards
- identify NPP vulnerabilities and systems for which design improvements or modifications to operational procedures could reduce the probabilities of severe accidents or mitigate their consequences
- assess the adequacy of emergency procedures
- provide insights into the severe accident management (SAM) program

The post-Fukushima safety assessment reviewed PSA results from Canadian NPP licensees as part of the assessment of the provisions for using existing plant capabilities, complementary design features and emergency mitigating equipment (EME) in SAM and recovery. Severe accident assessments have been extended to consider further design improvements that have either been implemented or are being planned.

Requirements for probabilistic safety assessment

The CNSC published REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, in May 2014. This document sets out the requirements for the PSA and it supersedes CNSC regulatory standard S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. REGDOC-2.4.2 would also be applied to the construction phase for new-build projects. One of the key requirements is CNSC acceptance of the methodology and the computer codes used for the PSA.

The PSA update interval in REGDOC-2.4.2 is five years – or sooner, if major changes occur in the facility. The updates are subject to regulatory review.

REGDOC-2.4.2 refers to the IAEA safety series to provide general guidance on PSA methodology. In general, the methodologies developed by the licensees are based on the guidance available in documents issued by internationally recognized organizations such as the IAEA and the United States Nuclear Regulatory Commission, as well as good practices.

The PSA assessments of the probabilities of occurrences for severe core damage states, along with the assessments of the risks of major radioactive releases into the environment, are compared with safety goals. The safety goals for new NPPs, which are established in CNSC regulatory document REGDOC-2.5.2, *Design of Reactor Facilities: Nuclear Power Plants*, are summarized in the table below. These safety goals are consistent with those in International Nuclear Safety Group (INSAG) document INSAG-12, *Basic Safety Principles for Nuclear Power Plants*.

CNSC safety goals for new NPPs

Safety goal	Rationale	Numerical objective
Core damage frequency	Related to accident prevention	Sum of frequencies of all event sequences that can lead to core degradation is less than 10^{-5} per reactor-year
Small release frequency	Release that would trigger evacuation	Sum of frequencies of all event sequences that can lead to a release of more than 10^{15} Bq of I-131 is less than 10^{-5} per reactor-year
Large release frequency	Release that would trigger long-term relocation	Sum of frequencies of all event sequences that can lead to a release to the environment of more than 10^{14} Bq of Cesium-137 (corresponds to 1% of the Chernobyl accident radioactive release) is less than 10^{-6} per reactor-year

Although there are no explicit requirements for safety goals at the existing NPPs, the CNSC does expect the licensees of operating NPPs to establish safety goals that are aligned with international practices. Consistent with INSAG-12 and/or IAEA specific safety guide SSG-3, *Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants*, the NPP licensees have established and meet, the following safety goals for the existing NPPs:

- severe core damage frequency (SCDF) of less than 10^{-4} per reactor-year
- large release frequency (LRF) of less than 10^{-5} per reactor-year

Consistent with international practice, small release frequency is generally not included in the safety goals of existing Canadian NPPs.

Development of probabilistic safety assessment and implementation of REGDOC-2.4.2

At the time of writing the sixth Canadian report, NPP licensees had developed PSAs in accordance with CNSC regulatory document S-294, which required a Level 2 PSA that includes both internal and external events.

CNS Challenge C-2 for Canada from the Sixth Review Meeting
"Enhance probabilistic safety assessment (PSA) to consider multi-units and to consider irradiated fuel bays (spent fuel pools)"

The new REGDOC-2.4.2 requires Level 1 and Level 2 PSAs that include all potential, site-specific initiating events and potential hazards:

- internal initiating events and internal hazards
- external hazards, both natural and human-induced, but non-malevolent

The new REGDOC-2.4.2 includes amendments regarding lessons learned from Fukushima. The revised requirements consider all sources of radioactivity – not just the reactor core. It introduced new requirements related to multi-units, irradiated fuel bays, and low-power operational states. It identifies specific external initiating events, such as seismic, flooding, and high wind. It also requires licensees to consider potential combinations of external hazards.

Consequential events (e.g., external consequential events, such as a tsunami caused by an earthquake) are also considered in the PSAs. A PSA is required for the full-power and shutdown states of the NPP as well as any state where the reactor is expected to operate for extended periods of time.

NPP licensees have either completed or are in the process of completing Level l and Level 2 PSAs that address, among other things, re-evaluation of site-specific external initiating events. These include:

- Level 1 and 2 at-power internal events
- Level 1 outage
- Level 1 internal flood
- Level 1 and 2 fire
- Level 1 and 2 seismic
- Level 1 and 2 high wind

The application of PSA in the assessment of external events is further discussed in subarticle 17(iii).

During the reporting period, the NPP licensees performed gap analyses against the revised requirements of REGDOC-2.4.2 and submitted their transition plans to CNSC. NPP licensees have started to transition towards compliance with REGDOC-2.4.2 requirements and all licensees are expected to be fully compliant by 2020. Full-scope PSAs are either completed or the licensees are making acceptable progress towards completion.

The new requirements for the irradiated fuel bay PSA may be dealt with through alternative methods to PSA (as allowed by REGDOC-2.4.2), for which guidance is currently being developed by industry. Licensees plan to complete this work in the next reporting period.

Recent PSA updates (now submitted every five years) have included estimates of the multi-unit PSA results (severe core damage frequency and large release frequency). Further, OPG is collaborating with other members of the industry in the development of a whole-site PSA methodology. A concept-level, whole-site PSA methodology has been issued as a COG document representing the common preliminary perspective of the industry. Industry, through COG, is developing a safety goal framework and a pilot application of the whole-site PSA methodology. This methodology is expected to be completed by 2017.

Use of probabilistic safety assessment

Licensees are at various stages of utilizing the results from their PSAs. Typical applications include the use of PSA results in conjunction with deterministic analytical results to refine programs for reliability and maintenance. For example, PSA results are used to support the identification of the systems important to safety for the reliability program (see section 19(iii)). Recent developments at NPPs indicate a growing use of PSAs for risk monitoring. The most recent revisions of the PSAs for Darlington and Pickering were used to develop computerized tools for routine risk monitoring, using severe core damage frequency, for both outages and full-power operation. The PSAs have also been used to reduce risk at the NPPs by making changes to operating procedures that improve preparedness for an event. The PSAs will continue to be used to enhance operational risk monitoring programs, and will also provide input to NPP refurbishment decisions. For example, OPG investigated the implementation of possible cost-effective measures to meet its target core damage frequency for existing NPPs as part of the overall operational plan to the end of life for Pickering.

Design changes to improve safety have been identified through the use of PSA. Some examples are provided in annex 18(i).

Status of PSAs at each NPP

CNSC staff accepted in 2015 the results of the updated PSAs for Bruce A and B, which incorporate Fukushima enhancements. The PSA reports are consistent with the accepted methodologies, as well as applicable quality assurance requirements. The results show that the Fukushima enhancements improve safety in terms of providing mitigating capabilities as an additional layer of defence in depth for very rare events. The SCDF and the LRF limits were met for both Bruce A and Bruce B. The PSA results are posted on Bruce Power's website.

CNSC staff accepted in 2015 the Darlington PSA update, which evaluates the contribution of both the safety improvement opportunities and EME. CNSC staff accepted in 2014 the results of the updated Pickering PSA, which incorporated Fukushima enhancements. OPG is currently in the process of updating the Pickering PSA to incorporate the contribution of both the risk improvement plan and EME. The PSA reports are consistent with the accepted methodologies, as well as applicable quality assurance requirements. The Darlington and Pickering PSA update results show that the contributions described above and other Fukushima enhancements improved safety in terms of providing mitigating capabilities as an additional layer of defence in depth for very rare events. The SCDF and the LRF limits were met for both Darlington and Pickering. The results for both NPPs were posted on OPG's website.

NB Power is in the process of completing the first periodic update of its PSA reports that were originally submitted to and accepted by the CNSC in 2008. This update will include NB Power's responses to the CNSC Action Plan. The existing PSA reports are consistent with the accepted methodologies, as well as applicable quality assurance requirements. The results of the PSA updates submitted to-date have shown that the Fukushima enhancements improved safety in terms of providing mitigating capabilities as an additional layer of defence in depth for very rare events. The assessments have demonstrated that the risk for severe core damage or large release frequency has been reduced significantly.

14 (i) (e) Reviews by the World Association of Nuclear Operators and IAEA

The NPP licensees and CNL are members of WANO, an organization dedicated to helping its members achieve the highest levels of operational safety and performance. WANO conducts periodic evaluations to promote excellence in the operation, maintenance and support of operating NPPs, with a focus on safety and reliability. These evaluations are not required by law or regulation but are requested on a voluntary basis by WANO members. Details of the WANO peer-review process are provided in the sixth Canadian report.

The following WANO peer reviews were conducted in Canada during the reporting period.

- Bruce A and B (corporate) September 2013
- Bruce A February 2014
- Bruce B June 2014
- OPG (corporate) November 2015
- Darlington March 2014
- Pickering June 2013, June 2015
- NB Power (corporate) December 2013
- Point Lepreau October 2013, October 2015
- Gentilly-2 No peer reviews conducted

The feedback, insights and learning from the WANO peer-review process are highly valuable. The process drives major improvements and helps to continually raise the standard of performance and practice across the industry. In support of general improvement, WANO shares good practices identified during reviews with all members.

The following WANO peer reviews are planned in Canada during the next reporting period:

- Bruce A and B (corporate) 2017
- Bruce A September 2016
- Bruce B May 2017
- Darlington May 2016
- Pickering October 2017
- Point Lepreau Fall 2017
- Gentilly-2 No peer reviews scheduled

An OSART mission was conducted at the Bruce B facility from November 30 to December 17, 2015. The OSART team identified 10 good practices, five recommendations, 12 suggestions and 25 good performances. Good practices were identified in planning for refurbishment and asset management, new tooling, safety, training, communications and emergency preparedness. The final report was posted on the Bruce Power and CNSC websites.

Canada has invited the IAEA to conduct OSART missions at several Canadian facilities over the next few years and one is scheduled for Pickering during the fall of 2016.

Article 17 – Siting

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

(i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;
(ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;
(iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;
(iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

In Canada, the term "siting" comprises site evaluation and site selection. The applicant's selection of a site is not a regulated activity. However, the resultant site selection case is assessed as part of the application for a licence to prepare a site. The framework and process for issuing a licence to prepare a site for an NPP are described in subarticle 7.2(ii), with further details in subsection 7.2(ii)(b).

Prior to the CNSC's issuance of a site preparation licence, a positive decision regarding an environmental assessment (EA), which will be described in this article, is required. The EA process evaluates the effects of the project lifecycle of a proposed NPP on the environment. The CNSC separately evaluates the licence applicant's proposed measures to protect individuals, society and the environment during site preparation activities.

Fulfilling principle (1) of the 2015 *Vienna Declaration on Nuclear Safety* as it relates to siting

Principle (1) of the 2015 *Vienna Declaration on Nuclear Safety* (VDNS) states that new NPPs are to be designed, sited and constructed, consistent with the objective of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible releases of radionuclides causing long-term offsite contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and actions.

Following the Fukushima accident, the IAEA revised five Safety Requirements, which were approved by the Board of Governors in March 2015. Subsequently, the Director General of the IAEA requested the Commission on Safety Standards (CSS) to review the need for further revisions to the Safety Requirements. In August 2015, the Chair of the CSS determined that there was no need for further revisions because the technical objectives of the VDNS were already well reflected in the Safety Requirements.

As explained in subsection 7.2(i)(b), CNSC regulations and regulatory documents align with the IAEA safety standards, including those used for siting NPPs. This article provides further examples of how the regulatory framework for siting addresses IAEA safety standards.

Therefore, the CNSC framework and processes used in the regulation of activities related to site preparation ensure that the siting of new NPPs in Canada will meet principle (1) of the VDNS.

See article 18 for a similar statement on the activities of design and construction.

Level of NPP design information expected to demonstrate site suitability

Under the NSCA, the decisions made by the Commission on an application for a licence to prepare a site for a new NPP may be made with high-level facility design information from a range of reactor designs. The design information provided by the applicant must be credible and sufficient to adequately bound the evaluations of environmental effects and site suitability from a range of reactor designs that might later be deployed at the site.

The bounding design parameters must contain sufficient information to describe the NPP–site interface and take into consideration the characteristics of the proposed site. The underpinning of the bounding approach is that the environmental effects of the reactor design eventually selected for construction should be less than the bounding effects assessed in the site evaluation and the environmental impact statement (EIS), which the applicant prepares as part of the EA process.

Although the CNSC accepts high-level information in support of the site evaluation case, there is an increased level of regulatory scrutiny during the construction and operation licensing processes to validate the claims made. When applying for a licence to construct, the applicant will be expected to submit detailed design information verifying the evaluations presented previously remain valid. If the level of information provided at the outset is limited, however, there is a greater likelihood that fundamental barriers to licensing will appear during the review process for a licence to construct. Thus, it is in the best interest of the applicant to make its submissions as complete as possible at the outset.

The required level of design information for a site evaluation includes:

- a technical outline of the facility layout (preliminary or schematic in nature)
- qualitative descriptions of all major structures, systems and components (SSCs) that could significantly influence the course or consequences of principal types of accidents and malfunctions
- qualitative descriptions of the functionality of the SSCs important to safety
- qualitative descriptions of principal types of accidents and malfunctions to identify limiting credible sequences that include external hazards (both natural- and human-induced), design-basis accidents and beyond-design-basis accidents (BDBA, which include severe accidents)

For EA purposes, the limiting source terms must consider accident sequences that could occur with a frequency greater than 10^{-6} per reactor-year of operation. For those less than 10^{-6} per reactor-year, but sufficiently close to this frequency, the rationale for not including them for further analysis should be provided.

For site evaluation carried out in support of licensing (including emergency planning purposes), the CNSC expects severe accident sequences to be addressed. The severe accident sequences include, where applicable, multi-unit events, simultaneous with loss of the electrical grid/station blackout events, and events with a simultaneous loss of offsite power and loss of heat sink for an extended period of time.

A description of specific (out-of-reactor) criticality events must be provided, showing that these events do not violate criteria established by international standards and national guidance as triggers for public evacuation.

If the applicant chooses to pursue a licence to prepare a site without choosing a final NPP technology, the activities permitted under the issued licence to prepare the site would be limited to site preparation activities that are independent of any specific reactor technology. Such activities include clearing and grading the site or building support infrastructure such as roads, power, water and sewer services, but do not include excavation for the purposes of establishing the facility footprint.

Regardless of the approach used by an applicant to apply facility design information to its site selection case, a fundamental expectation of the CNSC is that the applicant will demonstrate the capability of a "smart buyer". This means that the applicant will be expected to demonstrate a clear understanding of the technologies it is proposing to use and the basis from which the site selection case is developed.

Site evaluation criteria – general

The information provided in an application for a licence to prepare a site is assessed against the criteria described in the CNSC regulatory document RD-346, *Site Evaluation for New Nuclear Power Plants*. RD-346 adapts the tenets set forth by the IAEA safety requirements document NS-R-3, *Site Evaluation for Nuclear Installations*, and its associated guides. RD-346 addresses some Canadian expectations that are not addressed in NS-R-3, such as protection of the environment, security of the site, and protection of prescribed information and equipment. RD-346 elaborates upon the criteria for evaluating the effect of the site on the safety of the NPP (see subsection 7.2(i)) and the impact of the NPP on the surrounding population and the environment (see subsection 7.2(ii)(b)). Specifically, RD-346 articulates the CNSC's expectations with respect to the evaluation of site suitability over the life of a proposed NPP, and includes:

- the potential effects of external events (such as earthquakes, tornadoes and floods) and human activity on the site
- the characteristics of the site and its environment that could influence the transfer to persons and the environment of radioactive and hazardous material that may be released
- the population density, population distribution and other characteristics of the region, insofar as they may affect the implementation of emergency measures (see subsection 16.1(c)) and evaluation of risks to individuals, the surrounding population and the environment

RD-346 also requires the consideration of certain aspects, such as security and decommissioning requirements, projected population growth in the vicinity of the site, and possible future life extension activities, when evaluating the site.

If the site evaluation indicates safety concerns that design features, site protection measures, or administrative procedures cannot remedy, the site is deemed unacceptable. The site evaluation includes:

- evaluation against safety goals
- consideration of evolving natural and human-induced factors
- evaluation of the hazards associated with external events

- determination of the potential effects of the NPP on the environment
- consideration of projected population growth in the vicinity of the site along with emergency planning that takes those projections into account

An example of an evaluation against safety goals, set in the context of OPG's EIS and application for a licence to prepare a site for the Darlington new-build project, was provided in annex 17 of the sixth Canadian report.

Additional details related to site evaluation criteria are provided under subarticles 17(i) and 17(ii) below.

17 (i) Evaluation of site-related factors

The safety case for the licence to prepare a site includes an assessment of hazards or bounding analysis and should address the impact of site-specific factors on the safety of the NPP. Such factors include the site's susceptibility to flooding (e.g., storm surge, dam burst), hurricanes, tornadoes, ice storms or other severe weather, and earthquakes. The return periods for severe weather, flood or wind are not prescribed. However, the applicant is expected to propose adequate periods based on criteria identified in the IAEA documents that are referenced in RD-346 (specifically, IAEA safety guides NS-G-1.5, NS-G-3.2, NS-G-3.4 and NS-G-3.5).

Licensees also have to perform a site-specific external hazards screening to identify other hazards that may require a PSA or a bounding analysis. Further, the licensees must consider combinations of events, including consequential and correlated events. Examples of consequential events include external events (such as a cooling water intake blockage caused by severe weather, a tsunami caused by an earthquake or a mud slide caused by heavy rain) and internal events (such as a fire caused by an earthquake). Examples of correlated events include heavy rainfall concurrent with a storm surge or high winds caused by a hurricane.

It should be pointed out that consequential events are also considered in the PSAs (see subsection 14(i)(d)) required in the licensing process following the application for a licence to prepare site.

RD-346 requires the applicant to consider climate change when evaluating the potential impact of these phenomena. An example of this consideration for Bruce A and B was provided in annex 17(iii)(a) of the sixth Canadian report.

Site-related factors also include the proximity of the site to one or more of the following:

- railroad tracks (possibility of derailments and the release of hazardous material)
- flight paths for major airports (possibility of airplane crashes)
- toxic chemical plants (possibility of toxic releases)
- propane storage facilities or refineries (possibility of industrial accidents)
- military test ranges (possibility of stray missiles)

The above concerns are further affected by projected land use near the site, access to the site, emergency preparedness and security.

The licence applicant addresses these criteria during the application process for a licence under the NSCA (and in its EIS), the results of which are integrated into the safety case. Applications identify and assess the site characteristics that may be important to the safety of the proposed NPP, including:

- land use
- present population and predicted population expansion
- principal sources and movement of water
- water usage
- meteorological conditions
- seismology
- local geology

17 (ii) Impact of the installation on individuals, society and environment

17 (ii) (a) Environmental assessment

An EA pursuant to the *Canadian Environmental Assessment Act, 2012* (CEAA) is initiated following an application for a licence to prepare a site. An EA under the *Nuclear Safety and Control Act* is undertaken for other licensing decisions such as licence renewal/amendment. EAs identify whether a specific project is likely to cause significant environmental effects taking mitigating measures into account. The potential impact on the environment is evaluated in the EA process by examining the effects on parameters such as water supply, air quality, wildlife, lakes and rivers. EAs ensure that, early in a project, potentially significant adverse effects are identified and mitigated to the extent possible. In accordance with RD-346, prior to the triggering of the EA and licensing processes, the applicant is expected to use a robust process to characterize proposed sites over the full lifecycle of the facility and then develop a fully documented defence of the site selection. This case forms the backbone for submissions in support of the EA and the application for a licence to prepare the site, which is reviewed by the CNSC and other applicable federal authorities.

EAs are conducted at every phase of the lifecycle of a facility or activity. These assessments are commensurate with the scale and complexity of the environmental risks associated with the facility or activity.

As stated above, EAs are carried out either under the CEAA or under the NSCA. An environmental risk assessment (ERA), see subsection 17(iii)(a), forms the basis of an EA, either under CEAA or under the NSCA. Early in the process, CNSC staff members determine which EA applies by reviewing the information provided by the applicant or licensee in their application and supporting documentation.

In accordance with paragraph 15(a) of CEAA, an EA is required when the CNSC is the responsible authority with respect to a designated project per the *Regulations Designating Physical Activities*. In addition, an EA under CEAA is carried out early in the licensing process (at the beginning of the lifecycle of the project) and serves as a planning tool.

For applicants proposing facilities or activities in areas of Canada subject to land claim agreements (such as the territories and parts of Quebec and Newfoundland and Labrador), CNSC staff members support the EA process of that land-claim regime and the Commission uses the information gathered in the EA process in its licensing decision under the NSCA.

0745

IAEA Safety Standards

for protecting people and the environment

Site Evaluation for Nuclear Installations

Safety Requirements

No. NS-R-3 (Rev. 1)

IAEA

International Atomic Energy Agency

IAEA SAFETY STANDARDS AND RELATED PUBLICATIONS

IAEA SAFETY STANDARDS

Under the terms of Article III of its Statute, the IAEA is authorized to establish or adopt standards of safety for protection of health and minimization of danger to life and property, and to provide for the application of these standards.

The publications by means of which the IAEA establishes standards are issued in the **IAEA Safety Standards Series**. This series covers nuclear safety, radiation safety, transport safety and waste safety. The publication categories in the series are **Safety Fundamentals**, **Safety Requirements** and **Safety Guides**.

Information on the IAEA's safety standards programme is available on the IAEA Internet site

http://www-ns.iaea.org/standards/

The site provides the texts in English of published and draft safety standards. The texts of safety standards issued in Arabic, Chinese, French, Russian and Spanish, the IAEA Safety Glossary and a status report for safety standards under development are also available. For further information, please contact the IAEA at: Vienna International Centre, PO Box 100, 1400 Vienna, Austria.

All users of IAEA safety standards are invited to inform the IAEA of experience in their use (e.g. as a basis for national regulations, for safety reviews and for training courses) for the purpose of ensuring that they continue to meet users' needs. Information may be provided via the IAEA Internet site or by post, as above, or by email to Official.Mail@iaea.org.

RELATED PUBLICATIONS

The IAEA provides for the application of the standards and, under the terms of Articles III and VIII.C of its Statute, makes available and fosters the exchange of information relating to peaceful nuclear activities and serves as an intermediary among its Member States for this purpose.

Reports on safety in nuclear activities are issued as **Safety Reports**, which provide practical examples and detailed methods that can be used in support of the safety standards.

Other safety related IAEA publications are issued as **Emergency Preparedness and Response** publications, **Radiological Assessment Reports**, the International Nuclear Safety Group's **INSAG Reports**, **Technical Reports** and **TECDOCs**. The IAEA also issues reports on radiological accidents, training manuals and practical manuals, and other special safety related publications.

Security related publications are issued in the **IAEA Nuclear Security Series**.

The **IAEA Nuclear Energy Series** comprises informational publications to encourage and assist research on, and the development and practical application of, nuclear energy for peaceful purposes. It includes reports and guides on the status of and advances in technology, and on experience, good practices and practical examples in the areas of nuclear power, the nuclear fuel cycle, radioactive waste management and decommissioning.

SITE EVALUATION FOR NUCLEAR INSTALLATIONS

The following States are Members of the International Atomic Energy Agency:

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BOSNIA AND HERZEGOVINA
BOTSWANA
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VIET NAM
YEMEN
ZAMBIA
ZIMBABWE

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

IAEA SAFETY STANDARDS SERIES No. NS-R-3 (Rev. 1)

SITE EVALUATION FOR NUCLEAR INSTALLATIONS

SAFETY REQUIREMENTS

This publication includes a CD-ROM containing the IAEA Safety Glossary: 2007 Edition (2007) and the Fundamental Safety Principles (2006), each in Arabic, Chinese, English, French, Russian and Spanish versions. The CD-ROM is also available for purchase separately. See: http://www-pub.iaea.org/books

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FOREWORD

by Yukiya Amano
Director General

The IAEA's Statute authorizes the Agency to "establish or adopt… standards of safety for protection of health and minimization of danger to life and property" — standards that the IAEA must use in its own operations, and which States can apply by means of their regulatory provisions for nuclear and radiation safety. The IAEA does this in consultation with the competent organs of the United Nations and with the specialized agencies concerned. A comprehensive set of high quality standards under regular review is a key element of a stable and sustainable global safety regime, as is the IAEA's assistance in their application.

The IAEA commenced its safety standards programme in 1958. The emphasis placed on quality, fitness for purpose and continuous improvement has led to the widespread use of the IAEA standards throughout the world. The Safety Standards Series now includes unified Fundamental Safety Principles, which represent an international consensus on what must constitute a high level of protection and safety. With the strong support of the Commission on Safety Standards, the IAEA is working to promote the global acceptance and use of its standards.

Standards are only effective if they are properly applied in practice. The IAEA's safety services encompass design, siting and engineering safety, operational safety, radiation safety, safe transport of radioactive material and safe management of radioactive waste, as well as governmental organization, regulatory matters and safety culture in organizations. These safety services assist Member States in the application of the standards and enable valuable experience and insights to be shared.

Regulating safety is a national responsibility, and many States have decided to adopt the IAEA's standards for use in their national regulations. For parties to the various international safety conventions, IAEA standards provide a consistent, reliable means of ensuring the effective fulfilment of obligations under the conventions. The standards are also applied by regulatory bodies and operators around the world to enhance safety in nuclear power generation and in nuclear applications in medicine, industry, agriculture and research.

Safety is not an end in itself but a prerequisite for the purpose of the protection of people in all States and of the environment — now and in the future. The risks associated with ionizing radiation must be assessed and controlled without unduly limiting the contribution of nuclear energy to equitable and sustainable development. Governments, regulatory bodies and operators everywhere must ensure that nuclear material and radiation sources are used beneficially, safely and ethically. The IAEA safety standards are designed to facilitate this, and I encourage all Member States to make use of them.

PREFACE

The accident at the Fukushima Daiichi nuclear power plant in Japan followed the Great East Japan Earthquake and Tsunami of 11 March 2011. The IAEA Action Plan on Nuclear Safety (GOV/2011/59-GC(55)/14) was developed in response to the Fukushima Daiichi accident[1] and was approved by the IAEA Board of Governors and endorsed by the IAEA General Conference in September 2011 (GC(55)/RES/9). It includes an action headed: Review and strengthen IAEA Safety Standards and improve their implementation.

This action called upon the Commission on Safety Standards (CSS) and the IAEA Secretariat to review, and revise as necessary, the relevant IAEA safety standards in a prioritized sequence, and called on Member States to utilize the IAEA safety standards as broadly and effectively as possible.

This review covered, among other topics, the regulatory structure, emergency preparedness and response, and nuclear safety and engineering aspects (site selection and evaluation, assessment of extreme natural hazards, including their combined effects, management of severe accidents, station blackout, loss of heat sink, accumulation of explosive gases, the behaviour of nuclear fuel and the safety of spent fuel storage).

In 2011, the Secretariat commenced such a review of Safety Requirements publications in the IAEA Safety Standards Series on the basis of information that was available on the Fukushima Daiichi accident, including two reports from the Government of Japan, issued in June 2011 and September 2011, the report of the IAEA International Fact Finding Expert Mission conducted in Japan from 24 May to 2 June 2011, and a letter from the Chair of the International Nuclear Safety Group (INSAG) to the Director General dated 26 July 2011. As a priority, the Secretariat reviewed the Safety Requirements publications applicable to nuclear power plants and to the storage of spent fuel.

The review consisted first of a comprehensive analysis of the findings of these reports. In the light of the results of this analysis, the Safety Requirements publications were then examined in a systematic manner in order to decide whether amendments were desirable to reflect any of these findings.

On that basis, the CSS approved, at its meeting in October 2012, a proposal for a revision process by amendment for the following five Safety Requirements publications: Governmental, Legal and Regulatory Framework for Safety (IAEA Safety Standards Series No. GSR Part 1, 2010); Safety Assessment for Facilities and Activities (GSR Part 4, 2009); Safety of Nuclear Power

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[1] For further information, see INTERNATIONAL ATOMIC ENERGY AGENCY, The Fukushima Daiichi Accident: Report by the Director General, IAEA, Vienna (2015).

Plants: Design (SSR-2/1, 2012); Safety of Nuclear Power Plants: Commissioning and Operation (SSR-2/2, 2011); and Site Evaluation for Nuclear Installations (NS-R-3, 2003).

Additional inputs were considered in preparing the draft text of the proposed amendments to these five safety standards in 2012 and 2013, including the findings of the IAEA International Experts Meetings and presentations made at the Second Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety, in August 2012. Several national and regional reports were also considered.

On the review of the Safety Requirements, the Commission's conclusion, reflected in a letter from the CSS Chair to the Director General dated 6 January 2014, was that:

> "the review has confirmed so far the adequacy of the current Safety Requirements. The review revealed no significant areas of weakness, and just a small set of amendments were proposed to strengthen the requirements and facilitate their implementation. The CSS believes that the IAEA Safety Standards should be enhanced mainly through the well-established review and revision process that has been in use for some years. At the same time, CSS members highlighted that the basis for the review and revision of the IAEA Safety Standards should not be limited to the lessons of the Fukushima Daiichi accident. This basis should also include other operating experience from elsewhere as well as information gained from advances in research and development. The CSS also stressed that greater attention needs to be paid to the implementation of IAEA safety standards by and in Member States."

The draft amendments were reviewed by the Secretariat in consultants meetings, as well as by the Nuclear Safety Standards Committee, the Radiation Safety Standards Committee, the Transport Safety Standards Committee and the Waste Safety Standards Committee, in the first half of 2013. They were also presented for information to the Nuclear Security Guidance Committee in 2013. The draft amendments were then submitted to IAEA Member States for comment and revised in consultants meetings in the light of comments received. The proposed amendments were then approved by all four Safety Standards Committees at their meetings in June and July 2014, and were endorsed by the CSS at its meeting in November 2014.

The revisions to NS-R-3 relate to the following main areas:

— The potential occurrence of events in combination;
— Establishing levels of hazard for the design basis for the installation and their associated uncertainties;
— Multiple facilities at a single site;
— Monitoring of hazards and periodic review of site specific hazards.

Amendments have been made to specific paragraphs, as outlined below. New paragraphs have been added; these are indicated by means of an uppercase letter (A, B, …). In addition, where a paragraph has been deleted, this is indicated in the text.

The following requirements and paragraphs have been amended or added in this revised edition: 1.9, 2.2, 2.5, 2.5A, 2.7, 2.13A, 3.6, 3.21, 3.51 and 5.1A. Some modifications of an editorial nature have also been made.

A table of changes made is available upon request to the IAEA (Safety.Standards@iaea.org).

The Board, at its meeting starting on 2 March 2015, established as an IAEA safety standard — in accordance with Article III.A.6 of the Statute of the IAEA — the draft of this revised Safety Requirements publication, and authorized the Director General to promulgate these revised safety requirements and to issue them as a Safety Requirements publication in the IAEA Safety Standards Series.

The 59th IAEA General Conference, in September 2015, encouraged Member States to implement measures nationally, regionally and internationally to ensure nuclear, radiation, transport and waste safety, as well as emergency preparedness, taking full account of IAEA safety standards; requested the IAEA to continuously review, strengthen and implement as broadly and effectively as possible the IAEA safety standards; and supported the CSS and the Safety Standards Committees in their review of the relevant safety standards in the light of the Fukushima Daiichi accident, as well as the lessons identified in the IAEA report on the Fukushima Daiichi accident[1].

The General Conference requested the Secretariat:

> “to continue its close cooperation with the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the International Commission on Radiological Protection (ICRP) and other relevant organizations in the development of safety standards, including, but not limited to, the protection of the environment”.

The 59th IAEA General Conference also encouraged Member States to use the IAEA safety standards in their national regulatory programmes, as appropriate, and noted the need to consider the periodic review of national regulations and guidance against internationally established standards and guidance, and to report on progress in appropriate international forums such as review meetings under the terms of the relevant safety conventions.

The General Conference further encouraged Member States to ensure regular self-assessments of their domestic nuclear, radiation, transport and waste safety, as well as emergency preparedness, using the IAEA self-assessment tools and taking into account relevant IAEA safety standards.

THE IAEA SAFETY STANDARDS

BACKGROUND

Radioactivity is a natural phenomenon and natural sources of radiation are features of the environment. Radiation and radioactive substances have many beneficial applications, ranging from power generation to uses in medicine, industry and agriculture. The radiation risks to workers and the public and to the environment that may arise from these applications have to be assessed and, if necessary, controlled.

Activities such as the medical uses of radiation, the operation of nuclear installations, the production, transport and use of radioactive material, and the management of radioactive waste must therefore be subject to standards of safety.

Regulating safety is a national responsibility. However, radiation risks may transcend national borders, and international cooperation serves to promote and enhance safety globally by exchanging experience and by improving capabilities to control hazards, to prevent accidents, to respond to emergencies and to mitigate any harmful consequences.

States have an obligation of diligence and duty of care, and are expected to fulfil their national and international undertakings and obligations.

International safety standards provide support for States in meeting their obligations under general principles of international law, such as those relating to environmental protection. International safety standards also promote and assure confidence in safety and facilitate international commerce and trade.

A global nuclear safety regime is in place and is being continuously improved. IAEA safety standards, which support the implementation of binding international instruments and national safety infrastructures, are a cornerstone of this global regime. The IAEA safety standards constitute a useful tool for contracting parties to assess their performance under these international conventions.

THE IAEA SAFETY STANDARDS

The status of the IAEA safety standards derives from the IAEA's Statute, which authorizes the IAEA to establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property, and to provide for their application.

With a view to ensuring the protection of people and the environment from harmful effects of ionizing radiation, the IAEA safety standards establish fundamental safety principles, requirements and measures to control the radiation exposure of people and the release of radioactive material to the environment, to restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation, and to mitigate the consequences of such events if they were to occur. The standards apply to facilities and activities that give rise to radiation risks, including nuclear installations, the use of radiation and radioactive sources, the transport of radioactive material and the management of radioactive waste.

Safety measures and security measures[1] have in common the aim of protecting human life and health and the environment. Safety measures and security measures must be designed and implemented in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security.

The IAEA safety standards reflect an international consensus on what constitutes a high level of safety for protecting people and the environment from harmful effects of ionizing radiation. They are issued in the IAEA Safety Standards Series, which has three categories (see Fig. 1).

Safety Fundamentals

Safety Fundamentals present the fundamental safety objective and principles of protection and safety, and provide the basis for the safety requirements.

Safety Requirements

An integrated and consistent set of Safety Requirements establishes the requirements that must be met to ensure the protection of people and the environment, both now and in the future. The requirements are governed by the objective and principles of the Safety Fundamentals. If the requirements are not met, measures must be taken to reach or restore the required level of safety. The format and style of the requirements facilitate their use for the establishment, in a harmonized manner, of a national regulatory framework. Requirements, including numbered 'overarching' requirements, are expressed as 'shall' statements. Many requirements are not addressed to a specific party, the implication being that the appropriate parties are responsible for fulfilling them.

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[1] See also publications issued in the IAEA Nuclear Security Series.

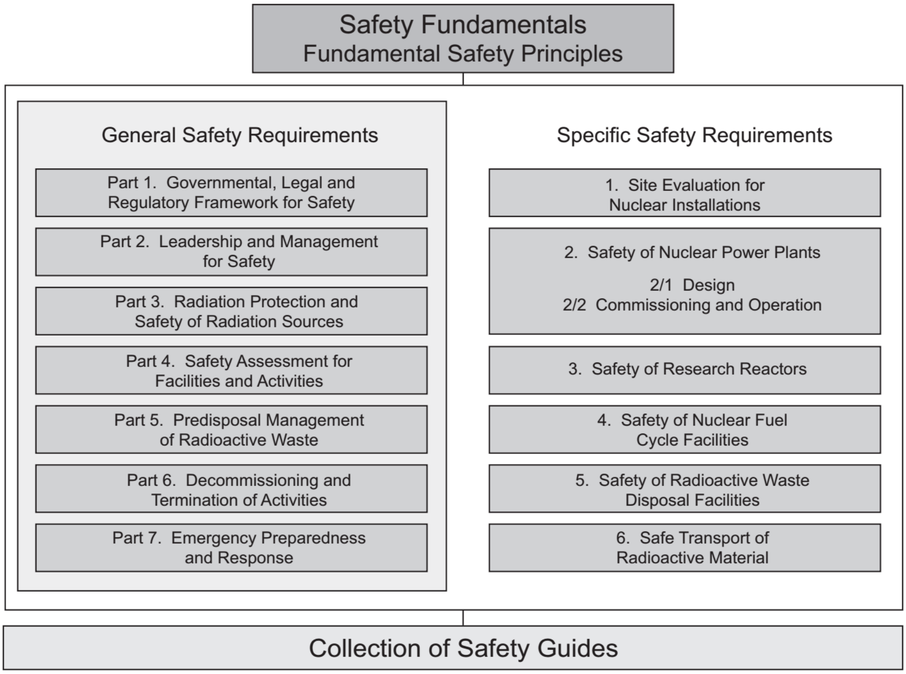

FIG. 1. The long term structure of the IAEA Safety Standards Series.

Safety Guides

Safety Guides provide recommendations and guidance on how to comply with the safety requirements, indicating an international consensus that it is necessary to take the measures recommended (or equivalent alternative measures). The Safety Guides present international good practices, and increasingly they reflect best practices, to help users striving to achieve high levels of safety. The recommendations provided in Safety Guides are expressed as 'should' statements.

APPLICATION OF THE IAEA SAFETY STANDARDS

The principal users of safety standards in IAEA Member States are regulatory bodies and other relevant national authorities. The IAEA safety standards are also used by co-sponsoring organizations and by many organizations that design, construct and operate nuclear facilities, as well as organizations involved in the use of radiation and radioactive sources.

The IAEA safety standards are applicable, as relevant, throughout the entire lifetime of all facilities and activities — existing and new — utilized for peaceful purposes and to protective actions to reduce existing radiation risks. They can be used by States as a reference for their national regulations in respect of facilities and activities.

The IAEA's Statute makes the safety standards binding on the IAEA in relation to its own operations and also on States in relation to IAEA assisted operations.

The IAEA safety standards also form the basis for the IAEA's safety review services, and they are used by the IAEA in support of competence building, including the development of educational curricula and training courses.

International conventions contain requirements similar to those in the IAEA safety standards and make them binding on contracting parties. The IAEA safety standards, supplemented by international conventions, industry standards and detailed national requirements, establish a consistent basis for protecting people and the environment. There will also be some special aspects of safety that need to be assessed at the national level. For example, many of the IAEA safety standards, in particular those addressing aspects of safety in planning or design, are intended to apply primarily to new facilities and activities. The requirements established in the IAEA safety standards might not be fully met at some existing facilities that were built to earlier standards. The way in which IAEA safety standards are to be applied to such facilities is a decision for individual States.

The scientific considerations underlying the IAEA safety standards provide an objective basis for decisions concerning safety; however, decision makers must also make informed judgements and must determine how best to balance the benefits of an action or an activity against the associated radiation risks and any other detrimental impacts to which it gives rise.

DEVELOPMENT PROCESS FOR THE IAEA SAFETY STANDARDS

The preparation and review of the safety standards involves the IAEA Secretariat and four safety standards committees, for nuclear safety (NUSSC), radiation safety (RASSC), the safety of radioactive waste (WASSC) and the safe transport of radioactive material (TRANSSC), and a Commission on Safety Standards (CSS) which oversees the IAEA safety standards programme (see Fig. 2).

All IAEA Member States may nominate experts for the safety standards committees and may provide comments on draft standards. The membership of the Commission on Safety Standards is appointed by the Director General and

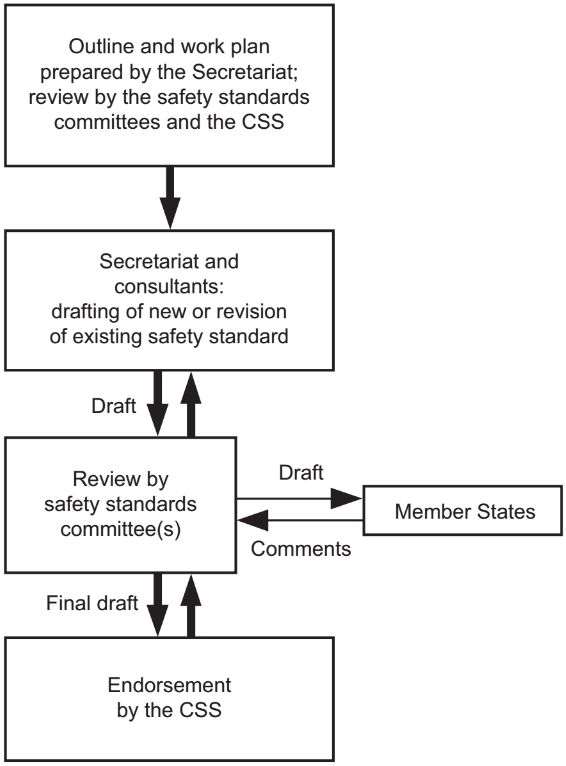

FIG. 2. The process for developing a new safety standard or revising an existing standard.

the Commission on Safety Standards is appointed by the Director General and includes senior governmental officials having responsibility for establishing national standards.

A management system has been established for the processes of planning, developing, reviewing, revising and establishing the IAEA safety standards. It articulates the mandate of the IAEA, the vision for the future application of the safety standards, policies and strategies, and corresponding functions and responsibilities.

INTERACTION WITH OTHER INTERNATIONAL ORGANIZATIONS

The findings of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the recommendations of international expert bodies, notably the International Commission on Radiological Protection

(ICRP), are taken into account in developing the IAEA safety standards. Some safety standards are developed in cooperation with other bodies in the United Nations system or other specialized agencies, including the Food and Agriculture Organization of the United Nations, the United Nations Environment Programme, the International Labour Organization, the OECD Nuclear Energy Agency, the Pan American Health Organization and the World Health Organization.

INTERPRETATION OF THE TEXT

Safety related terms are to be understood as defined in the IAEA Safety Glossary (see http://www-ns.iaea.org/standards/safety-glossary.htm). Otherwise, words are used with the spellings and meanings assigned to them in the latest edition of The Concise Oxford Dictionary. For Safety Guides, the English version of the text is the authoritative version.

The background and context of each standard in the IAEA Safety Standards Series and its objective, scope and structure are explained in Section 1, Introduction, of each publication.

Material for which there is no appropriate place in the body text (e.g. material that is subsidiary to or separate from the body text, is included in support of statements in the body text, or describes methods of calculation, procedures or limits and conditions) may be presented in appendices or annexes.

An appendix, if included, is considered to form an integral part of the safety standard. Material in an appendix has the same status as the body text, and the IAEA assumes authorship of it. Annexes and footnotes to the main text, if included, are used to provide practical examples or additional information or explanation. Annexes and footnotes are not integral parts of the main text. Annex material published by the IAEA is not necessarily issued under its authorship; material under other authorship may be presented in annexes to the safety standards. Extraneous material presented in annexes is excerpted and adapted as necessary to be generally useful.

CONTENTS

1. INTRODUCTION

BACKGROUND

1.1. This Safety Requirements publication supersedes the edition of Site Evaluation for Nuclear Installations that was issued in 2003 as IAEA Safety Standards Series No. NS-R-3[1]. NS-R-3 took account of developments relating to site evaluations for nuclear installations since the Code on Siting was issued in 1988 as Safety Series No. 50-C-S (Rev. 1)[2]. It applies the Safety Fundamentals publication SF-1 on Fundamental Safety Principles [1]. Requirements for site evaluation are intended to ensure adequate protection of site personnel and the public and protection of the environment from harmful effects of ionizing radiation that could arise from nuclear installations. It is recognized that there are steady advances in technology and scientific knowledge in the area of nuclear safety and in what is considered adequate protection. Safety requirements change with these advances and this publication reflects the present consensus among States.

1.2. This Safety Requirements publication establishes requirements and provides criteria for ensuring safety in site evaluation for nuclear installations. The Safety Guides on site evaluation listed in the references provide recommendations on how to meet the requirements established in this Safety Requirements publication.

OBJECTIVE

1.3. The objective of this publication is to establish the requirements for the elements of a site evaluation for a nuclear installation so as to characterize fully the site specific conditions pertinent to the safety of the nuclear installation.

1.4. The purpose is to establish requirements for criteria, to be applied as appropriate to site and site–installation interactions in operational states and

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[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. NS-R-3, IAEA, Vienna (2003).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Code on the Safety of Nuclear Power Plants: Siting, Safety Series No. 50-C-S (Rev. 1), IAEA, Vienna (1988).

accident conditions, including those interactions that could lead to conditions that warrant emergency response actions, for:

(a) Defining the extent of information on a proposed site to be presented by the applicant;
(b) Evaluating a proposed site to ensure that the site related phenomena and characteristics are adequately taken into account;
(c) Analysing the characteristics of the population of the region and the capability of implementing emergency plans over the projected lifetime of the installation;
(d) Defining site related hazards.

1.5. This publication does not specifically address underground or offshore installations.

SCOPE

1.6. The scope of this publication encompasses site related factors and site–installation interaction factors relating to operational states and accident conditions, including those that could warrant emergency response actions, and natural and human induced events external to the installation that are important to safety. The external human induced events considered in this Safety Requirements publication are all of accidental origin. Considerations relating to the physical protection of the installation against wilful actions by third parties are outside its scope.

1.7. The phrase ‘external to the installation’ is intended to include more than the external zone [2]. In addition to the area immediately surrounding the site, the site area itself could contain objects that pose a hazard to the installation, such as an oil storage tank for diesel generators or another reactor on a multiunit site.

1.8. The siting process for a nuclear installation generally consists of an investigation of a large region to select one or more candidate sites (site survey)[3], followed by a detailed evaluation of those candidate sites. This publication is primarily concerned with the latter stage.

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[3] Site survey is the process that is used to identify preferred candidate sites for nuclear installations on the basis of safety and other considerations.

1.9. Previous safety standards on this subject related to land based, stationary thermal neutron power plants. This Safety Requirements publication covers a more comprehensive range of nuclear installations, with the use of a graded approach on the basis of the radiation risks that they pose to people and the environment. In some instances in this publication a requirement is stated to apply to nuclear power plants. In these cases, the requirements are most appropriate for nuclear power plants, but they may also apply to other nuclear installations.

1.10. The level of detail needed in an evaluation to meet the requirements established in this publication will vary according to the type of installation being sited. Nuclear power plants will generally require the highest level of detail. Depending on the level of risks posed by the installation, less detail and smaller areas of coverage may be sufficient to comply with the requirements established in this publication.

1.11. This publication is concerned with the evaluation of those site related factors that have to be taken into account to ensure that the site–installation combination does not constitute an unacceptable risk to individuals, the population or the environment over the lifetime of the installation. Evaluation of the non-radiological impacts of a nuclear installation is not considered here.

1.12. As used in this publication, the term ‘risk’ refers to the product derived from the multiplication of the probability of a particular event that results in the release of radioactive material by a parameter corresponding to the radiological consequences of this event. In concept, a comprehensive risk analysis includes all the sequential steps of analysing all the initiating events, following for each initiating event all the possible sequences of subsequent events, associating a probability value with each of these sequences and finally assessing the consequences for individuals, the population and the environment. In some States, it is an established practice to utilize parts of such a risk analysis and to define probabilistic requirements to supplement traditional deterministic analysis and engineering judgement.

1.13. This publication is concerned mainly with severe events of low probability that relate to the siting of nuclear installations and that have to be considered in designing a particular nuclear installation. If events of lesser severity but with higher probabilities of occurrence make a significant contribution to the overall risk, they are also to be considered in the design of the nuclear installation.

1.14. The scope of the investigation for the site of a nuclear installation covers the entire process of the site evaluation — the selection, assessment, pre-operational and operational stages. The requirements established in this publication do not apply to the site selection stage, for which a different series of criteria may be used. These may include criteria that have little direct relevance to safety, such as the distance to the planned consumers of the power to be generated.

STRUCTURE

1.15. This Safety Requirements publication follows the relationship between safety principles and the safety objective [1], and establishes safety requirements and criteria. Section 2 provides the general safety criteria for site related evaluation of external natural and human induced hazards to the nuclear installation. It also establishes requirements relating to the effects of the installation on the region and matters relating to population and emergency planning. Section 3 establishes specific requirements for the characterization of hazards for natural and human induced events. Section 4 establishes specific requirements for site related evaluation of the effects of the installation on the regional environment — the atmosphere, the hydrosphere and the biosphere — and on the population. Section 5 establishes requirements for continuous monitoring of natural and human induced hazards throughout the lifetime of the installation. Section 6 establishes requirements for a quality assurance programme for site evaluation.

2. GENERAL REQUIREMENTS

OBJECTIVE

2.1. The main objective in site evaluation for nuclear installations in terms of nuclear safety is to protect the public and the environment from radiological consequences of radioactive releases due to accidents. Radioactive releases due to normal operation (i.e. discharges) shall also be considered. In the evaluation of the suitability of a site for a nuclear installation, the following aspects shall be considered:

(a) The effects of external events occurring in the region of the particular site (the external events could be of natural origin or human induced);

(b) The characteristics of the site and its environment that could influence the transfer to persons and to the environment of radioactive material that has been released;
(c) The population density and population distribution and other characteristics of the external zone in so far as they could affect the possibility of implementing emergency response actions and the need to evaluate the risks to individuals and to the population.

2.2. If the site evaluation for the three aspects cited indicates or if subsequent reviews indicate that the site is unacceptable and the deficiencies cannot be compensated for by design features, measures for site protection or administrative procedures, the site shall be deemed unsuitable.

USES FOR SITE EVALUATION

2.3. In addition to providing the technical basis for the safety analysis report to be submitted to the regulatory body, the technical information obtained for use in complying with these safety requirements will also be useful in fulfilling the requirements for the environmental impact assessment for radiological hazards.

GENERAL CRITERIA

2.4. Site characteristics that could affect the safety of the nuclear installation shall be investigated and assessed. Characteristics of the natural environment in the region that might be affected by potential radiological impacts in operational states and in accident conditions shall be investigated. All these characteristics shall be observed and monitored throughout the lifetime of the installation.

2.5. Proposed sites for a nuclear installation shall be evaluated with regard to the frequency and severity of external natural and human induced events, and potential combinations of such events, that could affect the safety of the installation.

2.5A. Information on frequency and severity derived from the characterization of the hazards resulting from external events shall be used in establishing the design basis hazard level for the nuclear installation. Account shall be taken of uncertainties in the design basis hazard level.

2.6. The foreseeable evolution of natural and human-made factors in the region that could have a bearing on safety shall be evaluated for a time period that encompasses the projected lifetime of the nuclear installation. These factors, and in particular population growth and population distribution, shall be monitored over the lifetime of the nuclear installation. If necessary, appropriate measures shall be taken to ensure that the overall risk remains acceptably low. There are three means available to ensure that risks are acceptably low: design features, measures for site protection (e.g. dykes for flood control) and administrative procedures. Design features and protective measures are the preferred means of ensuring that risks are kept acceptably low.

2.7. The hazards associated with external events that are to be considered in the design of the nuclear installation and in its safety assessment shall be determined. For an external event (or a combination of events) the parameters and the values of those parameters that are used to characterize the hazards shall be chosen so that they can be used easily in the design of the installation and in its safety assessment.

2.8. In the derivation of the hazards associated with external events, consideration shall be given to the effects of the combination of these hazards with the ambient conditions (e.g. hydrological, hydrogeological and meteorological conditions).

2.9. In the analysis to determine the suitability of the site, consideration shall be given to additional matters relating to safety, such as the storage and transport of input and output materials (uranium ore, UF_6, UO_2, etc.), fresh fuel and spent fuel and radioactive waste.

2.10. The possible non-radiological impact of the installation, due to chemical or thermal releases, and the potential for explosion and the dispersion of chemical products shall be taken into account in the site evaluation process.

2.11. The potential for interactions between radioactive and non-radioactive effluents, such as interactions due to the combination of heat or chemicals with radioactive material in liquid effluents, shall be considered.

2.12. For each proposed site the potential radiological impacts in operational states and in accident conditions on people in the region, including impacts that could warrant emergency response actions, shall be evaluated with due consideration of relevant factors, including population distribution, dietary habits, uses of land and water, and the radiological impacts of any other releases of radioactive material in the region.

2.13. For nuclear power plants, the total nuclear capacity to be installed on the site shall be determined as far as possible at the first stages of the siting process. If it is proposed that the installed nuclear capacity be significantly increased to a level greater than that previously determined to be acceptable, the suitability of the site shall be re-evaluated.

2.13A. An assessment shall be made of the feasibility of implementation of emergency plans. All on-site and collocated installations shall be considered in the assessment, with special emphasis on nuclear installations that could concurrently experience accidents.

CRITERIA FOR HAZARDS ASSOCIATED WITH EXTERNAL NATURAL AND HUMAN INDUCED EVENTS

2.14. Proposed sites shall be adequately investigated with regard to all the site characteristics that could be significant to safety in external natural and human induced events.

2.15. Possible natural phenomena and human induced situations and activities in the region of a proposed site shall be identified and evaluated according to their significance for the safe operation of the nuclear installation. This evaluation shall be used to identify the important natural phenomena or human induced situations and activities in association with which potential hazards are to be investigated.

2.16. Foreseeable significant changes in land use shall be considered, such as the expansion of existing installations and human activities or the construction of high risk installations.

2.17. Prehistoric, historical and instrumentally recorded information and records, as applicable, of the occurrences and severity of important natural phenomena or of human induced situations and activities shall be collected for the region and shall be carefully analysed for reliability, accuracy and completeness.

2.18. Appropriate methods shall be adopted for establishing the hazards associated with major external phenomena. The methods shall be justified in terms of being up to date and compatible with the characteristics of the region. Special consideration shall be given to applicable probabilistic methodologies. It should be noted that probabilistic hazard curves are generally needed to conduct probabilistic safety assessments for external events.

2.19. The size of the region to which a method for establishing the hazards associated with major external phenomena is to be applied shall be large enough to include all the features and areas that could be of significance for the determination of the natural and human induced phenomena under consideration and for the characteristics of the event.

2.20. Major natural and human induced phenomena shall be expressed in terms that can be used as input for deriving the hazards associated with the nuclear installation; that is, appropriate parameters for describing the hazard shall be selected or developed.

2.21. In the determination of hazards, site specific data shall be used, unless such data are unobtainable. In this case, data from other regions that are sufficiently relevant to the region of interest may be used in the determination of hazards. Appropriate and acceptable simulation techniques may also be used. In general, data obtained for similar regions and simulation techniques could be used to augment the site specific data.

CRITERIA FOR DETERMINING THE POTENTIAL EFFECTS OF THE NUCLEAR INSTALLATION IN THE REGION

2.22. In the evaluation of a site to determine its potential radiological impacts on the region for operational states and accident conditions that could warrant emergency response actions, appropriate estimates shall be made of expected or potential releases of radioactive material, with account taken of the design of the installation and its safety features. These estimates shall be confirmed when the design and its safety features have been confirmed.

2.23. The direct and indirect pathways by which radioactive material released from the nuclear installation could potentially reach and affect people and the environment shall be identified and evaluated. In such an evaluation, specific regional and site characteristics shall be taken into account, with special attention paid to the function of the biosphere in the accumulation and transport of radionuclides.

2.24. The site and the design for the nuclear installation shall be examined in conjunction to ensure that the radiation risks to the public and to the environment associated with radioactive releases are acceptably low.

2.25. The design of the installation shall be such as to compensate for any unacceptable potential effects of the nuclear installation in the region, or otherwise the site shall be deemed unsuitable.

CRITERIA DERIVED FROM CONSIDERATIONS OF POPULATION AND EMERGENCY PLANNING

2.26. The proposed region shall be studied to evaluate the present and foreseeable future characteristics and the distribution of the population of the region. Such a study shall include an evaluation of present and future uses of land and water in the region and account shall be taken of any special characteristics that could affect the potential consequences of radioactive releases for individuals and the population as a whole.

2.27. In relation to the characteristics and distribution of the population, the combined effects of the site and the installation shall be such that:

(a) For operational states of the installation the exposure of the population remains as low as reasonably achievable and in any case is in compliance with national requirements, with account taken of international recommendations;
(b) The radiation risks to the population associated with accident conditions, including those that could warrant emergency response actions being taken, are acceptably low.

2.28. If, after thorough evaluation, it is shown that no appropriate measures can be developed to meet the above mentioned requirements, the site shall be deemed unsuitable for the location of a nuclear installation of the type proposed.

2.29. The external zone for a proposed site shall be established with account taken of the potential for radiological consequences for people and the feasibility of implementing emergency plans, and of any external events or phenomena that might hinder their implementation. Before construction of the nuclear installation is started, it shall be confirmed that there will be no insurmountable difficulties in establishing an emergency plan for the external zone before the start of operation of the installation.

3. SPECIFIC REQUIREMENTS FOR EVALUATION OF EXTERNAL EVENTS

EARTHQUAKES AND SURFACE FAULTING

Earthquakes

3.1. The seismological and geological conditions in the region and the engineering geological aspects and geotechnical aspects of the proposed site area shall be evaluated (see Refs [3, 4]).

3.2. Information on prehistoric, historical and instrumentally recorded earthquakes in the region shall be collected and documented.

3.3. The hazards associated with earthquakes shall be determined by means of a seismotectonic evaluation of the region with the greatest possible use of the information collected.

3.4. Hazards due to earthquake induced ground motion shall be assessed for the site with account taken of the seismotectonic characteristics of the region and specific site conditions. A thorough uncertainty analysis shall be performed as part of the evaluation of seismic hazards.

Surface faulting

3.5. The potential for surface faulting (i.e. the fault capability) shall be assessed for the site. The methods to be used and the investigations to be undertaken shall be sufficiently detailed that a reasonable decision can be reached using the definition of fault capability given in para. 3.6.

3.6. A fault shall be considered capable if, on the basis of geological, geophysical, geodetic or seismological data (including palaeoseismological and geomorphological data), one or more of the following conditions applies:

(a) It shows evidence of past movement or movements (significant deformations and/or dislocations) of a recurring nature within such a period that it is reasonable to infer that further movements at or near the surface could occur. In highly active areas, where both earthquake data and geological data consistently reveal short earthquake recurrence intervals, periods of the order of tens of thousands of years may be appropriate for the assessment of capable faults. In less active areas, it is likely that much longer periods will be required.

(b) A structural relationship with a known capable fault has been demonstrated such that movement of one could cause movement of the other at or near the surface.

(c) The maximum potential earthquake associated with a seismogenic structure is sufficiently large and at such a depth that it is reasonable to infer that, in the geodynamic setting of the site, movement at or near the surface could occur.

3.7. Where reliable evidence shows the existence of a capable fault that has the potential to affect the safety of the nuclear installation, an alternative site shall be considered.

METEOROLOGICAL EVENTS

3.8. The extreme values of meteorological variables and rare meteorological phenomena listed below shall be investigated for the site of any installation. The meteorological and climatological characteristics for the region around the site shall be investigated (see Ref. [5]).

Extreme values of meteorological phenomena

3.9. In order to evaluate their possible extreme values, the following meteorological phenomena shall be documented for an appropriate period of time: wind, precipitation, snow, temperature and storm surges.

3.10. The output of the site evaluation shall be described in a way that is suitable for design purposes for the nuclear installation, such as the probability of exceedance values relevant to design parameters. Uncertainties in the data shall be taken into account in this evaluation.

Rare meteorological events

Lightning

3.11. The potential for the occurrence and the frequency and severity of lightning shall be evaluated for the site.

Tornadoes

3.12. The potential for the occurrence of tornadoes in the region of interest shall be assessed on the basis of detailed historical and instrumentally recorded data for the region.

3.13. The hazards associated with tornadoes shall be derived and expressed in terms of parameters such as rotational wind speed, translational wind speed, radius of maximum rotational wind speed, pressure differentials and rate of change of pressure.

3.14. In the assessment of the hazards, missiles that could be associated with tornadoes shall be considered.

Tropical cyclones

3.15. The potential for tropical cyclones in the region of the site shall be evaluated. If this evaluation shows that there is evidence of tropical cyclones or a potential for tropical cyclones, related data shall be collected.

3.16. On the basis of the available data and the appropriate physical models, the hazards associated with tropical cyclones shall be determined in relation to the site. Hazards for tropical cyclones include factors such as extreme wind speed, pressure and precipitation.

3.17. In the assessment of the hazards, missiles that could be associated with tropical cyclones shall be considered.

FLOODING

Floods due to precipitation and other causes

3.18. The region shall be assessed to determine the potential for flooding due to one or more natural causes, such as runoff resulting from precipitation or snowmelt, high tide, storm surge, seiche and wind waves, that could affect the safety of the nuclear installation (see Ref. [5]). If there is a potential for flooding, then all pertinent data, including historical data, both meteorological and hydrological, shall be collected and critically examined.

3.19. A suitable meteorological and hydrological model shall be developed with account taken of the limits on the accuracy and quantity of the data, the length of the historical period over which the data were accumulated, and all known past changes in relevant characteristics of the region.

3.20. The possible combinations of the effects of several causes shall be examined. For example, for coastal sites and sites on estuaries, the potential for flooding by a combination of high tide, wind effects on bodies of water and wave actions, such as those due to cyclones, shall be assessed and taken into account in the hazard model.

3.21. The hazards for the site due to flooding shall be derived by the use of appropriate models.

3.22. The parameters used to characterize the hazards due to flooding shall include the height of the water, the height and period of the waves (if relevant), the warning time for the flood, the duration of the flood and the flow conditions.

3.23. The potential for instability of the coastal area or river channel due to erosion or sedimentation shall be investigated.

Water waves induced by earthquakes or other geological phenomena

3.24. The region shall be evaluated to determine the potential for tsunamis or seiches that could affect the safety of a nuclear installation on the site.

3.25. If there is found to be such a potential, prehistoric and historical data relating to tsunamis or seiches affecting the shore region around the site shall be collected and critically evaluated for their relevance to the evaluation of the site and their reliability.

3.26. On the basis of the available prehistoric and historical data for the region and comparisons with similar regions that have been well studied with regard to these phenomena, the frequency of occurrence, magnitude and height of regional tsunamis or seiches shall be estimated and shall be used in determining the hazards associated with tsunamis or seiches, with account taken of any amplification due to the coastal configuration at the site.

3.27. The potential for tsunamis or seiches to be generated by regional offshore seismic events shall be evaluated on the basis of known seismic records and seismotectonic characteristics.

3.28. The hazards associated with tsunamis or seiches shall be derived from known seismic records and seismotectonic characteristics as well as from physical and/or analytical modelling. These include potential draw-down and run-up[4] that could result in physical effects on the site.

Floods and waves caused by failure of water control structures

3.29. Information relating to upstream water control structures shall be analysed to determine whether the nuclear installation would be able to withstand the effects resulting from the failure of one or more of the upstream structures.

3.30. If the nuclear installation could safely withstand all the effects of the massive failure of one or more of the upstream structures, then the structures need be examined no further in this regard.

3.31. If a preliminary examination of the nuclear installation indicates that it might not be able to withstand safely all the effects of the massive failure of one or more of the upstream structures, then the hazards associated with the nuclear installation shall be assessed with the inclusion of all such effects; otherwise such upstream structures shall be analysed by methods equivalent to those used in determining the hazards associated with the nuclear installation to show that the upstream structures could survive the event concerned.

3.32. The possibility of storage of water as a result of a temporary blockage of rivers upstream or downstream (e.g. caused by landslides or ice) so as to cause flooding and associated phenomena at the proposed site shall be examined.

GEOTECHNICAL HAZARDS

Slope instability

3.33. The site and its vicinity shall be evaluated to determine the potential for slope instability (such as landslides, rockslides and snow avalanches) that could affect the safety of the nuclear installation (see Ref. [3]).

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[4] Draw-down is a falling of the water level at a coastal site. Run-up is a sudden surge of water up a beach or a structure.

3.34. If there is found to be a potential for slope instability that could affect the safety of the nuclear installation, the hazard shall be evaluated by using parameters and values for the site specific ground motion.

Collapse, subsidence or uplift of the site surface

3.35. Geological maps and other appropriate information for the region shall be examined for the existence of natural features such as caverns and karstic formations and human-made features such as mines, water wells and oil wells. The potential for collapse, subsidence or uplift of the site surface shall be evaluated.

3.36. If the evaluation shows that there is a potential for collapse, subsidence or uplift of the surface that could affect the safety of the nuclear installation, practicable engineering solutions shall be provided or otherwise the site shall be deemed unsuitable.

3.37. If there do seem to be practicable engineering solutions available, a detailed description of sub-surface conditions obtained by reliable methods of investigation shall be developed for the purposes of determination of the hazards.

Soil liquefaction

3.38. The potential for liquefaction of the sub-surface materials of the proposed site shall be evaluated by using parameters and values for the site specific ground motion.

3.39. The evaluation shall include the use of accepted methods of soil investigation and analytical methods to determine the hazards.

3.40. If the potential for soil liquefaction is found to be unacceptable, the site shall be deemed unsuitable unless practicable engineering solutions are demonstrated to be available.

Behaviour of foundation materials

3.41. The geotechnical characteristics of the sub-surface materials, including the uncertainties in them, shall be investigated and a soil profile for the site in a form suitable for design purposes shall be determined.

3.42. The stability of the foundation material under static and seismic loading shall be assessed.

3.43. The groundwater regime and the chemical properties of the groundwater shall be studied.

EXTERNAL HUMAN INDUCED EVENTS

Aircraft crashes

3.44. The potential for aircraft crashes on the site shall be assessed with account taken, to the extent practicable, of characteristics of future air traffic and aircraft (see Ref. [6]).[5]

3.45. If the assessment shows that there is a potential for an aircraft crash on the site that could affect the safety of the installation, then an assessment of the hazards shall be made.

3.46. The hazards associated with an aircraft crash that are to be considered shall include impact, fire and explosions.

3.47. If the assessment indicates that the hazards are unacceptable and if no practicable solutions are available, then the site shall be deemed unsuitable.

Chemical explosions

3.48. Activities in the region that involve the handling, processing, transport and storage of chemicals having a potential for explosions or for the production of gas clouds capable of deflagration or detonation shall be identified.

3.49. Hazards associated with chemical explosions shall be expressed in terms of overpressure and toxicity (if applicable), with account taken of the effect of distance.

3.50. A site shall be considered unsuitable if such activities take place in its vicinity and there are no practicable solutions available.

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[5] Wilful actions that could potentially affect the site area are excluded from consideration here.

Other important human induced events

3.51. The region shall be investigated for installations (including collocated units of nuclear power plants and installations within the site boundary) in which flammable, explosive, asphyxiant, toxic, corrosive or radioactive materials are stored, processed, transported and otherwise dealt with that, if released under normal conditions or accident conditions, could jeopardize the safety of the nuclear installation. This investigation shall also include installations that could give rise to missiles of any type that could affect the safety of the nuclear installation. The potential effects of electromagnetic interference, eddy currents in the ground and the clogging of air or water inlets by debris shall also be evaluated. If the effects of such phenomena and occurrences would produce an unacceptable hazard and if no practicable solution is available, the site shall be deemed unsuitable.

OTHER IMPORTANT CONSIDERATIONS

3.52. Historical data concerning phenomena that have the potential to give rise to adverse effects on the safety of the nuclear installation, such as volcanism, sand storms, severe precipitation, snow, ice, hail, and sub-surface freezing of subcooled water (frazil), shall be collected and assessed (see Refs [7, 8]). If the potential is confirmed, the hazard shall be assessed and design bases for these events shall be derived.

3.53. In the design of systems for long term heat removal from the core, site related parameters such as the following shall be considered:

(a) Air temperatures and humidity;
(b) Water temperatures;
(c) Available flow of water, minimum water level and the period of time for which safety related sources of cooling water are at a minimum level, with account taken of the potential for failure of water control structures.

3.54. Potential natural and human induced events that could cause a loss of function of systems required for the long term removal of heat from the core shall be identified, such as the blockage or diversion of a river, the depletion of a reservoir, an excessive amount of marine organisms, the blockage of a reservoir or cooling tower by freezing or the formation of ice, ship collisions, oil spills and fires. If the probabilities and consequences of such events cannot be reduced to acceptable levels, then the hazards for the nuclear installation that are associated with such events shall be established.

3.55. If the hazards for the nuclear installation are unacceptable and no practicable solution is available, the site shall be deemed unsuitable.

4. SITE CHARACTERISTICS AND THE POTENTIAL EFFECTS OF THE NUCLEAR INSTALLATION IN THE REGION

ATMOSPHERIC DISPERSION OF RADIOACTIVE MATERIAL

4.1. A meteorological description of the region shall be developed, including descriptions of the basic meteorological parameters, regional orography and phenomena such as wind speed and direction, air temperature, precipitation, humidity, atmospheric stability parameters, and prolonged inversions (see Ref. [9]).

4.2. A programme for meteorological measurements shall be prepared and carried out at or near the site with the use of instrumentation capable of measuring and recording the main meteorological parameters at appropriate elevations and locations. Data from at least one full year shall be collected, together with any other relevant data that might be available from other sources.

4.3. On the basis of the data obtained from the investigation of the region, the atmospheric dispersion of radioactive material released shall be assessed with the use of appropriate models. These models shall include all significant site specific and regional topographic features and characteristics of the installation that could affect atmospheric dispersion.

DISPERSION OF RADIOACTIVE MATERIAL THROUGH SURFACE WATER

4.4. A description of the surface hydrological characteristics of the region shall be developed, including descriptions of the main characteristics of water bodies, both natural and artificial, the major structures for water control, the locations of water intake structures and information on water use in the region.

4.5. A programme of investigation and measurement of the surface hydrology shall be carried out to determine to the extent necessary the dilution and dispersion characteristics for water bodies, the reconcentration ability of sediments and biota, transfer mechanisms of radionuclides in the hydrosphere and exposure pathways.

4.6. An assessment of the potential impact of the contamination of surface water on the population shall be performed by using the collected data and information in a suitable model.

DISPERSION OF RADIOACTIVE MATERIAL THROUGH GROUNDWATER

4.7. A description of the groundwater hydrology of the region shall be developed, including descriptions of the main characteristics of the water bearing formations and their interaction with surface waters, and data on the uses of groundwater in the region.

4.8. A programme of hydrogeological investigations shall be carried out to permit the assessment of radionuclide movement in hydrogeological units. This programme shall include investigations of the migration and retention characteristics of the soils, the dilution and dispersion characteristics of the aquifers, and the physical and physicochemical properties of underground materials, mainly in relation to transfer mechanisms of radionuclides in groundwater and their exposure pathways.

4.9. An assessment of the potential impact of the contamination of groundwater on the population shall be performed by using the data and information collected in a suitable model.

POPULATION DISTRIBUTION

4.10. The distribution of the population within the region shall be determined.

4.11. In particular, information on existing and projected population distributions in the region, including resident populations and to the extent possible transient populations, shall be collected and kept up to date over the lifetime of the nuclear installation. The radius within which data are to be collected shall be chosen on the basis of national practices, with account taken of special situations. Special attention shall be paid to the population living in the immediate vicinity of the installation, to densely populated areas and population centres in the region, and to residential institutions such as schools, hospitals and prisons.

4.12. The most recent census data for the region, or information obtained by extrapolation of the most recent census data, shall be used in obtaining the population distribution. In the absence of reliable data, a special study shall be carried out.

4.13. The data shall be analysed to give the population distribution in terms of the direction and distance from the nuclear installation. An evaluation shall be performed of the potential radiological impacts of discharges and accidental releases of radioactive material, including reasonable consideration of releases due to severe accidents, with the use of site specific parameters as appropriate.

USES OF LAND AND WATER IN THE REGION

4.14. The uses of land and water shall be characterized in order to assess the potential effects of the nuclear installation in the region and in particular for the purposes of preparing emergency plans. The investigation shall cover land and water bodies that may be used by the population or that could serve as a habitat for organisms in the food chain.

AMBIENT RADIOACTIVITY

4.15. Before commissioning of the nuclear installation the ambient radioactivity of the atmosphere, hydrosphere, lithosphere and biota in the region shall be assessed so as to be able to determine the effects of the nuclear installation. The data thus obtained are intended for use as baseline data in future investigations.

5. MONITORING OF HAZARDS

5.1. The characteristics of natural hazards and human induced hazards as well as the demographic, meteorological and hydrological conditions of relevance to the nuclear installation shall be monitored over the lifetime of the nuclear installation. This monitoring shall be commenced no later than the start of construction and shall be continued up until decommissioning. All the hazards and conditions that are considered in this Safety Requirements publication and that are pertinent to the licensing and safe operation of the installation shall be monitored.

5.1A. Site specific hazards shall be periodically reviewed using updated knowledge, typically every ten years, and shall be re-evaluated when necessary. A review after a shorter interval shall be considered in the event of evidence of potentially significant changes in hazards (for example, in the light of the feedback of operating experience, a major accident or the occurrence of extreme events). The implications of such a review of site specific hazards for the safe operation of the nuclear installation shall be evaluated.

6. QUALITY ASSURANCE

6.1. An adequate quality assurance programme shall be established to control the effectiveness of the execution of the site investigations and assessments and engineering activities performed in the different stages of the site evaluation for the nuclear installation (see Refs [10–12]).

6.2. The quality assurance programme shall cover the organization, planning, work control, personnel qualification and training, verification and documentation for the activities to ensure that the required quality of the work is achieved.

6.3. The quality assurance programme is a part of the overall quality assurance programme for the nuclear installation. However, since activities for site investigation are normally initiated long before the establishment of a nuclear project, the quality assurance programme shall be established at the earliest possible time consistent with its application in the conduct of site evaluation activities for the nuclear installation.

6.4. The results of the activities for site investigation shall be compiled in a report that documents the results of all in situ work, laboratory tests and geotechnical analyses and evaluations.

6.5. The results of studies and investigations shall be documented in sufficient detail to permit an independent review.

6.6. A quality assurance programme shall be implemented for all activities that could influence safety or the derivation of parameters for the design basis for the site. The quality assurance programme may be graded in accordance with the importance to safety of the individual siting activity under consideration.

6.7. The process of establishing site related parameters and evaluations involves technical and engineering analyses and judgements that require extensive experience and knowledge. In many cases the parameters and analyses might not lend themselves to direct verification by inspections, tests or other techniques that can be precisely defined and controlled. These evaluations shall be reviewed and verified by individuals or groups (e.g. by peer review) who are separate from those who did the work.

6.8. In accordance with the importance of engineering judgement and expertise in geotechnical engineering, the feedback of experience is an important aspect. For the assessment of matters such as the liquefaction potential, the stability of slopes and the safety in general of earth and of buried structures, information from the feedback of experience of failures in comparable situations shall be documented and analysed in order to be able to provide evidence that similar failures will not occur.

6.9. Records shall be kept of the work carried out in the activities for site evaluation for the nuclear installation.

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ACR Licensing Basis Project

Licensing Guide: Design

Submitted to

Canadian Nuclear Safety Commission

September 2004

R. A. Brown & Associates

Licensing Guide: Design

This document has been prepared for the CNSC by

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Licensing Guide: Design

A report submitted by R.A. Brown & Associates under contract to the Canadian Nuclear Safety Commission.

ABSTRACT

This project was established to develop licensing basis documentation for the ACR 700 reactor that will be used by CNSC staff as a guide for the assessment of licensability of the ACR design. The Project has three deliverable documents: Report on Early Identification of Issues, Licensing Basis Review Guide and ACR Licensing Guide: Design. The approach taken to develop these documents will be top-down, systematic and comprehensive. Current regulatory requirements and industry standards and practices for the licensing of a CANDU reactor have been examined, and the suitability for application to the ACR assessed. Where necessary, changes are proposed and/or new requirements recommended. The IAEA Safety Standards Series Document NS-R-1 entitled "Safety of Nuclear Power Plants; Design" is used as the template for the Basis for the Licensing Guide: Design.

The report proposes modifications that will make the overall licensing process more risk informed than the current deterministic based approach. It requires a combination of deterministic analysis and Probabilistic Safety Assessments. The report recommends the adoption of Quantitative Safety Goals, and a new event classification scheme for analysis of accidents is introduced. Recommendations are also made to change several of the current rules for the design of systems in the areas of reliability, shutdown requirements, trip requirements, sharing of instrumentation and equipment between process and safety systems, safety classification, containment leakage requirements and the introduction of Operating Limits and Conditions. These modifications will bring the Canadian licensing process more into line with accepted international practice; at the same time ensuring plants built to these requirements will provide a high level of safety.

As far as is practicable this document proposes requirements that can be applied to both future CANDU and future non-CANDU reactors.

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mitigatory measures shall be provided to ensure that nuclear safety is not compromised.

5.53 Where external events initiate internal fires or floods that lead to the generation of missiles, such interaction of external and internal events shall be considered in the design, where appropriate.

5.54 Where two fluid systems operating at different pressures are interconnected, either the systems shall both be designed to withstand the higher pressure, or provision shall be made to preclude the design pressure of the system operating at the lower pressure from being exceeded, on the assumption that a single failure (the initiating event) occurs.

EXTERNAL EVENTS

5.55 The design basis natural and human induced external events shall be determined for the proposed combination of site and plant. All those events with which significant radiological risk may be associated shall be considered. A combination of deterministic and probabilistic methods shall be used to select a subset of external events that the plant is designed to withstand, and from which the design bases are determined.

5.56 Natural external events that shall be considered include those which have been identified in site characterization, such as earthquakes, floods, high winds, tornadoes, tsunami (tidal waves) and extreme meteorological conditions. Human induced external events that shall be considered include those that have been identified in site characterization and for which design bases have been derived. The list of these events shall be reassessed for completeness at an early stage of the design process.

SITE RELATED CHARACTERISTICS

5.57 In determining the design basis of a nuclear power plant, various interactions between the plant and the environment, including such factors as population, meteorology, hydrology, geology and seismology, shall be taken into account.

5.58 The availability of off-site services upon which the safety of the plant and protection of the public may depend, such as the electricity supply and fire fighting services, shall be taken into account in the design of the plant.

COMBINATIONS OF EVENTS

5.59 Where combinations of randomly occurring individual events could credibly lead to AOOs or accident conditions, they shall be considered in the design. Such combinations shall be identified early in the design phase and shall be confirmed by PSA techniques.

5.60 Certain events may be the consequences of other events, such as a flood following an earthquake. Such consequential effects shall be considered to be part of the original PIE.

Review of ACR-LBD-001, *Licensing Basis Document for New Nuclear Power Plants in Canada*, Draft dated 2004 December

by John W. Beare, P.Eng.

This report is submitted to the Canadian Nuclear Safety Commission in accordance with Contract 87055-04-0857. Part 1 is the main report with comments on the draft Licensing Basis Document. Part 1 includes a brief historical review of the development of the current Canadian approach to nuclear reactor safety and some history of the Atomic Energy Control Board, the predecessor of the Canadian Nuclear Safety Commission, to place these developments in context. Part 2 consists of the Licensing Basis Document with my comments on certain paragraphs, the most important of which are included in Part 1. The electronic version of Part 2 contains the full text of the Licensing Basis Document with my comments side-by-side. To save paper, the paper version of Part 2 contains only those paragraphs of the Licensing Basis Document on which I have comments.

Canadian Nuclear Safety Commission file No.: 34-R240-2

2005 March 31

> *… it is an absorbing concern with safety that will bring about safety — not just the meeting of narrowly prescribed and complex regulations.*
>
> Report Of The President's Commission On The Accident At Three Mile Island

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shut down systems with a limited sharing of components between one of them and the reactor control system. Because of lack of information about the intrinsic safety characteristics of the ACR it is not clear how the issue of two shut down systems should be treated for that type of reactor; however, for design of existing CANDU the result would be a reduction in safety.

Task 4:

14. *Where the Contractor is of the opinion that some provisions of the Licensing Basis Document may be counter-productive to safety or, conversely, unnecessarily burdensome or prescriptive, identify them and make recommendations for changes.*

15. **Finding:** The Licensing Basis Document does not give sufficient emphasis or recognition to the risk from common mode failures. The current Canadian approach places a limit on the believability of reliability estimates for systems. At lower levels the risk field is dominated by common mode failures. The probability of common mode failures is next to impossible to predict and avoidance of common mode failures has to be treated deterministically based on lessons learned from destructive reactor accidents. The current Canadian approach puts emphasis on avoidance of common mode failures through diversity and independence of systems. This emphasis is lacking in the Licensing Basis Document, which would permit limited sharing of equipment among safety systems, except for one of the safety shutdown systems.

16. In some instances the Licensing Basis Document goes too far, for example, by requiring too high a level of anti-seismic design for some systems. In some cases the Licensing Basis Document is too prescriptive. Examples are given in the main body of the report.

17. One requirement, paragraph 5.49 of the Licensing Basis Document, if applied logically might preclude any kind of reactor with large pressure vessels, including the ACR. This requirement sets a cut-off for failure sequences at 10E-8/a. Massive failure of even high grade pressure vessels falls into this range so logically should be included in the design basis even if it is not a failure sequence , as such. Massive failure of a large pressure vessel would certainly initiate a failure sequence whose consequences would be unpredictable. The lower cut-off should be 10E-7/a for individual failure events or sequences. There seems to be general agreement in the international community on this value and general agreement that the failure frequency of high quality pressure vessels is less than this value if they are inspected in-service and if designed for *leak-before-break*.

Task 5:

18. *Where the Contractor is of the opinion that there appear to be gaps or weaknesses in the safety requirements in the new guide, identify them and make recommendations to fill the gaps or remedy the weaknesses.*

19. There are two significant gaps in the Licensing Basis Document. There is no indication how the safety goals in paragraphs 2.13, 2.14 and 2.15 of the Licensing Basis Document relate to

the general safety objective in paragraph 2.2. The safety goals are independent of the site, the size of the exclusion area (if any) and the demographics of the area around the site. I was advised that site considerations do not affect the design requirements for the nuclear power plant but that explanation is difficult to accept.

20. Before issuing this Licensing Basis Document the Canadian Nuclear Safety Commission should document and publish its siting policy giving quantitative values for the tolerable risk (*not unreasonable* to use the wording of the *Nuclear Safety and Control Act*)to individuals and the population around a nuclear power plant site. One weakness of the current siting policy in AECB-1059 is that only radiological risks are addressed. In AECB-1059 the frequency and radiological consequences of process failures alone and in combination with safety system failures are addressed for individuals and the population, but only the risk to individuals from more serious accidents. These weaknesses in the current siting policy should be remedied.

21. The second gap in the Licensing Basis Document is the lack of any guidance on how to use the risk-informed approach. There should be at least a tentative list of Beyond Design Basis Accidents and Severe Accidents in the appendices. The Canadian Nuclear Safety Commission surely has enough experience with current reactors to produce a tentative list. If the Licensing Basis Document retains the cut-off value of 10E-8 then the list can be expected to be very long. I recommend that the Licensing Basis Document start with a list derived from Regulatory Guide C-6, *mutatis mutandis*. The absence of such a list makes it difficult to tell how the Canadian Nuclear Safety Commission intends this new approach to be applied.

Introduction: a brief history of the development of the Canadian approach to nuclear reactor safety

The early years

22. Until the late 1950s the main concern of the Atomic Energy Control Board was control of nuclear materials and information for security reasons, rather than health and safety. It was the management policy of the Atomic Energy Control Board to keep its staff small. The Board delegated outside federal and provincial departments and agencies to fulfill many of the Board's health and safety responsibilities under the 1946 *Atomic Energy Control Act*. Atomic Energy of Canada Limited's activities were exempted by regulation from Atomic Energy Control Board licensing. Until the mid-1970s the composition of the Board and its advisers was biased towards industry, with the President of Atomic Energy of Canada Limited and also the President of Eldorado Nuclear among the five Members.

23. When the first non-Atomic Energy of Canada Limited reactor, the McMaster Nuclear Reactor, was proposed, there was no other department or agency to which the Board could reasonably delegate its authority for controlling this new technology. The Reactor Safety Advisory Committee was created to advise the Board on nuclear reactor safety and licensing. The nuclear expertise of the Reactor Safety Advisory Committee consisted

primarily of full time employees of Atomic Energy of Canada Limited from the Chalk River Nuclear Laboratories. Those members of the Atomic Energy Control Board staff assigned to nuclear reactor safety were considered primarily staff for the Reactor Safety Advisory Committee. The staff did not communicate with the Board except that they reported to the President of the Atomic Energy Control Board, who for many years (1961—1974) was also the Chairman of the Reactor Safety Advisory Committee.

24. Early attempts by the Atomic Energy Control Board to document its safety requirements were resisted by the licensees. For example, the Atomic Energy of Canada Limited designers objected to the 1964 Reactor Siting and Design Guide on the grounds that it usurped their prerogative. The Atomic Energy Control Board accepted this argument and removed provisions touching on design. The document was reissued as The Reactor Siting Guide which contained only general principles and criteria, as found in AECB-1059. As a result the legally binding safety requirements were those in the Act, the Atomic Energy Control Regulations and, primarily, the applicable licence. Other than the Radiation Protection Regulations there were no technical safety requirements in the Atomic Energy Control Regulations. The Licence included, by reference, various submissions from the licensee, with a general reference to other submissions which are widely dispersed and many submissions were not expressly referenced.

25. It was the intention to document the safety requirements more fully as experience in applying the safety approach was accumulated. This intention was not realized because of continued resistance from licensees and lack of Atomic Energy Control Board resources. Licensees, particularly designers, did not want to be limited by rules about design.

26. Although the Board's regulatory regime could not be said to be independent, except in narrow legal terms, there was a collegial working relationship among the Board, the Reactor Safety Advisory Committee and the licensees. During this early period the Canadian safety approach to nuclear reactor safety evolved as a result of discussions between the reactor designers and the Reactor Safety Advisory Committee, AECB-1059 being the latest statement of this approach in which the Reactor Safety Advisory Committee was instrumental.

27. The main elements of the Canadian approach were in place by 1964. The next year the site for the first two units of Pickering was approved and it was evident then that Ontario Hydro intended to build two more. At the time the only operating experience with CANDU was with the small NPD reactor which had begun operation in 1962. The Douglas Point reactor did not commence operation until 1967 and its initial operating history was anything but smooth. Depending on one's perspective, from the safety point of view the approval of the Pickering site was an act of faith or hubris. At the time, the Pickering site had the highest population density in the world, a population density that has been exceeded by only a few other sites since then.

28. Because of the pro-nuclear bias in the Board and the Reactor Safety Advisory Committee there was no question of the Board holding up a licence because of any unresolved safety

49. Limits were placed on the individual and total dose to the surrounding population for postulated serious process failures and dual failures. Dose in the stochastic (probabilistic) range implies a risk of fatal cancer in the future from that dose. Therefore, there were three quantitative safety goals established based on risk. Although this approach put a limit on the risk of early fatality to individuals from a catastrophic failure, no consideration was given to the total risk to the population or to the social and economic effects from a catastrophic failure. The risk of early fatality to an individual from a catastrophic failure is basically a design issue. The risk to the population from a catastrophic failure, including all societal effects such as effects an the economy, environment and land use as well as health, is basically a siting issue. The Reactor Safety Advisory Committee issued what it called the Siting Guide which did not address this basic siting issue. Despite this omission, the Canadian approach was *in concept* an advance over the Light Water Reactor approach to defence-in-depth. Most problems with the Canadian approach have been ones of *implementation*, for example, safety analyses not being taken to their logical conclusion. As a consequence the role of what are now called *safety support systems* was not at first explicitly recognized in safety assessments. What we now call the safety support systems were designed to be reliable but considerations such as mission-time were not included. Typically, safety analyses ran only until 15 minutes after the postulated serious process failure. Dealing with the longer term effects was left to what was called *unspecified operator action*. This approach probably reflects the experience of the Reactor Safety Advisory Committee's nuclear members with the 1952 NRX reactor accident where improvisation by the operators was successful in dealing with the longer term aspects of that accident. However, it did not take into account the enormously greater power of nuclear-electric generation reactors, the high power density of the nuclear fuel, the high pressure and temperature of the coolant systems and the complexity of the analyses of fault conditions.

50. The Canadian approach to defence-in-depth has the advantage that the designer has greater freedom in designing the process systems than in Light Water Reactor. For example, Canada was the first to use computerized control systems for the process systems, starting in a limited way with Douglas Point and in a major way with Pickering A. This is not to say that the Atomic Energy Control Board took lightly unsafe failures in the process systems. Ontario Hydro was taken to task by the Atomic Energy Control Board when faults in the Pickering A computerized control system indicated that the reliability of the system was lower than that of analogue reactor regulating systems and did not represent good industrial practice. Improvements were demanded and made. Also the Atomic Energy Control Board overruled a CSA code and required regular in-service inspection of pressure tubes. This decision was made before the massive failure of a pressure tube actually occurred in Pickering. The designers had argued that pressure tubes would leak to reveal any crack before it grew to a critical length. Despite extensive research into and testing of pressure tubes no one had anticipated the conditions that led to delayed hydride cracking. The Atomic Energy Control Board reached its decision based on what it considered to be good industrial practice.

expressed in terms of the risk of consequences to the public, not to the reactor, as such. Other criteria may be derived from these basic safety goals but it is not clear in the Licensing Basis Document to what basic safety goal core damage frequency relates or what kind of core damage is referred to: only fuel failure or collapse of the core lattice. Instead of core damage it might be better to base this safety goal on the release of a certain amount of radioactive substances or combustible gas into the containment.

122. Because this Licensing Basis Document is for the design of nuclear power plants siting considerations have not been included in the safety goals. If siting factors, such as the size of the exclusion zone and demographics, are not included there is no logical connection between the safety objectives in paragraph 2.2 of the Licensing Basis Document and the safety goals.

123. **Recommendation:** Either in the Licensing Basis Document or another document issued at the same time the Canadian Nuclear Safety Commission should set out quantitatively what it considers to be reasonable radiological and non-radiological risk to individuals and the population in the vicinity of a nuclear power plant.

Beyond Design Basis Accidents (sic)

124. It is evident from the Licensing Basis Document that combined failures of process and safety systems would now be classed as *Beyond Design Basis Accidents*, (an illogical expression, as discussed above). There is no specific guidance in the Licensing Basis Document as to which failure combinations should be included in the (beyond) design basis. In particular there is no lower limit on believability in the probability of failure of any system comprising common design elements. This approach might lead to a more thorough examination of multiple failures among process and safety systems than in the approach outlined in C-6. More likely it will lead to an interminable argument with the licensees on believable values for probabilities of failures and whether due allowance has been made for common mode failures, including the probability of human error and design failures.

125. Experience shows that the cause of destructive reactor accidents is dominated by common mode failures, not random failures of structures, systems and components. Common mode failures may affect more than one system, and not just common elements within a system. The main source of common mode failures have been gross human error and design deficiencies.

126. The probability of some human errors can be estimated, such as an operator pushing the wrong button. Gross human error is virtually impossible to model; such as occurred in a complex and unpredictable way in the NRX reactor accident; the carelessness that contributed to the Windscale fire; the operators of Three Mile Island-2 taking several hours to correctly diagnose the situation; and, the determination of the Chornobyl operators to improvise in order to finish a test. There is some evidence that the SL-1 reactor accident may have been deliberate; a suicide by the operator who was connecting the control rod drives and who was fully aware of the consequences of pulling the central control rod too

REGULATORY SITE REQUIREMENTS NEEDED FOR NEW NUCLEAR POWER PLANTS IN CANADA

LICENCE TO PREPARE SITE

BASIS FOR THE DEVELOPMENT OF LICENSING REQUIREMENTS TO PREPARE A SITE FOR NEW NUCLEAR INSTALLATIONS IN CANADA

Final Report – June 2007

ABSTRACT

The Site Evaluation requirements contained in the regulatory frameworks of the Canadian Nuclear Safety Commission, the United States Nuclear Regulatory Commission (USNRC), Finland's Radiation and Nuclear Safety Authority (STUK) and the International Atomic Energy Agency's (IAEA) Safety Requirements and Safety Requirements series have been reviewed. Supplied documents from France's Nuclear Safety Authority have also been reviewed for any requirements applied to nuclear power plant Site Evaluation programs.

These reviews identified similarities and differences in Site Evaluation requirements from these jurisdictions that are the basis of observations and recommendations from the contractor to the CNSC regarding the development of requirements for a Licence to Prepare Site for new nuclear installations in Canada.

DISCLAIMER

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1. INTRODUCTION

The Canadian Nuclear Safety Commission (CNSC) identified a need to survey international regulatory practices relating to the site evaluations conducted for new nuclear installations. This survey aimed at producing the basis for the CNSC's development of Site Evaluation requirements for new nuclear facilities in Canada. Atlantic Nuclear Services Limited (ANSL) was chosen to perform this work. This report describes the conduct of and presents the results of ANSL's work.

Progress reports for this project provided descriptions of the contractor's findings from the study and cross-comparison of requirements for Site Evaluation drawn from licensing frameworks and safety documents of the CNSC, the International Atomic Energy Agency (IAEA), the United States Nuclear Regulatory Commission (USNRC), the Agence de Sécurité Nucléaire (ASN) of France and the Radiation and Nuclear Safety Authority (STUK) of Finland.

A specific feature of the First Progress Report was a preliminary assessment of the suitability of the IAEA requirements for use in a Canadian licensing context. That early assessment was requested by CNSC staff so that they would be in a position to respond to requests for a Licence to Prepare Site tabled at that time, or soon to be tabled, by proponents of new nuclear power plants in Canada.

This report contains the final results of the contractor's studies, evaluations and cross-comparisons of these bodies of regulatory requirements for Site Evaluation.

2. BACKGROUND TO THE ESTABLISHMENT OF REQUIREMENTS FOR A LICENCE TO PREPARE SITE.

Site evaluation is one of the first formal activities undertaken by the proponent of a new nuclear facility. During this evaluation, all site characteristics important to the safe design, construction and operation of the facility are examined with the objectives of demonstrating that:

- Properly engineered solutions and management solutions exist, and will be incorporated into the facility, to address the impacts of the site on the facility, and,

- Properly engineered solutions and management solutions exist, and will be incorporated into the facility and/or applied to the site, to address the impacts of the facility on the site.

The purpose of site evaluation programs therefore is to ensure the design basis for the facility is correct – that properly engineered accommodations are available, and will be included to satisfactorily address site/facility interactions.

Site evaluation activities set in motion subsequent activities in the design, construction and operational phases of the nuclear facility. It is through the detailed examination of site characteristics during site evaluation that design and operating features such as seismic qualification of plant equipment and special mitigation measures for plant emissions are considered and developed. Indeed, seismic qualification and emission control are among several aspects of plant design and operation which, if not properly considered at the site evaluation stage may result in costly design changes, operating constraints and licensing restrictions during subsequent phases of the plant's life cycle.

From discussions with CNSC staff, the description of the activities allowed by the granting of a Licence to Prepare Site suggested that this licence will be generally equivalent to the Atomic Energy Control Board's (AECB) Site Approval[1] licensing step. A pre-requisite to the granting of a Site Approval by the AECB was the satisfactory completion of a site evaluation program and the acceptance of its results.

In its consideration of site evaluations for nuclear power plants, the AECB did not have detailed and specific written requirements to structure and guide the work of the proponent or the review and acceptance of that work by its staff. Site evaluation programs were thus open to criticisms that they were ad-hoc, insufficiently comprehensive and overly subjective. AECB staff acceptance of the results of site evaluation could similarly be criticized as being too reliant on expert judgment, and without clear, documented connections to established acceptance criteria.

Today, the public and the nuclear community have expectations that demand a different, more transparent and more defensible approach. New nuclear installations under CNSC licensing review must have a site evaluation conducted in accordance with rigorous, written and publicly available requirements that are aligned with global practices. These requirements must also be coordinated with the requirements of other interested jurisdictions, including those jurisdictions whose primary focus is environmental protection.

In particular, with respect to environmental protection requirements, the Canadian environmental legislation and associated assessment and review processes were relatively new requirements at the time of the most recent of the AECB's nuclear power plant site evaluations. The application of federal legislation of this nature to provincially sponsored nuclear power plants was subject to jurisdictional uncertainty at that time.

Now, there is no such lack of clarity. In Canada, a proposed site for a nuclear power plant requires a positive decision on the Environmental Assessment conducted pursuant to Section 5(1)(d) of the Canadian Environmental Assessment Act. Apart from any considerations of public interest in nuclear safety and environmental protection, the

[1] The Atomic Energy Control Board was the predecessor nuclear regulatory agency to the Canadian Nuclear Safety Commission. The AECB's licensing process for nuclear power plants included four major steps: Conditional Site Approval, Site Approval, Construction Licence and Operating Licence.

effective and efficient coordination of the activities of agencies at all three levels of government will need properly constituted and accepted bodies of pre-published requirements and criteria for site evaluation and environmental assessment activities.

3. DEVELOPMENT OF THE BASIS FOR REQUIREMENTS FOR A LICENCE TO PREPARE SITE

In carrying out this work for the CNSC, the contractor's objective was to develop a foundation from which the CNSC could establish requirements for the site evaluation of new nuclear facilities in Canada. This foundation or basis must:

i. Reflect current international practices relating to site evaluation programs,

ii. Be technology neutral, that is, the requirements developed from the basis supplied by the contractor shall be applicable to site evaluations conducted for nuclear power plants irrespective of their design and shall also be applicable to nuclear facilities other than nuclear power plants, and

iii. Incorporate advances made in nuclear safety, relevant to site evaluation programs.

Additionally, the basis developed by the contractor needed to satisfy two overall criteria, in that it shall:

iv. Relate exclusively to the interactions occurring between the nuclear installation and the proposed site, from a nuclear safety perspective[2],

v. Be directed at those interactions that arise from natural external events, from human-induced, accidental external events and from the characteristics of the proposed site.

Achieving the objective was pursued through a structured, sequential review of documents relating to site evaluation requirements obtained from international and national nuclear safety and nuclear regulation jurisdictions:

- Canadian Nuclear Safety Commission (CNSC)
- International Atomic Energy Agency (IAEA)
- United States Nuclear Regulatory Commission (USNRC)
- Radiation and Nuclear Safety Authority (STUK – Finland)
- Agence de Sécurité Nucléaire (ASN - France).

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[2] Nuclear safety, in this context means the protection of public health, safety, security and the environment from the effects of planned and unplanned releases of radioactive material and hazardous substances.

Appendix A shows the documents reviewed for site evaluation program requirements during this work.

As these documents were reviewed, requirements that satisfied the overall screening criteria (items iv. and v. above) were tabulated into a format that facilitated the cross-comparison of requirements from the different jurisdictions. These tabulations are attached in Appendices B through E.

The cross-comparison of requirements identified those areas, or topics that were similarly treated by the different jurisdictions (similarities), and those areas where topics received different treatment (gaps). Similarities and gaps were noted, and formed the basis of the contractor's observations.

After the cross-comparisons were completed, it was evident that the IAEA site evaluation requirements were the most up-to-date and comprehensive. The contractor then considered several specific considerations relating to this body of requirements:

i. Were the IAEA requirements suitable for use in a Canadian context, that is, could the CNSC adopt and/or adapt these requirements for incorporation into its licensing framework?

ii. Were there any gaps in the IAEA requirements identified by the review of CNSC material, USNRC requirements, ASN requirements and STUK requirements?

iii. Were there any aspects of the current CNSC licensing framework that the contractor felt should be changed, or improved based on the results of the reviews and cross-comparisons?

iv. Were the IAEA requirements technology neutral or instead were they biased towards any particular nuclear facility or nuclear plant design? and,

v. Were there any observed limitations to the application of the IAEA requirements?

4. OBSERVATIONS OF THE CONTRACTOR

On the basis of the work performed the contractor forwards the following observations:

<u>4.1 Observations – Site Evaluation in the CNSC Licensing Framework</u>

1. The Class I Nuclear Facility Regulations contain requirements for an application for a Licence to Prepare Site. Among those requirements is the submission of a description of the Site Evaluation process and the investigations that have been or will be done on the site and the surrounding area. There are no other significant technical descriptions of Site Evaluation programs or activities contained in other documents in the CNSC's licensing framework.

The Class I Nuclear Facility Regulations also specify that an application for a Licence to Prepare Site shall contain descriptions of the site's susceptibility to human activity and natural phenomena. Natural phenomena are to include seismic events, tornadoes and floods. Other than as described below under Observation 4, there are no other statements in the Licensing Framework that specify or infer the regulator's expectations regarding Site Evaluation activities.

The contractor noted that the Class 1 Regulations use the term "Site Evaluation process" – there is no reference to a Site Evaluation Program, where 'Program' is intended to address a comprehensive set of topics including Quality Assurance, Staff Training and Record Keeping for example.

2. The CNSC's Regulatory Documents do not contain a description of the activities sanctioned by the granting of a "Licence to Prepare Site". The timing of a Licence to Prepare Site shown in the Licensing Process suggests that the Site Evaluation activities will have been largely completed when the Licence is issued and therefore would not be governed by conditions contained in this Licence.

3. A distinct and separate Site Evaluation step is not contained in the CNSC's regulatory framework, even though it is an essential part of a nuclear facility's design process. From the material reviewed, it appears that the CNSC's sole interest in Site Evaluation programs and activities is as a required submission for a Licence to Prepare Site.

4. The CNSC'S Licensing Process, INFO-0756, Section 3.2.1 identifies several topical areas of investigation for Site Evaluation programs. The document speaks of these topics in the context of Site Preparation, thereby reinforcing the observation that a Site Evaluation program is considered only as a pre-requisite submission for a Licence to Prepare Site, not as a matter that merits specific regulatory attention during the program's development and execution.

In consideration of the above Observations, the Contractor concluded that beyond the topics identified in the Class 1 Regulations, the CNSC's Regulatory Framework contains no information that will guide the applicant in developing or conducting a Site Evaluation program. Equally, there is no written material that the CNSC Staff can use to make determinations of the acceptability of a Site Evaluation program and for the subsequent development of recommendations and proposed licensing positions on such a program.

The contractor also concluded that the CNSC should clarify the nature and extent of its regulatory interest in Site Evaluation Programs.

4.2 Observations– The IAEA Safety Guide NS-R-3 and Lower Tier Standards

1. The contractor has reviewed IAEA NS-R-3 and the lower tier Safety Guides of Appendix A, Table 2. In the contractor's view, the contained requirements and

guidelines are appropriate, comprehensive and clearly expressed. The technical content of these documents should be an excellent tool for applicants and licensees engaged in the development and execution of Site Evaluation programs. CNSC staff should find the material valuable for evaluating the content and conduct of a Site Evaluation program and for developing recommendations and licensing positions for the Commission's consideration.

2. Clause 2.10 of IAEA NS-R-3 requires consideration of a proposed nuclear installation's non-radiological impacts:

   "The possible non-radiological impact of the installation, due to chemical or thermal releases, and the potential for explosion and the dispersion of chemical products shall be taken into account in the site evaluation process."

   CNSC staff has confirmed to the contractor that non-radiological impacts of nuclear facilities are interests that legitimately fall within the Commission's mandate, and thus this requirement can be suitably adopted into the licensing framework.

3. The content of the IAEA Safety Guides is very detailed, highly technical material. The contractor's view is that these documents can serve as guidance for applicant and licensees engaged in the conduct of a Site Preparation/Evaluation program, and to CNSC engaged in review of that program. The material is too detailed to adopt or adapt to a licensing framework as mandatory requirements.

4. The contractor was requested to consider whether or not the IAEA NS-R-3 requirements were suitable for application to two specific nuclear installation types:

   - Pebble-bed or fluidized bed nuclear reactors, and

   - Underground storage facilities for nuclear wastes.

   The Scope statements of the document make quite clear that NS-R-3 is intended to cover a comprehensive range of nuclear installations: land-based stationary nuclear power plants and research reactors, as well as nuclear fuel cycle facilities, including enrichment plants, processing plants, spent fuel storage facilities and reprocessing plants. In some cases the NS-R-3 requirements are stated to apply to nuclear power plants, and where so, the requirements are most appropriate for a nuclear power plant, but the requirement may also apply to other nuclear installations.

   As for underground facilities, Clause 1.5 of the document clearly states that it is not intended to address underground or offshore installations.

4.3 Observations – USNRC 10CFR 52 – Early Site Permits

1. The statements contained in 10CFR 52.17 (2) suggest, in the contractor's view, that the nuclear regulatory authority could be implicated in the comparative review of alternate sites proposed for a new nuclear power plant. The contractor considers that such a position is untenable for a nuclear regulator.

2. USNRC 10CFR 52.17 (c) contains a requirement for site redress plans that would be applied in the event that a project is abandoned or lapses after initial work has altered the proposed site. This USNRC requirement is shown in Appendix D, page 39. The contractor recommends that the CNSC investigate its regulatory position in the event that such a situation developed with respect to a nuclear facility project in Canada.

4.4 Observations – USNRC 10CFR 100 – Reactor Site Criteria

1. The requirements contained in USNRC 10CFR 100, Appendix A correspond, in level of detail to the material contained in the IAEA's Safety Guides NS-G 3.3 "Evaluation of Seismic Hazards for Nuclear Power Plants" and NS-G 3.6 "Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants". This level of detail, as noted above is inappropriate in a framework of mandatory requirements, but could be used as non-mandatory guidance in the conduct or assessment of site evaluation programs.

4.5 Observation – USNRC 10CFR 50 – Domestic Licensing of Production Facilities

1. USNRC 10CFR 50.10 has been tabulated in Appendix D to illustrate the type of description the contractor is considering in Recommendation No. 3 for the Licence to Prepare Site in the Canadian licensing process.

4.6 Observations – STUK (Finland) Site Evaluation Requirements

1. There are no specific Observations forwarded relating the STUK Requirements and Criteria. There are several Observations made under 4.8 "Cross-Comparisons" referring to the Finnish material.

4.7 Observation – ASN (France) Site Evaluation Requirements

1. The material supplied by the CNSC to the contractor did not contain any requirements relating to site evaluation of future nuclear facilities. The material describes design criteria for possible European nuclear power plants.

4.8 Observations – Cross-Comparison of Site Evaluation Requirements

1. When the topical areas of investigation for Site Evaluation programs of CNSC INFO-0756 and the Class I Nuclear Facilities Regulations are compared with the topics contained in IAEA NS-R-3, there are gaps not addressed by the Canadian

documents. Important gaps not addressed in the CNSC documents (or anywhere in its licensing framework) include:

- Required evaluation of "site characteristics that may affect the safety of the nuclear installation". This requirement of the IAEA documents is important to capture "non-event" type characteristics such as normal meteorological conditions and geological features.
- Required assessment of all major geotechnical conditions.
- Required evaluation of "characteristics of the natural environment that may be affected by potential radiological impacts."
- Criteria for the rejection of a proposed site if it is deemed unsuitable.
- Required assessment of ancillary activities, e.g., the movement of spent fuel or radioactive waste, and the interactions between the site and these activities.
- Required monitoring of site characteristics over the lifetime of the nuclear facility and the imposition of remedial measures to compensate for changes, if necessary.
- Required Quality Assurance Program(s) for Site Preparation/Evaluation activities.
- Required finding that there are no insurmountable obstacles to the establishment of suitable emergency measures before a Construction Licence is issued.

2. Additionally, the IAEA's NS-R-3 "Site Evaluation for Nuclear Installations" contains four important differences from the requirements of the USNRC and STUK documents. These are:

    - NS-R-3 requires the lifetime monitoring of site characteristics important to facility safety and the undertaking of remedial measures should changes in these characteristics warrant.
    - NS-R-3 is directed at all nuclear facilities whereas the STUK and USNRC documents specifically address nuclear power plants only.
    - NS-R-3 contains a requirement that ancillary activities to the main licensed activity be assessed with respect to their impact on the site, and vice-versa.
    - NS-R-3 contains requirements for Quality Assurance programs applied to site evaluation programs.

3. The USNRC requirements contains one topic not addressed by the IAEA's NS-R-3 document, that being that a proposed site shall be evaluated and shown to present no impediments to the eventual establishment of adequate physical security measures for the facility.

   Other than this difference, all Site Evaluation requirements contained in the USNRC documents are appropriately addressed in IAEA NS-R-3.

4. The contractor notes the wording of STUK YVL 1.10, Section 3.1 ". . . Effects on the supply of cooling water and on electric power grid connections shall also be considered." The reliability of off-site power to the proposed site of the new installation may influence the design and operating features of the facility and should therefore be addressed during site evaluation.

   IAEA NS-R-3 adequately addresses the reliability of cooling water supplies in Paragraphs 3.53 and 3.54. The document does not however address considerations relating to the reliability of off-site power supplies.

   Other than this single difference, all Site Evaluation requirements contained in the STUK documents are appropriately addressed in IAEA NS-R-3.

5. The contractor notes that the Site Evaluation requirements from the IAEA, the USNRC and STUK share a common requirement in that the proponent must show, as a result of Site Evaluation activities that it has been confirmed that there will be no insurmountable difficulties in establishing an emergency plan before the start of operation. This demonstration of the practicality of planned emergency measures must be done to the regulatory agency's satisfaction prior to the granting of a Construction Licence.

   This is a significant difference from the traditional Canadian approach to licensing nuclear power plants, where considerations relating to emergency measures to be taken in the event of a postulated accident were principally addressed at the Operating Licence stage.

5. RECOMMENDATIONS OF THE CONTRACTOR

On the basis of the Observations made above, the contractor makes the following recommendations. The rationale for each recommendation is also presented, developed from the foregoing observations, and the contractor's experience.

5.1 Recommendation No. 1

5.1.1 Recommendation

The CNSC can adopt IAEA Safety Standards Series NS-R-3 "Site Evaluation for Nuclear Installations" as the minimum set of Canadian requirements for Site

Preparation/Site Evaluation programs and activities. These requirements are suitable for application to Site Evaluation activities conducted for any nuclear facility proposed for siting in Canada, with the exception of underground and offshore facilities.

5.1.2 Rationale to Recommendation No. 1

The contractor makes this recommendation on the basis of four considerations of rationale:

- The contractor considers that all important safety related aspects of a site are appropriately addressed by the requirements of IAEA NS-R-3, with the exception of the items discussed below in Recommendation No. 3. The contractor makes this statement generally on the basis of the results of the reviews conducted during this project, and in particular on the finding that the review of USNRC and STUK requirements did not reveal any major gaps in IAEA requirements. Additionally, the IAEA requirements contained the topical areas of investigation known to the contractor from previous knowledge and experience gained during the Site Evaluations conducted for Canadian nuclear power plants.

- The contractor also looked for any requirements of NS-R-3 that would be, or could be contrary, in a significant and irresolvable way to Canadian practice. No items were found in NS-R-3 that could be considered contrary to Canadian interests and practice.

  There is one requirement of NS-R-3 that is different than previous Canadian practice. That difference relates to the need to investigate emergency situations during Site Evaluation. The proponent is required to show that there are no foreseen obstacles to the eventual establishment of suitable emergency measures. The proponent's findings in this regard must be available as a pre-requisite to the granting of a Construction Licence. The emergency plans themselves are to be available before an Operating Licence is granted.

  Given the body of experience in the CNSC, and in the Canadian Nuclear Industry with emergency planning, the contractor does not consider this to be an irresolvable difference. The adoption of this requirement into the CNSC's licensing framework will bring Canadian requirements in this area into proper alignment with international expectations.

- The Quality Assurance requirements of this document are suitable for oversight of the conduct of a Site Evaluation program in Canada.

- The requirements are technology neutral; they may be applied to any nuclear facility of any design (with the limitations expressed earlier regarding underground and offshore facilities).

5.2 Recommendation No. 2

5.2.1 Recommendation

The CNSC should adopt the IAEA Safety Guides of Appendix, Table 2 as supplementary technical guidance for applicants and licensees engaged in Site Evaluation activities and for CNSC staff engaged in the assessment of such programs.

5.2.2 Rationale to Recommendation No. 2

The contractor's rationale for this recommendation relates to the level of detail and technical nature of the IAEA Safety Guides.

The material is quite detailed, highly technical in content and is most appropriately directed at the field practitioner engaged in the collection of site related data, and the interpretation of that data. In some instances, these Guides note that the technology associated with an area of site evaluation is 'evolving' – that new techniques for data acquisition and interpretation are being developed.

If the CNSC was to make these Guides a mandatory set of Canadian requirements, then Canadian licensees or proponents could be confined to prescriptive adherence to those requirements, and would not be able to propose alternative means to accumulate site related information and/or to interpret that data. The alternatives could be superior or more effective than the methods described in the current IAEA Guides as a result of technical advances made since the publication of the Guides, and should therefore be available for consideration, not prescriptively ruled out.

The contractor wishes to note that adopting these Guides as non-mandatory will provide both a proponent and the CNSC staff with a framework for the development, and the assessment, respectively, of Site Evaluation programs. For the CNSC, adopting the Guides will be a significant step away from its traditional reliance on 'expert-judgment' and an equally significant step towards establishing written criteria.

5.3 Recommendation No. 3

5.3.1 Recommendation

Two requirements not contained in IAEA NS-R-3 are recommended for adaptation into a Canadian licensing framework for site evaluation programs and/or a Licence to Prepare Site. These requirements are:

- The reliability of off-site power supplies to the proposed facility shall be assessed during the site evaluation activities, and shown to be commensurate with the design and operating requirements under all plant operating conditions (from STUK Requirements).

- A proponent shall assess site characteristics to ensure that there are no insurmountable obstacles to the eventual development and establishment of appropriate physical security measures for an operating facility (from USNRC Regulations).

5.3.2 Rationale to Recommendation No. 3

With respect to the reliability of off-site power, the contractor's rationale is drawn from the objectives of a Site Evaluation program. Given that this objective is to ensure the correctness of the design basis, then an assessment of the reliability of off-site power, to the level of detail required as a preliminary input to the design process seems only proper and necessary. At the minimum such an assessment can identify to the proponent if the proposal regarding the facility and submitted to the CNSC must include measures to increase or augment the as-found reliability.

With respect to physical security measures, again, the contractor does not find it unreasonable for a proponent to be required to conduct a preliminary assessment of any major foreseen difficulties presented by the proposed site. The contractor wishes to note a potential area of concern – that being the possible 'creep' in the scope of such assessments. The investigation is of site-related factors, the interactions of those factors with physical security plans, and how the proponent would accommodate or address those interactions. At the site-evaluation stage, this is a suitable investigative pursuit. In the contractor's opinion, the CNSC, and the proponent must guard against the growth of these preliminary investigations at such an early stage in the facility's life cycle into more detailed examination of the proponent's security plans for postulated security threats. Such a detailed examination is clearly outside the legitimate scope of Site Evaluation activities.

5.4 Recommendation No. 4

5.4.1 Recommendation

The activities sanctioned by the CNSC's granting of a Licence to Prepare Site need to be specified. Clearly defined milestone events must be chosen for the beginning and end of this phase of a nuclear facility's life cycle such as the cutting of exploratory trenches, or the excavation of surface materials or the pouring of concrete for foundations.

5.4.2 Rationale to Recommendation No. 4

The contractor considers that clearly written descriptions of the activities for which a proponent will require a particular licence or permit are a fundamental to the universal understanding of the CNSC's expectations. Without such descriptions, there is room for misunderstandings in the industry, in the CNSC staff and in the public's minds regarding the scope and extent, and applicability of a licensing process step.

5.5 Recommendation No. 5

5.5.1 Recommendation

The CNSC should clarify the nature of its interests in Site Evaluation programs – those assembled activities that are undertaken to describe the site in terms of its geology, meteorological conditions, hydrology, surrounding population, activities and facilities, and its susceptibility to external events of either natural or human-induced origins. The clarification will make clear whether the CNSC will be involved in the acceptance/approval of a Site Evaluation program during its development and in the oversight of its execution, or instead, will only assess and accept the results of such a program as a pre-requisite to the granting of a Licence to Prepare Site.

5.5.2 Rationale to Recommendation No. 5

The contractor views this recommendation in a similar light to that of Recommendation No. 4. The CNSC's specific interests in Site Evaluation programs must be written down, in clear language for all to understand. The contractor has no particular bias in either direction – the CNSC can choose to be interested in Site Evaluation simply as a pre-requisite to a Licence to Prepare Site, and evaluate the program at that time, or, the CNSC can choose a greater level of regulatory involvement during the development and execution of the program.

Whatever set of interests the CNSC chooses, those interests should be transparently stated for the industry, the CNSC staff and the public to understand.

6.0 References:

1. Request for Proposal Number: 87055-06-0016 "Regulatory Site Requirements Needed for New Nuclear Power Plants in Canada – 'Licence to Prepare Site'

APPENDIX A

TABLES OF DOCUMENTS REVIEWED FOR SITE EVALUATION REQUIREMENTS

Table 1: CNSC Regulations and Regulatory Documents

General Nuclear Safety and Control Regulations
Class I Nuclear Facilities Regulations
Licensing Process for New Nuclear Power Plants in Canada, INFO 756
Requirements for Design of Nuclear Power Plants – Pre-Consultation Draft
Financial Guarantees For the Decommissioning of Licensed Activities, G-206
Transport Security for Category I, II, and III Nuclear Material, G-208
Decommissioning Planning for Licensed Activities, G-219
Environmental Monitoring Program at Class I Nuclear Facilities and Uranium Mines and Mills, S-224/G-224
Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills, G-225
Security Programs for Category I or II Nuclear Material or Certain Facilities, G-274
Environmental Protection Policies, Programs and Procedures at Class I nuclear Facilities and Uranium Mines and Mills, G-296/S-296

Table 2: IAEA Safety Requirements and Safety Guides

Site Evaluation for Nuclear Installations, IAEA Safety Standards Series No. NS-R-3
External Human Induced Events in Site Evaluations for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-3.1
Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-3.2
Evaluation of Seismic Hazards for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-3.3
Meteorological Events in Site Evaluation for Nuclear Power Plants, IAEA Safety Standards Series, No. NS-G-3.4
Flood Hazard for Nuclear Power Plants on Coastal and River Sites, IAEA Safety Standards Series No. NS-G-3.5
Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-3.6

Table 3: USNRC Regulations

USNRC 10 CRF Part 50 – Domestic Licensing of Production and Utilization Facilities
USNRC 10CFR Part 52 – Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants.
USNRC 10 CFR Part 100 – Reactor Site Criteria
USNR 10 CFR Part 100, Appendix A – Seismic and Geologic Siting Criteria for Nuclear Power Plants

Table 4: ASN Material

Letter: Lacoste to EDF, "Safety Options of the EPR Reactor Project", Sept 28, 2004
Technical Guidelines for the Design and Construction of the Next Generation of Nuclear Power Plants with Pressurized Water Reactors
Technical Guidelines for the Construction of the Main Primary System and Main Secondary System of Pressurized Water Reactors

Table 5: STUK Criteria

Safety Criteria for Design of Nuclear Power Plants – YVL 1.0, 12 January 1996
Safety Criteria for Siting a Nuclear Power Plant – YVL 1.10, 11 July 2000
Seismic Events and Nuclear Power Plants – YVL 2.6, 19 December 2001
Probabilistic Safety Analysis in Safety Management of Nuclear Power Plants – YVL 2.8, 28 May 2003
Radiation Safety Aspects in the Design of a Nuclear Power Plant – YVL 7.18 26 September 2003

APPENDIX B

CNCS REGULATIONS AND REGULATORY DOCUMENTS

TABULATION OF SITE EVALUATION REQUIREMENTS

GENERAL NUCLEAR SAFETY REGULATIONS	NOTES
3. (1) An application for a licence shall contain the following information: (a) the applicant's name and business address; (b) the activity to be licensed and its purpose; (c) the name, maximum quantity and form of any nuclear substance to be encompassed by the licence; (d) a description of any nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence; (e) the proposed measures to ensure compliance with the Radiation Protection Regulations and the Nuclear Security Regulations; (f) any proposed action level for the purpose of section 6 of the Radiation Protection Regulations; (g) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information; (h) the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information; (i) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application.	In the context of an Application for Site Preparation, General Nuclear Safety Regulations 3.(1) (a) through (n) do not satisfy the overall screening criteria.
(j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste; (k) the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the Act and the regulations made under the Act,	"the activity to be licensed" in this clause has limited if any relevance to site preparation activities, but has a main relevance to nuclear facility operation.

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including the internal allocation of functions, responsibilities and authority; (l) a description of any proposed financial guarantee relating to the activity to be licensed; (m) any other information required by the Act or the regulations made under the Act for the activity to be licensed and the nuclear substance, nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence; and (n) at the request of the Commission, any other information that is necessary to enable the Commission to determine whether the applicant i) is qualified to carry on the activity to be licensed, or ii) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.	

CLASS I NUCLEAR FACILITIES REGULATIONS	**NOTES**
General Requirements **3.** An application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain the following information in addition to the information required by section 3 of the *General Nuclear Safety and Control Regulations*: (*a*) a description of the site of the activity to be licensed, including the location of any exclusion zone and any structures within that zone;	Class I Nuclear Facilities Regulations 3 (a), (b), and (c) do not satisfy the overall screening criteria.

(*b*) plans showing the location, perimeter, areas, structures and systems of the nuclear facility;	
(*c*) evidence that the applicant is the owner of the site or has authority from the owner of the site to carry on the activity to be licensed;	
(*d*) the proposed quality assurance program for the activity to be licensed;	Class I NFR 3 d) satisfies the overall screening criteria (with a possible interpretation of "activity to be licensed") and is fully developed by IAEA NS-R-3 Section 6.
(*e*) the name, form, characteristics and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on; (*f*) the proposed worker health and safety policies and procedures; (*g*) the proposed environmental protection policies and procedures; (*h*) the proposed effluent and environmental monitoring programs;	Class I NFR's 3 (e), (f), (g) and (h) are presumed to refer in the context of this project to the Licence to Prepare Site, and not to the eventual Programs required of an applicant for a Licence to Operate a Nuclear Facility.
(*i*) if the application is in respect of a nuclear facility referred to in paragraph 2(*b*) of the *Nuclear Security Regulations*, the information required by section 3 of those Regulations;	The clause-by-clause review of the Nuclear Security Regulations did not identify any requirements that satisfied to screening criteria.
(*j*) the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed; and	Class I NFR 3(j) and (k) do not satisfy the overall screening criteria.

(*k*) the proposed plan for the decommissioning of the nuclear facility or of the site	For a Licence to Prepare Site, plans for site remediation if the site is abandoned would likely be more germane.
Licence to Prepare Site	
4. An application for a licence to prepare a site for a Class I nuclear facility shall contain the following information in addition to the information required by section 3:	
(*a*) a description of the site evaluation process and of the investigations and preparatory work that have been and will be done on the site and in the surrounding area;	Class I Nuclear Facilities Regulations, Section 4 (a), (b) and c) satisfy the screening criteria.
(*b*) a description of the site's susceptibility to human activity and natural phenomena, including seismic events, tornadoes and floods;	
(*c*) the proposed program to determine the environmental baseline characteristics of the site and the surrounding area;	
(*d*) the proposed quality assurance program for the design of the nuclear facility; and	Class I Nuclear Facilities Regulations, Section 4 (d) does not satisfy the overall screening criteria.
(*e*) the effects on the environment and the health and safety of persons that may result from the activity to be licensed, and the measures that will be taken to prevent or mitigate those effects.	For a Licence to Prepare Site, the 'effects' of 'the activity to be licensed' are minor. These aspects of the requirement appear to target the operational phase of a nuclear facility and thus, this requirement is impractical in the context of an Application for a Licence to Prepare Site.

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<table>
<tr><th>LICENSING PROCESS FOR NEW NUCLEAR POWER PLANTS
CNSC INFORMATION DOCUMENT INFO-0756</th><th>NOTES</th></tr>
<tr><td>Section 3.2.1 Site Preparation

Second Paragraph: "The following aspects are considered in the evaluation of the suitability of a site over the life of a nuclear power plant:

▪ the potential effects of external events (such as seismic events, tornadoes and floods) and human activity on the on the site;
▪ the characteristics of the site and its environment which could influence the transfer to persons and the environment of radioactive and hazardous material that may be released; and
▪ the population density, population distribution and other characteristics of the region, insofar as they may affect the implementation of emergency measures and the evaluation of the risks to individuals, the surrounding population and the environment."

Fourth Paragraph: "The technical information arising from consideration of external events, site specific characteristics and supporting safety assessments, are used as input into the design of the new nuclear power plant, and must be included in the application (at the site preparation stage)."</td><td>These requirements are taken directly from IAEA NS-R-3 and are fully applicable to the Application for Site Preparation.</td></tr>
</table>

FINANCIAL GUARANTEES FOR THE DECOMMISSIONING OF LICENSED ACTIVITIES – CNSC REGULATORY GUIDE G-206	**NOTES**
There are no requirements contained in this Regulatory Guide pertaining to the Application for a Licence To Prepare A Site	No contained requirements satisfied the overall screening criteria

TRANSPORTATION SECURITY PLANS FOR CATEGORY I, II OR III NUCLEAR MATERIAL – CNSC REGULATORY GUIDE G-208	**NOTES**
There are no requirements contained in this Regulatory Guide pertaining to the Application for a Licence To Prepare A Site	No contained requirements satisfied the overall screening criteria

DECOMMISSIONING PLANNING FOR LICENSED ACTIVITIES – CNSC REGULATORY DOCUMENT G-219	**NOTES**
Section 10.1 General Radiation Survey Requirements for Decommissioning "Radiation surveys are performed at various stages in the decommissioning planning process: - Pre-operational: to establish background conditions prior to construction.	This requirement of the Regulatory Document is brought forth merely to identify the link between the decommissioning and site evaluation phases of a nuclear project. The requirement itself does not satisfy the overall screening criteria applied for identifying requirements for the assessment of an Application for a Licence to Prepare a Site.

ENVIRONMENTAL MONITORING PROGRAM AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS	NOTES
Section 5.2.2 Designing An Environmental Monitoring Program "The design requires supportive information on the facility characteristics, environmental characteristics, anticipated environmental effects, and anticipated radiation doses to members of the public."	This requirement of the Regulatory Document is brought forth merely to identify the link between the decommissioning and site evaluation phases of a nuclear project. The requirement itself does not satisfy the overall screening criteria applied for identifying requirements for the assessment of an Application for a Licence to Prepare a Site.

EMERGENCY PLANNING AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS – CNSC REGULTORY GUIDE G-225	NOTES
Section 2.0 Scope "This guide applies to applicants for a CNSC licence to operate a Class I nuclear facility, and to applicants for uranium mine and mill licences."	This requirement of the Regulatory Document is brought forth merely to identify the limitation imposed by the Scope statement. IAEA NS-R-3 requires that before construction of the facility is started, that there are no insurmountable difficulties foreseen in establishing an emergency plan before the start of operation.

SECURITY PROGRAMS FOR CATEGORY I OR II NUCLEAR MATERIAL OR CERTAIN NUCLEAR FACILITIES – CNSC REGULATORY GUIDE G-274	**NOTES**
There are no requirements contained in this Regulatory Guide pertaining to the Application for a Licence To Prepare A Site	No contained requirements satisfied the overall screening criteria.

DEVELOPING ENVIRONMENTAL PROTECTION POLICIES, PROGRAMS AND PROCEDURES AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS – CNSC REGULATORY GUIDE G-296	**NOTES**
There are no requirements contained in this Regulatory Guide pertaining to the Application for a Licence To Prepare A Site	No contained requirements satisfied the overall screening criteria.

REQUIREMENTS FOR DESIGN OF NUCLEAR POWER PLANTS – PRE-CONSULTATION DRAFT ISSUED FOR TRIAL USE AND COMMENT	**NOTES**
There are no requirements contained in this Regulatory Guide pertaining to the Application for a Licence To Prepare A Site	No contained requirements satisfied the overall screening criteria.

APPENDIX C

INTERNATIONAL ATOMIC ENERGY AGENCY

NS-R-3 SAFETY REQUIREMENTS

SITE EVALUATION FOR NUCLEAR INSTALLATIONS

TABULATION OF SITE EVALUATION REQUIREMENTS

SITE EVALUATION FOR NUCLEAR INSTALLATIONS – IAEA SAFETY STANDARD NS-R-3	**NOTES**
GENERAL REQUIREMENTS 2.1 In the evaluation of the suitability of a site for a nuclear installation, the following aspects shall be considered:	
(a) The effects of external events occurring in the region of the particular site(these events could be of natural origin or human induced); (b) The characteristics of the site and its environment that could influence the transfer to persons and the environment of radioactive material that has been released; (c) The population density and population distribution and other characteristics of the external zone in so far as they may affect the possibility of implementing emergency measures and the need to evaluate the risks to individuals and the population.	IAEA NS-R-3.2.1 a), b), c) are incorporated into the CNSC Licensing Process INFO-756.
Site characteristics that may affect the safety of the nuclear installation shall be investigated and assessed.	The CNSC documents do not specifically refer to "site characteristics that may affect the safety of the nuclear installation." This clause in the IAEA requirements leads to investigation of geotechnical aspects of the site.
Characteristics of the natural environment in the region that may be affected by potential radiological impacts in operational states and accident conditions shall be investigated. All these characteristics shall be observed and monitored throughout	The CNSC documents do not specifically refer to "characteristics of the natural environment that may be affected by potential radiological

the lifetime of the installation.	impacts”
2.2. If the site evaluation for the three aspects cited indicates that the site is unacceptable and the deficiencies cannot be compensated for by means of design features, measures for site protection or administrative procedures, the site shall be deemed unsuitable.	There are no CNSC documents that contain statements regarding the unacceptability of a site if it does not meet requirements.
2.4. Site characteristics that may affect the safety of the nuclear installation shall be investigated and assessed. Characteristics of the natural environment in the region that may be affected by potential radiological impacts in operational states and accident conditions shall be investigated. All these characteristics shall be observed and monitored throughout the lifetime of the installation.	The notes above opposite 2.1 apply.
2.5. Proposed sites for nuclear installations shall be examined with regard to the frequency and severity of external natural and human induced events and phenomena that could affect the safety of the installation.	CNSC documents use the term “shall be considered” without specific direction to “frequency and severity” of external events.
2.6. The foreseeable evolution of natural and human made factors in the region that may have a bearing on safety shall be evaluated for a time period that encompasses the projected lifetime of the nuclear installation. These factors, particularly population growth and population distribution, shall be monitored over the lifetime of the nuclear installation. If necessary, appropriate measures shall be taken to ensure that the overall risk remains acceptably low.	The IAEA requirements in NS-R-3, Section 2 are more transparently strategic or forward-looking than the CNSC requirements. Specifically NS-R-3, 2.6 requires the monitoring of site characteristics over the lifetime of the nuclear installation, and the application of remedial measures if necessary.
2.7. The hazards associated with external events that are to be considered in the design of the nuclear installation shall be determined. For an external event (or a combination of events) the parameters and the values of those parameters that are used to characterize the hazards should be chosen so that they can be used easily in the design of the installation.	

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2.8 In the derivation of the hazards associated with external events, consideration should be given to the effects of the combination of these hazards with the ambient conditions (e.g. hydrological, hydrogeological and meteorological conditions).	The CNSC requirements do not address the possibility of the combining of external events with severe ambient conditions.
2.9. In the analysis to determine the suitability of the site, consideration shall be given to additional matters relating to safety such as the storage and transport of input and output materials (uranium ore, UF6, UO2, etc.), fresh and spent fuel and radioactive wastes.	The CNSC requirements do not address the assessment of activities that are ancillary to the nuclear installation's operation and the interactions between the site and these activities.
2.10. The possible non-radiological impact of the installation, due to chemical or thermal releases, and the potential for explosion and the dispersion of chemical products shall be taken into account in the site evaluation process.	
2.11. The potential for interactions between nuclear and non-nuclear effluents, such as the combination of heat or chemicals with radioactive material in liquid effluents, should be considered.	The CNSC documents do not identify the potential for nuclear/non-nuclear reactions in effluents.
2.12. For each proposed site the potential radiological impacts in operational states and in accident conditions on people in the region, including impacts that could lead to emergency measures, shall be evaluated with due consideration of the relevant factors, including population distribution, dietary habits, use of land and water, and the radiological impacts of any other releases of radioactive material in the region.	The CNSC documents do not directly target accident conditions arising from operation of the nuclear installation. The Licensing Process INFO-0756 uses the term "emergency measures" - one can only infer from this that accident conditions are to be considered in the Site Preparation work
2.13. For nuclear power plants, the total nuclear capacity to be installed on the site should be determined as far as possible at the first stages of the siting process. If it is proposed that the installed nuclear capacity be significantly increased to a level greater than that previously determined to be acceptable, the suitability of the site shall be re-evaluated, as appropriate.	This aspect of the IAEA requirements is adequately covered by the CNSC licensing process and legislation. The CNSC can require a new site evaluation in those situations where the installed capacity is being significantly increased.

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CRITERIA FOR HAZARDS ASSOCIATED WITH EXTERNAL NATURAL AND HUMAN INDUCED EVENTS	
2.14. Proposed sites shall be adequately investigated with regard to all the site characteristics that could be significant to safety in external natural and human induced events.	
2.15. Possible natural phenomena and human induced situations and activities in the region of a proposed site shall be identified and evaluated according to their significance for the safe operation of the nuclear installation. This evaluation should be used to identify the important natural phenomena or human induced situations and activities in association with which potential hazards are to be investigated.	A clear, straightforward approach to Site Preparation activities is presented. Identify possible external events, evaluate them, identify the important ones, and investigate the associated hazards.
2.16. Foreseeable significant changes in land use shall be considered, such as the expansion of existing installations and human activities or the construction of high risk installations.	The forward-looking aspect of the IAEA requirements has been identified under NS-R-3, 2.6
2.17. Prehistorical, historical and instrumentally recorded information and records, as applicable, of the occurrences and severity of important natural phenomena or human induced situations and activities shall be collected for the region and shall be carefully analysed for reliability, accuracy and completeness.	
2.18. Appropriate methods shall be adopted for establishing the hazards that are associated with major external phenomena. The methods shall be justified in terms of being up to date and compatible with the characteristics of the region.	
2.19. The size of the region to which a method for establishing the hazards associated with major external phenomena is to be applied shall be large enough to include all the features and areas that could be of significance in the determination of the natural and human induced phenomena under consideration and for the	The CNSC documents do not specifically address the parameter of Site Preparation activities - the spatial scope of investigation of external phenomena.

characteristics of the event. 2.20. Major natural and human induced phenomena shall be expressed in terms that can be used as input for deriving the hazards associated with the nuclear installation; that is, appropriate parameters for describing the hazard should be selected or developed 2.21. In the determination of hazards, site specific data shall be used, unless such data are unobtainable. In this case, data from other regions that are sufficiently relevant to the region of interest may be used in the determination of hazards. Appropriate and acceptable simulation techniques may also be used. In general, data obtained for similar regions and simulation techniques may also be used to augment the site specific data. <u>CRITERIA FOR DETERMINING THE POTENTIAL EFFECTS OF THE NUCLEAR INSTALLATION IN THE REGION</u>	
2.22. In the evaluation of a site to determine its potential radiological impact on the region for operational states and accident conditions that could lead to emergency measures, appropriate estimates shall be made of expected or potential releases of radioactive material, with account taken of the design of the installation and its safety features. These estimates shall be confirmed when the design and its safety features have been confirmed.	Specific requirement to include accident conditions in the Site Preparation investigation, with a subsequent requirement to confirm estimates used in that investigation when design work in completed. This aspect of site evaluation is not covered by the CNSC documents
2.23. The direct and indirect pathways by which radioactive material released from the nuclear installation could potentially reach and affect people and the environment shall be identified and evaluated; in such an evaluation specific regional and site characteristics shall be taken into account, with special attention paid to the function of the biosphere in the accumulation and transport of radionuclides.	Pathway analyses, in a Canadian context were traditionally done during the construction phase, and submitted in support of an application for an operating licence. The IAEA requirements move this activity forward to the site evaluation stage.

2.24. The site and the design for the nuclear installation shall be examined in conjunction to ensure that the radiological risk to the public and the environment associated with radioactive releases is acceptably low.	
2.25. The design of the installation shall be such as to compensate for any unacceptable potential effects of the nuclear installation on the region, or otherwise the site shall be deemed unsuitable.	Specific reference to criteria for the rejection of a site based on its unsuitability.
<u>CRITERIA DERIVED FROM CONSIDERATIONS OF POPULATION AND EMERGENCY PLANNING</u> 2.26. The proposed region shall be studied to evaluate the present and foreseeable future characteristics and the distribution of the population of the region. Such a study shall include the evaluation of present and future uses of land and water in the region and account shall be taken of any special characteristics that may affect the potential consequences of radioactive releases for individuals and the population as a whole. 2.27. In relation to the characteristics and distribution of the population, the combined effects of the site and the installation shall be such that: (a) For operational states of the installation the radiological exposure of the population remains as low as reasonably achievable and in any case is in compliance with national requirements, with account taken of international recommendations; (b) The radiological risk to the population associated with accident conditions, including those that could lead to emergency measures being taken, is acceptably low.	

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2.28. If, after thorough evaluation, it is shown that no appropriate measures can be developed to meet the above mentioned requirements, the site shall be deemed unsuitable for the location of a nuclear installation of the type proposed.	
2.29. The external zone for a proposed site shall be established with account taken of the potential for radiological consequences for people and the feasibility of implementing emergency plans, and of any external events or phenomena that may hinder their implementation. Before construction of the plant is started, it shall be confirmed that there will be no insurmountable difficulties in establishing an emergency plan for the external zone before the start of operation of the plant.	The IAEA requirements stipulate that a product of the Site Preparation and investigation activities is a positive finding with respect to the practicability of emergency plans. If practical emergency measures are not in hand, or at least foreseen to be achievable (no insurmountable obstacles) at the end of the process, the site shall be rejected as unsuitable.

APPENDIX D

UNITED STATES NUCLEAR REGULATORY COMMISSION

TABULATION OF SITE EVALUATION REQUIREMENTS

USNRC 10 CFR PART 50 – DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES	NOTES
Requirement of License, Exceptions **§ 50.10 License required.** (e)(1) The Director of Nuclear Reactor Regulation may authorize an applicant for a construction permit for a utilization facility which is subject to § 51.20(b) of this chapter, and is of the type specified in § 50.21(b) (2) or (3) or § 50.22 or is a testing facility to conduct the following activities: (i) Preparation of the site for construction of the facility (including such activities as clearing, grading, construction of temporary access roads and borrow areas); (ii) installation of temporary construction support facilities (including such items as warehouse and shop facilities, utilities, concrete mixing plants, docking and unloading facilities, and construction support buildings); (iii) excavation for facility structures; (iv) construction of service facilities (including such facilities as roadways, paving, railroad spurs, fencing, exterior utility and lighting systems, transmission lines, and sanitary sewerage treatment facilities); and (v) the construction of structures, systems and components which do not prevent or mitigate the consequences of postulated accidents that could cause undue risk to the health and safety of the public. No such authorization shall be granted unless the staff has completed a final environmental impact statement on the issuance of the construction permit as required by subpart A of part 51 of this chapter.	The contractor has recommended that the CNSC specify the activities sanctioned by the granting of a Site Preparation Licence. The requirements of USNRC 10CFR Part 50.10 (e)(1) are shown to illustrate the type of description of allowable activities that was being considered when the Recommendation was drafted.

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USNRC 10 CFR PART 52 – EARLY SITE PERMITS; STANDARD DESIGN CERTIFICATIONS; AND COMBINED LICENSES FOR NUCLEAR POWER PLANTS	NOTES
§ 52.15 Filing of applications. (a) Any person who may apply for a construction permit under 10 CFR part 50, or for a combined license under 10 CFR part 52, may file with the Director of Nuclear Reactor Regulation an application for an early site permit. An application for an early site permit may be filed notwithstanding the fact that an application for a construction permit or a combined license has not been filed in connection with the site or sites for which a permit is sought. (b) The application must comply with the filing requirements of 10 CFR 50.30 (a), (b), and (f) as they would apply to an application for a construction permit. The following portions of § 50.4, which is referenced by § 50.30(a)(1), are applicable: paragraphs (a), (b) (1)-(3), (c), (d), and (e). **§ 52.17 Contents of applications.** (a)(1) The application must contain the information required by § 50.33 (a) through (d), the information required by § 50.34 (a)(12) and (b)(10), and to the extent approval of emergency plans is sought under paragraph (b)(2)(ii) of this section, the information required by § 50.33 (g) and (j), and § 50.34 (b)(6)(v) of this chapter. The application must also contain a description and safety assessment of the site on which the facility is to be located. The assessment must contain an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in § 50.34(a)(1) of this chapter. Site characteristics must comply with part 100 of this chapter. In	The requirements of USNRC 10CFR Part 52 are principally administrative in nature, dealing with the content and submission requirements of Applications for the subject Permits, Certifications and Licences issued by the Commission.

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addition, the application should describe the following: (i) The number, type, and thermal power level of the facilities for which the site may be used; (ii) The boundaries of the site; (iii) The proposed general location of each facility on the site; (iv) The anticipated maximum levels of radiological and thermal effluents each facility will produce; (v) The type of cooling systems, intakes, and outflows that may be associated with each facility;	
(vi) The seismic, meteorological, hydrologic, and geologic characteristics of the proposed site; (vii) The location and description of any nearby industrial, military, or transportation facilities and routes; and (viii) The existing and projected future population profile of the area surrounding the site.	The investigations of site factors covered by clauses (vi), (vii), and (viii) are addressed by requirements in IAEA NS-R-3.
(2) A complete environmental report as required by 10 CFR 51.45 and 51.50 must be included in the application, provided, however, that such environmental report must focus on the environmental effects of construction and operation of a reactor, or reactors, which have characteristics that fall within the postulated site parameters, and provided further that the report need not include an assessment of the benefits (for example, need for power) of the proposed action, but must include an evaluation of alternative sites to determine whether there is any	Section (2) contains a requirement for a proponent to evaluate alternate sites to the one described in the application. The contractor recommends that this approach not be adopted in Canada, since doing so could lead the CNSC into an undesirable situation of determining the "best" site from several.

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obviously superior alternative to the site proposed. (b) (1) The application must identify physical characteristics unique to the proposed site, such as egress limitations from the area surrounding the site that could pose a significant impediment to the development of emergency plans. (2) The application may also either: (i) Propose major features of the emergency plans, such as the exact sizes of the emergency planning zones, that can be reviewed and approved by NRC in consultation with FEMA in the absence of complete and integrated emergency plans; or (ii) Propose complete and integrated emergency plans for review and approval by the NRC, in consultation with the Federal Emergency Management Agency, in accord with the applicable provisions of 10 CFR 50.47. (3) Under paragraphs (b)(1) and (2)(i) of this section, the application must include a description of contacts and arrangements made with local, state, and federal governmental agencies with emergency planning responsibilities. Under the option set forth in paragraph (b)(2)(ii) of this section, the applicant shall make good faith efforts to obtain from the same governmental agencies certifications that: (i) The proposed emergency plans are practicable; (ii) These agencies are committed to participating in any further development of the plans, including any required field demonstrations, and (iii) that these agencies are committed to executing their responsibilities under the plans in the event of an emergency. The application must contain any certifications that have been obtained. If these certifications cannot be obtained, the application must contain information, including a utility plan, sufficient to show that the proposed plans nonetheless provide reasonable assurance that adequate protective measures can	Item (b) (1) is addressed in IAEA NS-R-3 by the requirement to ensure no irresolvable impediments to the establishment of emergency plans at the construction licence stage.

and will be taken, in the event of a radiological emergency at the site. (c) If the applicant wishes to be able to perform, after grant of the early site permit, the activities at the site allowed by 10 CFR 50.10(e)(1) without first obtaining the separate authorization required by that section, the applicant shall propose, in the early site permit, a plan for redress of the site in the event that the activities are performed and the site permit expires before it is referenced in an application for a construction permit or a combined license issued under subpart C of this part. The application must demonstrate that there is reasonable assurance that redress carried out under the plan will achieve an environmentally stable and aesthetically acceptable site suitable for whatever non-nuclear use may conform with local zoning laws.	The contractor has commented on the need to consider redress activities of the proponent in the event a site is deemed unsuitable for a nuclear facility.

USNRC 10 CFR PART 100 – REACTOR SITE CRITERIA	**NOTES**
100.1 Purpose (c) Siting factors and criteria are important in assuring that radiological doses from normal operation and postulated accidents will be acceptably low, that natural phenomena and potential man-made hazards will be appropriately accounted for in the design of the plant, that site characteristics are such that adequate security measures to protect the plant can be developed, and that physical characteristics unique to the proposed site that could pose a significant impediment to the development of emergency plans are identified. (d) This approach incorporates the appropriate standards and criteria for approval of stationary power and testing reactor sites. The Commission intends to carry out a traditional defense-in-depth approach with regard to reactor siting to ensure public safety. Siting away from densely populated centers has been and will	USRNR 10CFR Part 100.1 (c) identifies a new requirement related to site evaluation, that being the need to ensure the chosen site does not present obstacles to establishing adequate security measures. This requirement is not addressed in IAEA NS-R-3.

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continue to be an important factor in evaluating applications for site approval. **Subpart A--Evaluation Factors for Stationary Power Reactor Site Applications Before January 10, 1997 and for Testing Reactors** **100.10 Factors to be considered when evaluating sites.** Factors considered in the evaluation of sites include those relating both to the proposed reactor design and the characteristics peculiar to the site. It is expected that reactors will reflect through their design, construction and operation an extremely low probability for accidents that could result in release of significant quantities of radioactive fission products. In addition, the site location and the engineered features included as safeguards against the hazardous consequences of an accident, should one occur, should insure a low risk of public exposure. In particular, the Commission will take the following factors into consideration in determining the acceptability of a site for a power or testing reactor: (a) Characteristics of reactor design and proposed operation including: (1) Intended use of the reactor including the proposed maximum power level and the nature and inventory of contained radioactive materials; (2) The extent to which generally accepted engineering standards are applied to the design of the reactor; (3) The extent to which the reactor incorporates unique or unusual features having a significant bearing on the probability or consequences of accidental release of radioactive materials;	

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in the application of this guide. Where very large cities are involved, a greater distance may be necessary because of total integrated population dose consideration. (b) For sites for multiple reactor facilities consideration should be given to the following: (1) If the reactors are independent to the extent that an accident in one reactor would not initiate an accident in another, the size of the exclusion area, low population zone and population center distance shall be fulfilled with respect to each reactor individually. The envelopes of the plan overlay of the areas so calculated shall then be taken as their respective boundaries. (2) If the reactors are interconnected to the extent that an accident in one reactor could affect the safety of operation of any other, the size of the exclusion area, low population zone and population center distance shall be based upon the assumption that all interconnected reactors emit their postulated fission product releases simultaneously. This requirement may be reduced in relation to the degree of coupling between reactors, the probability of concomitant accidents and the probability that an individual would not be exposed to the radiation effects from simultaneous releases. The applicant would be expected to justify to the satisfaction of the Commission the basis for such a reduction in the source term. (3) The applicant is expected to show that the simultaneous operation of multiple reactors at a site will not result in total radioactive effluent releases beyond the allowable limits of applicable regulations. **Subpart B--Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997**	

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seismic characteristics of the proposed site, such that, there is a reasonable assurance that a nuclear power plant can be constructed and operated at the proposed site without undue risk to the health and safety of the public. Applications to engineering design are contained in appendix S to part 50 of this chapter. (a) *Applicability*. The requirements in paragraphs (c) and (d) of this section apply to applicants for an early site permit or combined license pursuant to Part 52 of this chapter, or a construction permit or operating license for a nuclear power plant pursuant to Part 50 of this chapter on or after January 10, 1997. However, for either an operating license applicant or holder whose construction permit was issued prior to January 10, 1997, the seismic and geologic siting criteria in Appendix A to Part 100 of this chapter continues to apply. (b) *Commencement of construction*. The investigations required in paragraph (c) of this section are within the scope of investigations permitted by § 50.10(c)(1) of this chapter. (c) *Geological, seismological, and engineering characteristics*. The geological, seismological, and engineering characteristics of a site and its environs must be investigated in sufficient scope and detail to permit an adequate evaluation of the proposed site, to provide sufficient information to support evaluations performed to arrive at estimates of the Safe Shutdown Earthquake Ground Motion, and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site. The size of the region to be investigated and the type of data pertinent to the investigations must be determined based on the nature of the region surrounding the proposed site. Data on the vibratory ground motion, tectonic surface deformation, nontectonic deformation, earthquake recurrence rates, fault geometry and slip rates, site foundation material, and seismically induced floods and water waves must be obtained by reviewing pertinent literature and carrying out field investigations. However, each applicant shall	

investigate all geologic and seismic factors (for example, volcanic activity) that may affect the design and operation of the proposed nuclear power plant irrespective of whether such factors are explicitly included in this section. (d) *Geologic and seismic siting factors*. The geologic and seismic siting factors considered for design must include a determination of the Safe Shutdown Earthquake Ground Motion for the site, the potential for surface tectonic and nontectonic deformations, the design bases for seismically induced floods and water waves, and other design conditions as stated in paragraph (d)(4) of this section. (1) Determination of the Safe Shutdown Earthquake Ground Motion. The Safe Shutdown Earthquake Ground Motion for the site is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface. The Safe Shutdown Earthquake Ground Motion for the site is determined considering the results of the investigations required by paragraph (c) of this section. Uncertainties are inherent in such estimates. These uncertainties must be addressed through an appropriate analysis, such as a probabilistic seismic hazard analysis or suitable sensitivity analyses. Paragraph IV(a)(1) of appendix S to part 50 of this chapter defines the minimum Safe Shutdown Earthquake Ground Motion for design. (2) Determination of the potential for surface tectonic and nontectonic deformations. Sufficient geological, seismological, and geophysical data must be provided to clearly establish whether there is a potential for surface deformation. (3) Determination of design bases for seismically induced floods and water waves. The size of seismically induced floods and water waves that could affect a site from either locally or distantly generated seismic activity must be determined.	

(4) Determination of siting factors for other design conditions. Siting factors for other design conditions that must be evaluated include soil and rock stability, liquefaction potential, natural and artificial slope stability, cooling water supply, and remote safety-related structure siting. Each applicant shall evaluate all siting factors and potential causes of failure, such as, the physical properties of the materials underlying the site, ground disruption, and the effects of vibratory ground motion that may affect the design and operation of the proposed nuclear power plant.	

APPENDIX E

RADIATION AND NUCLEAR SAFETY AUTHORITY (STUK)

YVL GUIDES

TABULATION OF SITE EVALUATION REQUIREMENTS

STUK – Radiation and Nuclear Safety Authority, Finland **Safety Criteria for Design of Nuclear Power Plants – YVL 1.0**	**NOTES**
3.14 External events {According to paragraph one, section 20 of the Council of State Decision (395/91), *the most important nuclear power plant safety functions shall remain operable in spite of any natural phenomena estimated possible on site or other events external to the plant. In addition, the combined effects of accident conditions induced by internal causes and simultaneous natural phenomena shall be taken into account to the extent estimated possible.* }	This statement is brought forward from YVL 1.0 for information. It establishes a requirement to consider the combined effects of accidents and external phenomena.
Natural phenomena include at least freezing which hinders the operation of the final heat sink or blockage due to some other reason, thunderstorm, earthquake, storm wind, flooding, exceptionally cold or warm weather, exceptionally hard rain or drought and exceptionally low sea level. Other events external to the plant are at least electromagnetic disturbances, oil leaks, crashing aeroplanes, explosions, releases of poisonous gases and unauthorised plant site entry	The natural phenomena listed here are addressed by IAEA NS-R-3, specifically: Earthquakes: Sect 3.1 to 3.7 Meteorological Events: Sect 3.8 to 3.17 Flooding: Sect 3.18 to 3.32 Aircraft Crashes: Sect 3.44 to 3.47 Explosions: Sect 3.48 to 3.50 EMag Disturbances: Sect 3.51 Poisonous Gases: Sect 3.51 Oil Spills: Sect 3.54 Low Sea Level: Sect 3.52 to 3.55 Frazil Ice and Impairment of Final Heat Sink: Sect 3.53 to 3.54.

STUK – Radiation and Nuclear Safety Authority, Finland **Safety Criteria for Siting a Nuclear Power Plant – YVL 1.10**	**NOTES**
Section 2 Plant Site and Surroundings	
" . . . in the plant's vicinity there may not be facilities or population centres where the necessary protective measures, such as sheltering indoors or evacuation, would be difficult to implement. In the plant's vicinity, no activities may be carried out that could pose an external threat to the plant.	This requirement is addressed in IAEA NS-R-3 Sect 2.26 to 2.29
{ The general principle in the siting of nuclear power plants is to have the facilities in a sparsely populated area and far away from large population centres. What justifies placement in a sparsely populated area is that emergency planning will then be directed at a smaller population group and will thus be easier to implement. A nuclear power **plant site** extends to about a kilometre's distance from the facility. It is defined as an area where only power plant related activities are allowed as a rule. Permanent settlement is prohibited and only very limited employee accommodation or recreational settlement is allowed. The licensee responsible for the operation of the nuclear power plant shall have authority of decision over all activities in the area and shall be able to remove unauthorised individuals from the site, if necessary, or prevent such individuals from entering it. The plant site may contain other non-facility related activities provided that they do not pose a threat to plant safety. A traffic lane may traverse the site if the volume of traffic is small and if traffic can be directed elsewhere, if necessary. Visits onsite are allowed provided that the licensee has the possibility to control	The statements taken from YVL 1.10 are provided for information only. Traditional Canadian practice has not established concentric zones – exclusion zone, protective zone, planning zone. The CNSC's interest in the safe siting, and proper site evaluation of future nuclear installations can be adequately served by the requirement in IAEA NS-R-3 that at the construction licence stage, there shall be no identified insurmountable difficulties to the establishment of emergency plans.

the movement of visitors. The plant site is surrounded by a **protective zone** extending to about a five kilometres' distance from the facility. Land use restrictions are in force within the zone. Dense settlement and hospitals or facilities inhabited or visited by a considerable number of people are not allowed within the zone. The zone may not contain such significant productive activities as could be affected by an accident at the nuclear power plant. The number of permanent inhabitants should not be in excess of 200. The number of persons taking part in recreational activities may be higher, provided that an appropriate rescue plan can be drawn up for the area. In accordance with a Ministry of the Interior Order, the nuclear facility is to be surrounded by an **emergency planning zone** extending to about 20 kilometres from the facility; the zone shall be covered by detailed rescue plans for public protection drawn up by the authorities. The authorities also bear responsibility for the implementation of the plans. In implementation, special attention shall be paid to the characteristics of the site's surroundings, such as archipelagos that are difficult to cross and recreational settlements, for example. The emergency planning zone may not contain such populations or population centres as would render impossible the efficient implementation of rescue measures applicable to them. } **Section 3 Safety Factors Affecting Site Selection** 3.1 External Events Affecting Safety	
The applicant for a licence shall list those external events that could pose a threat to safety at the site in question and shall also assess the risks arising from these events. Effects on the supply of cooling water and on electric power grid connections shall also be considered.	The external events cited in this Section of YVL 1.10 are addressed in IAEA NS-R-3, with the exception of "effects on electric power grid connections". A query has been sent to STUK requesting information on the intent of this requirement, i.e., is the requirement

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Hazardous industry, traffic and exceptional natural phenomena shall be considered. Examples of exceptional natural phenomena include: • Freezing or other clogging of the cooling water intake • Storms • Snow loads • Flood • Low sea level • Seismic events. The risks arising from external events are assessed by analyses conducted in accordance with Guide YVL 2.8.	directed at future grid stability with the facility in operation (effect of the facility on the region or area) or is it directed at the reliability of off-site power during operational transients (effect of the environment on the facility)? Low sea level and other impairments of the final heat sink, including frazil ice formation and blockage are addressed in IAEA NS-R-3, Section 3.52 to 3.54.
3.2 Radioactive Releases When radiation doses to the surrounding population are calculated, the region's special characteristics--hydrological, geological and meteorological--as well as the living conditions and habits of the population shall be considered.	IAEA NS-R-3 addresses the requirements to consider these regional characteristics in calculating projected radiation exposures.

STUK – Radiation and Nuclear Safety Authority, Finland **Seismic Events and Nuclear Power Plants – YVL 2.6**	**NOTES**
There are no requirements contained in this Guide that satisfy the overall screening criteria.	

STUK – Radiation and Nuclear Safety Authority, Finland **Seismic Events and Nuclear Power Plants – YVL 2.6**	**NOTES**
There are no requirements contained in this Guide that satisfy the overall screening criteria.	

STUK – Radiation and Nuclear Safety Authority, Finland **Radiation Safety Aspects in the Design of a Nuclear Power Plant – YVL 7.18**	**NOTES**
There are no requirements contained in this Guide that satisfy the overall screening criteria.	

A TECHNICAL ASSESSMENT OF THE ENHANCED PLANNING AND PREPAREDNESS ARRANGEMENTS IN THE CONTIGUOUS ZONE SURROUNDING ONTARIO POWER GENERATION INC. NUCLEAR GENERATING STATIONS

1. Introduction

The revised Provincial Nuclear Emergency Plan (PNEP) defines the Contiguous Zone (the CZ) as

> *The zone immediately surrounding the nuclear installation.*

An increased level of nuclear planning and preparedness shall be undertaken within this area because of its proximity to the source of the potential hazard. (PNEP, Part I, s. 2.4.1 (a))

In practice, the CZ surrounding the nuclear stations extends from the site boundary (which is approximately 1 km from the reactors) to a distance of 3-4 km from the reactors.

Emergency Management Ontario (EMO) have defined "an increased level of nuclear planning and preparedness" to mean the existence of mechanisms to assure (a) timely alerting and notification and (b) priority evacuation of the residents of the CZ.

The issue at hand is whether it can be justified to have one, enhanced, level of planning and preparedness for the CZ and another level, seemingly "less enhanced", for the rest of the Primary Zone (up to 10 km from the reactors). It appears that some people are of the view that planning and preparedness should be at one unified level for the entire Primary Zone (PZ).

It is the aim of this paper to examine the technical basis for the distinction between the CZ and the rest of the PZ and the level of planning and preparedness appropriate to each.

2. Background

The planning basis of the revised PNEP is grounded, in part, on the recommendations of three separate studies: the Ontario Nuclear Safety Review (1988), the report of Provincial Working Group #8 (1988), and the report of the Royal Society of Canada/Canadian Academy of

Engineering (1996). All three studies concluded, essentially, that the Province should revise the (then) PNEP to take into account accidents *more severe* than had originally been in the "planning basis." These "more severe" accidents were at first given various qualitative descriptions (e.g., "Worst Credible Radiation Emission" by WG #8) and finally quantified by the RSC/CAE as a "10^{-7} accident", i.e. an accident whose expected frequency was at least 1 in 10 million reactor operating years. The implication was that accidents with a probability less than this cut-off value need not be planned for in detail.

EMO, realizing the remote likelihood of such an accident (with a probability comparable to that of a comet or asteroid strike on Earth resulting in a major extinction of species, similar to the Cretaceous-Tertiary event) and taking into account the necessity to allocate limited resources wisely, decided to implement the above general recommendation by enhancing nuclear planning and preparedness only in the Contiguous Zone.

This decision has been questioned, as it has been suggested that nuclear planning and preparedness should be uniform throughout the entire Primary Zone.

We believe that EMO's decision can be justified if it can be shown that the increased potential consequences (mortality or morbidity) of a "more severe" accident would be largely (or entirely) limited to the population of the CZ.

3. Hazards and Risks

Measures assuring the priority alerting and evacuation of the Contiguous Zone is thought by EMO to be an adequate enhancement of nuclear planning and preparedness to cater for a "more severe" accident.

Consider, as a typical example, the most severe accident (i.e., the one resulting in the greatest offsite consequences) described in the Pickering A Risk Assessment (PARA) that is within the suggested 10^{-7} cutoff and that also meets the criteria for the "more severe" accident listed in the PNEP, Part I, s. 2.3.5. These criteria include

> *A greatly limited warning period;*
>
> *High radiation doses in the Contiguous Zone;*
>
> *Radioiodines and particulates form a significant component of the release;*
>
> *Ground contamination could be significant.*

The PARA is used since it contains the most recent and detailed analysis of risks to the public from ~~an~~ a reactor accident contiguous to a heavily populated area. The Darlington Probabilistic Safety Evaluation (DPSE) is an older document (currently under revision) which does not use the most modern risk assessment "tools" and does not calculate public risks to the same extent that

PARA does. In addition, Darlington NGS is located in a more sparsely populated area and thus its collective risks are intrinsically less.

PARA divides accident scenarios into seven Ex-Plant Release Categories (EPRC-1 to EPRC-7), each characterized by a range of releases of radioactivity to the environment. The most severe release (i.e., with the most radioactivity released) falling within the frequency criterion is EPRC-3, with an expected frequency of almost exactly 1 in 10 million years. EPRC-3 is characterized by both extensive fuel failures and an early breach of containment, resulting in an unfiltered release of noble gases, radioiodines and particulates within 33 hours of the initiating event.

The presence of radioiodines and particulates results in a public dose profile significantly different from a more "standard" or "non-severe" accident, like EPRC-7, where an intact containment results in the release of noble gases only. In an accident similar to EPRC-3, then, many of the characterizations of a "more severe" accident as described in the PNEP (see above) are indeed satisfied. Thus, we conclude that **EPRC-3 can reliably be used as a blueprint or template for the "more severe" accident and its consequences applied as a testing ground for EMO's planning considerations.**

Although accident sequences EPRC-1 and EPRC-2 are even more "severe" than EPRC-3, their extremely low probability (less than the $1{:}10^{-7}$ cutoff recommended by the RSC/CAE) puts them outside the scope of the present paper.

In the PARA analysis, doses to the public from the EPRC-3 accident are calculated from basically two sources with different characteristics and, indeed, varying time frames. These are, first, acute ("early") doses and second, chronic or long-term doses. The acute doses are due to a short-term, intense release from the reactor(s) and the public dose would accrue largely from external exposure to noble gases and from the inhalation of radioiodines (collectively called the "plume exposure" dose). The chronic doses, on the other hand, arise primarily from the deposition of radioisotopes on the ground followed by doses due to ground shine, the inhalation of resuspended particulates, and the ingestion of various crops, meat, milk and water. In calculating the chronic public dose, PARA assumes a one-year integration time and no credit is given for any countermeasures which could be applied during that one-year period.

It is, however, self-evident that in the event of any accident with such long-term consequences, "Phase 2" countermeasures such as relocation, decontamination, and food and water controls *would* be in place; accordingly, chronic doses are not expected to be significant in practice and we shall therefore not consider the chronic component of the total public dose any further. Thus, we shall limit our analysis of the public dose consequences of EPRC-3 to the early (release) phase. Minimizing or eliminating these chronic doses is of course the primary purpose of Phase 2 planning and response.

Table 1 (attached) presents the *mean early individual dose* to an unprotected member of the public as a function of distance from the plant for the EPRC-3 accident, absent any countermeasures.

From Table 1, it is evident that **doses in the Contiguous Zone (1-3 km distance) could be considerably in excess of any Protective Action Level (PAL).** (The lower evacuation PAL is 1 rem.) In fact, in the absence of any immediate protective actions, such as evacuation, **the doses could be sufficiently high (30 rem to 150 rem) to warrant activation of the Radiation Exposure Plan** and the setting up of monitoring/decontamination centres and the Clinical Assessment Facilities.

Under these circumstances, **many individuals could suffer a variety of ill effects,** although early deaths would be unlikely since it is currently believed that doses of less than 300 rem would not be fatal in the short term. Delayed effects of such doses are widely believed to include a spectrum of fatal and non-fatal cancers. The probability of these delayed effects is thought to be proportional to the dose received, with no threshold level. Current international advice and recommendations are based on the assumption that this probability is equal to one fatal cancer per 10,000 people having received one rem each and that this probability increases linearly with dose.

In the rest of the Primary Zone beyond 3-4 km, in contrast, doses would be well below the morbidity/mortality threshold, even in the absence of countermeasures. However, doses would be greater than the upper evacuation PAL and therefore, evacuations would have to be ordered, given this scenario, for the entire Primary Zone. Given that, the possibility of delayed effects is always present (even though there is no *immediate* threat to peoples' lives or well-being), evacuations would be directed as quickly as possible, to limit the public's exposure.

Again, the major, immediate public risk from a "severe" accident such as EPRC-3, then, is clearly to the Contiguous Zone. However, protective measures would be ordered without delay for the entire Primary Zone.

4. Analysis

In this section, we consider the public safety implications of deviating from the current planning and preparedness framework. We consider two cases: (i) that of not having any increased planning and preparedness at all in the Contiguous Zone and (ii) that of having increased planning and preparedness throughout the entire Primary Zone. In both cases, the same level of planning and preparedness would be in place throughout the entire Primary Zone (as some would want) but, of course, this would exist at two different planes (which we shall call "standard" and "enhanced").

4.1 Standard Level throughout

Having a "standard" level of planning and preparedness throughout the PZ would imply having no particular enhancements for the 3-4 km CZ; in particular, having neither early warning systems nor plans for priority evacuations. But we have already seen that the "more severe" accident leads to the possibility of early public doses in excess of PALs and even into a range where early health effects (though not fatalities) are possible. Although the PARA analysis assumes a 33-hour holdup period, the actual delay time could be significantly less. Thus, given the possibility of a limited warning period and taking the possible doses into account, both components of enhanced preparedness (namely, early warning and priority in evacuation) would appear to be justified. **It is difficult to reconcile a "standard" level of preparedness with the necessity to plan adequately for the consequences to the CZ of a severe accident similar to EPRC-3.**

4.2 Enhanced Level throughout

This alternative would be to have an early warning system and priority evacuation planning in place for the entire Primary Zone. It is possible to have a PZ-wide warning system, although it would be extremely expensive to install, maintain and test. However, it is not clear how a "priority" evacuation plan for the entire Primary Zone could be implemented in practice – as a matter of logistics, additional prioritization would always have to be done, and this would necessarily revert to the area most at risk -- i.e. the CZ.

Could such enhanced measures be justified for the PZ as a whole? Immediate measures are justified when the risk, or hazard, is also immediate and/or severe. But Table 1 shows that total doses beyond 3-4 km are well below the level at which immediate health effects may occur. Even with a hold-up time of less than the assumed 33 hours, it appears that **a less enhanced level of PZ planning and preparedness is adequate to protect the populace.** This conclusion is based on the following considerations:

- the severe (EPRC-3) accident is extremely unlikely and we cannot plan for "everything";
- there would normally be *some* warning (i.e. an immediate release is very unlikely);
- the expected doses in the PZ are much smaller than in the CZ;
- Evacuations would, because of population density , have to be prioritized according to distance from the reactor, resulting in a less urgent need to know and take action the further away one is.
- the release itself would last some time (at least a day and perhaps much longer).

The last point perhaps requires additional clarification. The doses in Table 1 will not be delivered instantaneously; the PARA analysis anticipates a release duration of 30-40 hours, if not more. Thus, even if an immediate evacuation of the Primary Zone beyond 3-4 km was not possible (because evacuating the CZ had priority), **the doses in the PZ** resulting from a short-term exposure prior to complete evacuation (of the order of a few hours, say) **would likely still be below the** upper evacuation **PAL** in most cases. This is in marked contrast to the CZ, where even a short exposure could well lead to a dose approaching the upper evacuation PAL, or even exceeding it.

5. The size of the Primary Zone

Table 1 shows that areas as far away as 20-30 km from the station could receive doses above 1 rem (the lower evacuation PAL) in the absence of countermeasures. However, no location within the

Primary Zone would receive doses above 10 rem, the upper evacuation PAL. Under the PNEP, evacuations should be considered at the lower evacuation PAL but are compulsory only above the upper evacuation PAL. Since the PNEP already makes provision for evacuations up to 20 km from the station or 10 km beyond the Primary Zone (see, e.g., PNEP, Part I, section 2.3.7, p. 17, and PNEP, Part IV, Table 4.3) it would appear that a 10 km Primary Zone is appropriate..

6. Conclusions

- **EPRC-3 is a valid "blueprint" or "template" scenario for the "more severe" accident for which planning and preparedness is to be carried out.**
- **The most severe off-site impacts to the public from EPRC-3 is to the 1-3 km Contiguous Zone. At no distance farther than 10 km from the station would the Upper Evacuation PAL (10 rem) be exceeded.**
- **An enhanced level of planning and preparedness, including early warning systems and priority evacuations, is appropriate for the Contiguous Zone.**
- **A less stringent set of specifications for early warning is appropriate for the area of the Primary Zone that is beyond the Contiguous Zone (3-10 km).**

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May 2002

Table 1

EPRC-3

Mean Early Individual Effective Dose vs. Distance From Reactor

(Source: PARA, ch. 13, Table 13.5-2)

Distance (km)	Zone	Dose (rem)
1	Site Boundary	150
3	Contiguous Zone	29
6	Middle Ring	11
12	Primary Zone	4
20	Secondary Zone	1.4
28	Secondary Zone	0.8

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Planning areas for emergency response near nuclear power plants

Recommendation by the German Commission on Radiological Protection

Adopted at the 268th meeting of the German Commission on Radiological Protection on 13 and 14 February 2014

The German original of this English translation was published in 2014 by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety under the title:

Planungsgebiete für den Notfallschutz in der Umgebung von Kernkraftwerken

Empfehlung der Strahlenschutzkommission

Contents

I Recommendation

1 Introduction

On 11 March 2011 an earthquake measuring 9.0 on the Richter scale struck northern Japan, triggering a tsunami whose 15 m high waves devastated the coastal region. The earthquake and tsunami also caused a major nuclear accident at the Fukushima Daiichi Nuclear Power Station. The radiological impact demanded extensive measures for the protection of the affected population.

On the basis of what was learned from the accident in Japan, the German Commission on Radiological Protection reviewed the technical foundations of Germany's emergency preparedness and the accompanying regulations. The range of accidents included in the contingency planning was redefined to more closely reflect an accident's potential impact rather than its likelihood. This review has shown that the emergency preparedness planning areas near nuclear power plants must be revised.

2 Background

Pursuant to Article 70 of the Basic Law for the Federal Republic of Germany, hazard aversion is a duty of the federal states (Länder) which, to this end, have passed disaster control laws that form the basis for the general emergency response plans drawn up by the competent authorities. In addition to these, there must be special emergency response plans for areas near nuclear power plants as well as for other installations and facilities that have a high risk potential.

The “Basic Recommendations for Emergency Preparedness in the Vicinity of Nuclear Installations” (BMU 2008) aim to ensure that the dedicated emergency preparedness plans all across Germany are largely based on common principles. The “Basic Recommendations” include specifying planning areas. The “Radiological Bases for Decisions on Measures for the Protection of the Population against Accidental Releases of Radionuclides” (SSK 2014) provide the radiological basis for this dedicated planning.

This recommendation suggests changing Germany's emergency preparedness planning areas. Because the planning areas' nature and size are an important basis for the implementation of protective measures and the development of strategies, the recommendation was drafted in advance as the basis of the upcoming revision of the “Basic Recommendations for Emergency Preparedness”.

The recommendation should be seen as the basis for dedicated emergency preparedness plans for German nuclear power plants and those foreign facilities that require special planning measures within the scope of the “Basic Recommendations” given their proximity to the border.

3 Recommendations by the German Commission on Radiological Protection

Measures to protect the public must be prepared in the planning areas. These particular measures are part of a strategy to be implemented in case of an actual accident depending on the situation. The Commission on Radiological Protection recommends adopting the following planning areas:

- **Planning area "central zone"**

The central zone is a planning area in which certain public protection measures previously outlined (BMU 2008) such as “staying indoors”, “distribution and consumption of iodine tablets” as well as “evacuation” are to be readied. For nuclear power plants in operation, the central zone extends up to around 5 kilometres around the installation.

Local conditions, such as the structure of the terrain, settlement and administration are to be taken into account when determining the planning area.

Measures in the central zone are especially urgent because of the proximity to the nuclear installation. They are conducted regardless of the dispersal direction of radioactive substances.

The measures for the central zone must be planned in such a way that, if possible, they can be implemented before the release of radioactive substances in an accident.

It should be possible to completely evacuate the entire population from the central zone within around 6 hours of notifying the competent authorities.

The measures to prepare iodine blockade, i. e. the distribution of iodine tablets to all people for whom iodine blockade is envisaged, should be completable within the same time frame.

- **Planning area "middle zone"**

The middle zone surrounds the central zone, extending approximately 20 kilometres from operational nuclear power plants.

Local conditions, such as the structure of the terrain, settlement and administration are to be taken into account when determining the planning area.

For this area, as for the central zone, measures to avert acute dangers to lives and health of the public must be planned. These include in particular “staying indoors”, “distribution and consumption of iodine tablets” as well as “evacuation”. Middle zone measures can be implemented depending on the predicted or determined dispersal direction of the radioactive substances, if sufficient information is available to judge the radiological situation.

The evacuation must be planned in such a way that it is possible to completely evacuate the middle zone within 24 hours of notifying the competent authorities. The prerequisites for implementing iodine blockade, i. e. the distribution of iodine tablets to all people for whom iodine blockade is envisaged, should be set up within 12 hours.

The current division into sectors (12 sectors of 30 degrees with sector 1 to the north) can be retained.

- **Planning area "outer zone"**

The outer zone surrounds the middle zone. The outer limits of this planning area extend approximately 100 kilometres from operational nuclear power plants.

Local conditions, such as the structure of the terrain, settlement and administration are to be taken into account when determining the planning area.

In this planning area, measures are to be prepared to ascertain and monitor the radiological situation, so that it is possible to determine the necessity of further measures. In addition to monitoring programmes to ascertain the radiological situation, measures (staying indoors, distribution of iodine tablets to people envisaged for iodine blockade and warning the public about consuming recently harvested local produce) are to be readied. Outer zone measures are generally implemented depending on the predicted or monitored dispersal direction of the radioactive substances.

The current division into sectors (12 sectors of 30 degrees with sector 1 to the north) can be retained.

– **The entire territory of the Federal Republic of Germany**

The competent authorities should make concrete plans for the following measures for the entire territory of the Federal Republic of Germany:

- implementation of measures in accordance with the Precautionary Radiation Protection Act, especially the implementation of monitoring programmes to ascertain the radiological situation.
- providing iodine tablets to children and young people up to the age of 18 and to pregnant women to establish iodine blockade. Areas in the central and middle zones are subject to the applicable regulations concerning iodine blockade preparation.

The German Commission on Radiological Protection recommends including the changes to the planning areas in the special emergency preparedness plans for operational nuclear power plants.

The planning areas must be reviewed if in the future there are changes or expansions to the parameters relevant to determining planning areas (e. g. emergency reference levels, calculation methods for determining radiation exposure or other factors to be considered that arise from the harmonisation of Germany's planning with that of its neighbours).

4 Literature

BMU 2008 Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU). Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen, GMBl (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Basic Recommendations for Emergency Preparedness in the Vicinity of Nuclear Installations) 2008 No 62/63; p. 1278

SSK 2014 Strahlenschutzkommission (SSK). Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei Ereignissen mit Freisetzungen von Radionukliden (Radiological Bases for Decisions on Measures for the Protection of the Population against Accidental Releases of Radionuclides), adopted at the 268th meeting of the German Commission on Radiological Protection on 13 and 14 February 2014.

II Scientific foundation

1 Introduction

On 11 March 2011 an earthquake measuring 9.0 on the Richter scale struck northern Japan. The epicentre was around 130 kilometres off the east coast of the northern part of the main island, Honshu. The earthquake triggered a tsunami whose 15 m high waves devastated the coastal region.

This natural catastrophe led to a very serious nuclear accident at the Daiichi Nuclear Power Station with its six boiling water reactors (BWR) and light water reactors which the Japanese government later categorised as a level 7 accident on the International Nuclear Event Scale (INES).

The accident affected blocks 1 to 4 at the plant, with blocks 1, 2 and 3 suffering a core meltdown due to the failure of the external power supply, internal emergency generators and cooling systems. The cooling water supply to the fuel pools was interrupted, which put the integrity of the fuel rods at risk. This was particularly hazardous in block 4 as the entire core was being temporarily stored there due to maintenance work.

The damage caused to blocks 1, 2 and 3 led to major discharges of radioactive substances into the surrounding area for a period of more than 7 days. The prevailing weather conditions during the main period of discharge meant that the radioactive substances were carried towards the sea. Nevertheless, a number of extensive measures were required to protect people affected by the accident.

Based on the experiences gleaned from the reactor accident in Japan and the revised "Radiological Bases for Decisions on Measures for the Protection of the Population against Accidental Releases of Radionuclides" (SSK 2014), the German Commission on Radiological Protection suggests an update to Germany's emergency response planning areas in its recommendation "Planning areas for emergency response near nuclear power plants".

2 Review of the legislation for nuclear emergency response in Germany

The measures taken and the experience and insights gained in Japan were followed with interest all over the world. In Germany, the Fukushima accident led to the competent authorities for nuclear emergency response at national and state (Länder) level immediately launching an investigation into their own provisions and precautionary measures.

In June 2011 the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) tasked the SSK with reviewing current legislation on nuclear emergency response in light of the Fukushima accident.

The review was to cover the following points:

– Do the requirements or criteria set out in the regulations still comply with the state of the art in science and technology in light of the Fukushima accident?

– Do any of the individual provisions need to be updated or supplemented?

– Do the Fukushima accident or a combination of natural disasters reveal any gaps in the regulations?

– Do any other new regulations or regulation drafts published by international organisations (EU, IAEA, WHO) need to be incorporated? If so, which ones?

The following documentation forms the technical basis for German nuclear emergency response and should therefore be reviewed separately:

– Radiological Bases for Decisions on Measures for the Protection of the Population against Accidental Releases of Radionuclides (SSK 2009)[1],
– Basic Recommendations for Emergency Preparedness in the Vicinity of Nuclear Installations (BMU 2008),
– Guide to informing the public in the event of nuclear emergencies (SSK 2008),
– Criteria for notifying emergency services incumbent upon nuclear power plant operators (RSK/SSK 2004)[2] and
– General guidelines for emergency planning by nuclear power plant operators (RSK/SSK 2010).

Emergency response regulations in Germany are reviewed and updated both at regular intervals and when required. At the time of the Fukushima accident, the regulations were commensurate with the state of the art in science and technology, and the latest ICRP recommendations (ICRP 2007) were in the process of being added to the "Radiological Bases".

The SSK performed an extensive review of the insights gained from the Fukushima accident, discussed the lessons learned that were published worldwide, and performed an investigation as to whether these findings are of importance to emergency response measures in Germany. In addition, the SSK considered the process to update international regulations and legislation that was launched in the wake of the reactor accident and included the results of these changes in its investigation. The analysis into the experiences gained in Japan shows that the planning areas need to be reviewed.

The "planning areas" recommendation suggests changing Germany's emergency response planning areas. Because the planning areas' nature and size are an important basis for the implementation of protective measures and the development of strategies, the recommendation was drafted in advance as the basis of the revision of the "Basic Recommendations for Emergency Preparedness" (BMU 2008). A working group deployed by the SSK was supported by the Federal Office for Radiation Protection (BfS) and the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS), and it also worked closely with the interstate "Fukushima" working group of the Standing Conference of the States' Ministers and Senators of the Interior (IMK).

3 Initial situation

The planning areas for emergency response near nuclear power plants are set out in the "Basic Recommendations for Emergency Preparedness in the Vicinity of Nuclear Installations" (BMU 2008) which were last updated in 2008 to reflect the state of the art in science and technology. The planning areas are applied to German nuclear power plants and foreign facilities requiring special planning measures within the scope of the Basic Recommendations due to their proximity to the border.

[1] Revised version from 2014 (SSK 2014)
[2] Revised version from 2013 (RSK/SSK 2013)

Planning areas are areas near nuclear power plants where special planning measures are required. In the "Basic Recommendations" they are known as planning zones, which are then further broken down into a central zone, middle zone, outer zone and remote zone.

Table 1: Planning zones as stipulated in the "Basic Recommendations for Emergency Preparedness in the Vicinity of Nuclear Installations" (BMU 2008)

Central zone	The central zone is a planning area in which all emergency measures 2 are to be readied. Emergency measures 2 serve to avert acute danger to the lives and health of the public and include such measures as staying indoors, distribution and consumption of iodine tablets as well as evacuation. The central zone has a radius of approximately 2 kilometres. Measures in the central zone are especially urgent due to the zone's proximity to the nuclear installation. They are conducted irrespective of the dispersal direction of radioactive substances.
Middle zone	The middle zone is a ring-shaped planning zone where all emergency measures 2 are to be readied. The middle zone has an inner radius of approximately 2 kilometres and an outer radius of about 10 kilometres. Middle zone measures are generally implemented depending on the dispersal direction (divided into sectors) of the radioactive substances.
Outer zone	The outer zone is a ring-shaped planning zone where, in addition to monitoring programmes to ascertain the radiological situation, measures (distribution of iodine tablets to people up to the age of 45 and warning the public about consuming recently harvested local produce) are to be readied. The outer zone has an inner radius of approximately 10 kilometres and an outer radius of about 25 kilometres. Outer zone measures are generally implemented depending on the dispersal direction (divided into sectors) of the radioactive substances.
Remote zone	The remote zone is a ring-shaped planning zone where measures (distribution of iodine tablets to women and children and young people up to the age of 18 and warning the public about consuming recently harvested local produce) are to be readied. The remote zone has an inner radius of approximately 25 kilometres and an outer radius of about 100 kilometres. Additional rings can be specified within that range for the purpose of distributing iodine tablets. Remote zone measures are implemented depending on the dispersal direction (divided into sectors) of the radioactive substances.

Every zone apart from the central zone has to be divided into sectors.

The main objective of planning is to prevent or limit damage to public health due to the effects of a nuclear accident (BMU 2008).

4 Lessons learned from the Fukushima accident

The timings of events and the area contaminated by the Fukushima accident were used to investigate the potential impact of such an accident in Germany.

During the first few days after the accident, areas up to 20 kilometres away from the nuclear power plant were evacuated, while people within a radius of 30 kilometres of the plant were told to remain indoors. Contamination testing subsequently led to these residents also being evacuated.

The area in which protective measures (in particular evacuation) were implemented immediately after the accident occurred was much larger than the planning zones in place in Germany at that time.

These findings indicated a need to review the nature and size of the planning areas.

5 Radiological protection goals for emergency response planning

The radiological planning protection goals are stipulated in the “Radiological Bases for Decisions on Measures for the Protection of the Population against Accidental Releases of Radionuclides” (SSK 2014). The “Radiological Bases” are, in turn, based on radiobiological and radioepidemiological knowledge, particularly with regard to dose-risk and dose-response relationships for stochastic and deterministic effects. Pursuant to the “Radiological Bases”, the common goal of emergency response measures is to reduce radiation exposure to humans by implementing measures to prevent major deterministic effects and limit individual doses to levels below the threshold doses for deterministic effects. According to (SSK 2014), the ICRP understands major deterministic effects as irreversible illnesses that are directly attributable to radiation exposure and highly detrimental to the quality of life.

Suitable measures should help to avoid deterministic effects and reduce and limit the risk of stochastic effects on individuals.

The avoidance of major deterministic effects and major risks due to stochastic effects forms the basis for emergency response planning near nuclear power plants.

Planning areas should be calculated and measured in such a way that it is possible to achieve the radiological protection goals for the range of accidents on which planning is based.

6 Bases for specifying planning areas

6.1 Range of accidents

The risk studies and accident analyses that have been in use in Germany since the 1970s also include accidents whose effects are classified as today’s INES level 7. The range of INES 7 accidents adopted by German nuclear power plants has been revised over the last 40 years to maintain pace with the state of the art in science and technology. The latest analyses (Löffler et al. 2010) also include accidents where the radiological effects mirror those that occurred in Fukushima. This means that no new findings were gained from the Fukushima accident in terms of the extent of potential releases. The radiological impact of the Fukushima accident is therefore comparable with the results of analyses into potential major accidents at nuclear power plants in Germany.

In the past, the results of risk studies and accident analyses were also consulted to determine planning areas for emergency response plans and emergency preparedness in Germany. However, due to their low likelihood of occurrence, the consequences of incidents now classified as an INES level 7 were not used as a basis for determining requirements in terms of emergency preparedness plans required in addition to general emergency preparedness plans near nuclear power plants.

The SSK believes that the range of accidents included in emergency response planning should be redefined to more closely reflect an accident's potential impact rather than its likelihood.

The SSK therefore considers it necessary to expand the range of accidents included in the contingency planning and also add to emergency response planning and planning area considerations the INES level 7 accidents whose radiological effects mirror those of Fukushima.

The SSK therefore collaborated with the BMU offices responsible for nuclear safety and the GRS to agree on a reference accident to be used in the future as a basis for planning.

6.2 Concept and radiological criteria

The division of an area potentially affected by a hypothetical accident is based on fixed objectives and requirements in terms of effectively and efficiently implementing measures.

The concept used to size planning areas is based on the selection of a suitable reference accident and accompanying reference source term which are used to devise a dose-related approach involving a weighted assessment of the calculated dose distribution which, in turn, includes additional requirements and parameters such as ensuring that protective measures are accorded top priority.

Dispersion calculations were performed on the basis of the reference source term in order to size the planning areas. The aim of these calculations was to determine distances from the plant up to which protective measures would have to be carried out in the event of an accident. The planning areas were then drawn up on the basis of these calculations while also taking account of the determined requirements and parameters.

The emergency reference levels for the various different protective measures were used as criteria when drawing up areas in which measures to protect the general public would be required.

According to the “Radiological Bases”, emergency reference levels are dose values that people would or could receive in the event of certain exposure scenarios and also act as radiological trigger criteria for the respective protective measure. Emergency reference levels are planning values. Emergency reference levels refer to the effective dose for protective measures and the organ dose for the thyroid gland. The respective emergency reference levels are dose values that are well below the thresholds for deterministic effects.

The “Radiological Bases” stipulate the emergency reference levels for the protective measures set out below in table 2. The areas in which protective measures need to be carried out are determined on the basis of these emergency reference levels and various other influencing factors.

Table 2: Emergency reference levels for the measures "staying indoors", "consumption of iodine tablets" and "evacuation"

Measure	**Emergency reference levels**		
	Organ dose (thyroid gland)	**Effective dose**	**Integration times and exposure pathways**
Staying indoors		10 mSv	External exposure and committed effective dose due to inhaled radionuclides as a result of hypothetically remaining outdoors for a period of 7 days
Consumption of iodine tablets	50 mSv Children and adolescents up to the age of 18 and pregnant women 250 mSv People aged 18 to 45		Committed equivalent dose due to inhaled radionuclides as a result of hypothetically remaining outdoors for a period of 7 days
Evacuation		100 mSv	External exposure and committed effective dose due to inhaled radionuclides as a result of hypothetically remaining outdoors for a period of 7 days

The above emergency reference levels allow three planning areas to be determined:

Firstly, an area situated in the immediate vicinity of the plant where the population should be evacuated due to the risk of exceeding the 100 mSv criterion. Secondly, an area surrounding the first one where people designated for iodine blockade should take iodine tablets due to the risk of the respective emergency reference level (thyroid dose) being exceeded. And thirdly, an area surrounding the second one where children and young people up to the age of 18 should take iodine tablets due to the risk of exceeding the thyroid dose of 50 mSv in the given circumstances.

The level of potential radiation exposure decreases the further away one is from the plant. People in the immediate vicinity of the plant would therefore be more highly impacted by the radiological effects of a hypothetical accident than people situated further away from the plant. The planning area for which evacuation is to be planned has to be subdivided in order to optimise human protection in terms of their potential level of impact as a result of a hypothetical accident.

Here it should be noted that in the event of a hypothetical INES level 7 accident, major deterministic effects and a high risk of stochastic effects could occur in the area immediately next to the plant's premises if protective measures are not carried out. This therefore makes it necessary to prepare protective measures for this area which can be assigned top priority and carried out and completed as quickly as possible, ideally before a release caused by an accident. There were two main aspects involved in determining the planning area with top priority: firstly, the avoidance of major deterministic effects, and secondly, ensuring optimised implementation of protective measures in a prioritised manner.

When determining the planning area with top priority, investigations were performed as to the distance from the plant up to which major deterministic effects are still likely to occur in people who spent 7 days outdoors in the wake of a hypothetical accident. The threshold dose of the respective deterministic effect was used as a criterion for the potential occurrence of such effects. (SSK 2014) provides a detailed description of the various different deterministic effects and their dose thresholds. The threshold doses described there are generally values which, in 99% of exposed people, do not lead to any effects.

In terms of major deterministic effects, (SSK 2014) indicates that brief exposure of red bone marrow to radiation could cause a major impediment to blood cell formation at a dose threshold of 1,000 mGy. When compared with the other major deterministic effects described in the "Radiological Bases", a brief exposure of haematopoietic red bone marrow with a threshold dose of 1,000 mGy constitutes the most restrictive combination for adults and children. According to (SSK 2014), the enhanced sensitivity to radiation during prenatal development requires separate threshold doses for highly radiation-sensitive development phases of tissue and organs. In terms of major deterministic effects and their assigned threshold doses, the most restrictive conditions involve a threshold dose of 100 mGy in the event of a brief full-body exposure during the weeks 2 to 7 of the foetal development phase and a threshold dose of 300 mGy for the brain during the highly radiation-sensitive development phase during weeks 8 to 15 of pregnancy.

The table below summarises the thresholds for the occurrence of major deterministic effects that were taken into account when determining the planning area with top priority. All of the thresholds were taken from (SSK 2014)

Table 3: Thresholds for the occurrence of major deterministic effects

Dose criterion	Group of people	Threshold	Integration times and exposure pathways
Dose to red bone marrow	Adults, small children	1,000 mGy	External exposure and dose commitment due to inhaled radionuclides as a result of hypothetically remaining outdoors for a period of 7 days
Effective dose / uterus dose*	Fetus Weeks 2 to 7	100 mSv	External exposure and dose commitment due to radionuclides inhaled by mothers as a result of hypothetically remaining outdoors for a period of 7 days
Brain dose	Fetus Weeks 8 to 15	300 mGy	External exposure and dose commitment due to radionuclides inhaled by mothers as a result of hypothetically remaining outdoors for a period of 7 days

* As organogenesis does not provide any calculation options for fetus organ doses, the effective dose to the fetus due to inhalation by the mother is used as the equivalent dose to the fetus while the dose to the mother's uterus is used to determine external exposure (ICRP 2001).

In addition to the thresholds for major deterministic effects, the SSK introduced another criterion with an effective dose of 1,000 mSv for determining the top-priority planning area. The groups of people, integration times and exposure pathways correspond with the parameters of the emergency reference levels set out in (SSK 2014). This criterion was thus used to determine an area where measures with an extremely high priority are to be carried out and in which protective measures are highly effective. Similar to thresholds for the occurrence of major deterministic effects, this criterion is merely a planning factor to be used as an aid in determining the area where protective measures have to be immediately performed within a 360-degree radius, irrespective of the prevailing weather conditions. This criterion serves to implement the planning requirement that ensures measures are carried out in a prioritised manner.

As set out in the (SSK 2014), in the event of a real emergency, the planning criteria set out above are irrelevant to the top-priority area and the decisions regarding protective measures for all planning areas are made on the basis of the emergency reference levels.

7 Other parameters and criteria

7.1 Ensure implementation priority

Planning areas and their accompanying measures need to be stipulated and planned in advance in order to be able to carry out measures, particularly urgently needed ones, without delay and to the extent necessary. Planning areas serve to ensure that protective measures are implemented in a prioritised manner, i. e. people who are most at risk of or impacted by radiological effects should be given protection first by means of sufficient measures.

The top priority here is to implement measures in areas where deterministic effects and high doses may occur, which is why a top-priority planning area in the immediate vicinity of the plant premises needs to be defined.

7.2 Ensure effectiveness of measures

Planning areas and their designated measures are to be planned such that protective measures can be used to the best-possible effect.

This means creating individual planning areas of a manageable size in terms of the measures that may have to be implemented there. If planning areas are very large, there is a risk of not being able to ensure sufficient priority is given to the radiological exposure. If very large areas for swift evacuation are chosen, the simultaneous evacuation of a large number of people could impede the evacuation of people in the immediate vicinity of the plant who are most at risk, in turn preventing radiological protection objectives from being achieved. According to (IAEA 2013), the outer limit of the inner planning area should not be more than 5 kilometres away from the plant.

(IAEA 2013) also stipulates that planning areas for which evacuations have to be planned in order to limit stochastic effects should have an outer limit of 15 kilometres to 30 kilometres away from the plant. Existing resources should be put to best-possible use and evacuation should take place in a number of stages based on the given and forecast situation as well as the prevailing weather conditions.

7.3 Consideration of site-specific conditions

Plant-specific and regional conditions such as population structure, infrastructure and regional problems should always be taken into consideration when defining the sizes and outer limits of planning areas. It is therefore not possible to stipulate planning area data that can be applied to all plants. The planning areas suggested by the SSK only apply to emergency response in Germany.

7.4 Planning comprehensibility, transparency and quality

The effectiveness of emergency response measures depends on the decisions to implement measures taken in the event of a real emergency. It also depends on the quality of measures planning and acceptance of the measures by the people who are or may be impacted by them.

Emergency response planning quality is defined by technical quality, completeness, clarity, transparency and topicality. Good planning quality ensures that everyone draws upon the plans put in place in the event of an emergency. This forms a sound basis for reaching radiation protection objectives.

The Japanese investigation commissions observed a number of planning deficits which were described in detail in several reports, including the one published by the Japanese parliament's investigation commission (NAIIC 2012). With the onset of the accident at the Fukushima Daiichi Nuclear Power Station, the following deviations from the plans took place in Japan in terms of organising and carrying out protective measures:

1) Due to the consequences of the natural disaster, planned measures could not be implemented and there was a lack of alternative plans,
2) The people responsible for and involved in the plans were not even familiar with them,
3) The plans had not been updated for a number of years and even proved to be incomplete.

Around 150,000 people had to be evacuated or resettled. This gave rise to confusion because outdated and incomplete plans had to be used which often lacked information on how to maintain the infrastructure and ensure care, e. g. of people in hospitals. The evacuation led to a number of deaths that could have been avoided if there had been a better quality of planning in place (NAIIC 2012).

The decisions taken were often unclear to people impacted by them, and they were not sufficiently informed about the given risks. For a long time after the accident, members of the public affected by these decisions were very concerned and unsure as to how they should deal with the situation, which in turn was highly detrimental to their quality of life.

The SSK therefore considers the quality and transparency of emergency planning to be essential. This applies in particular when determining planning areas that form an important basis for the implementation of protective measures and the development of strategies in order to protect the general public. This is why a transparent method had to be chosen to determine planning areas.

7.5 Standardisation within Europe and on a global scale

The Fukushima Daiichi accident again showed that an accident causing major damage to a nuclear power plant's reactor core can have consequences on an international scale. This is why the plans put into place by individual countries and, in particular, neighbouring countries, should not differ from one another to any large extent. This requirement should also be observed when determining planning areas.

To the extent applicable in this mandate, the SSK has taken account of international regulations, in particular those of the IAEA and the EU. In the "EPR-NPP Public Protective Actions: Actions to Protect the Public in an Emergency Due to Severe Conditions at a Light Water Reactor" (IAEA 2013) document published in 2013, the IAEA provided a number of recommendations regarding planning area structure and the determination of planning areas. The method used by the SSK adopts the IAEA's dose-related approach based on representative source terms, thus ensuring comparability. The planning area structure recommended by the SSK also largely reflects the IAEA's recommendations. The SSK's recommendation regarding planning areas is open to standardisation based on the IAEA's recommendations.

8 Method used to determine planning areas

An analytical method was used to determine the planning areas. To this end, RODOS (Real-time Online Decision Support System) (Raskob und Gering 2010; see also http://www.rodos.fzk.de) was used to select a reference source term for determining planning areas which was also used to determine areas where, under the given conditions, high doses and major deterministic effects may occur and emergency reference levels for protective measures may be exceeded (see Section 8.2). The areas determined using this method are proposed as planning areas. Any other important influencing factors in terms of emergency response will be taken into account when selecting the reference source term and determining the parameters for calculation and evaluation. The individual steps of the method are described below:

- Determination of parameters for the hypothetical release of radioactive substances,
- Selection of reference source terms including scenarios comparable with the Fukushima accident,
- Selection of representative nuclear power plants in Germany,
- Determination of parameters for the RODOS calculations,
- Stipulation of evaluation method used to determine planning areas for protective measures,

– Performance of RODOS calculations to determine areas where the 1,000 mSv criterion is reached, where major deterministic effects may occur, and where protective measures would be necessary based on the emergency reference levels set out in (SSK 2014).

8.1 Reference source term

One or more reference source terms are required as a basis for determining planning areas. Reference source terms are characterised by parameters that describe the release of radioactive substances via the air pathway. Consideration of the air pathway is sufficient for determining planning areas as the inclusion of releases with water does not have any impact on the results.

The selection of reference source terms should be based on the lessons learned from the Fukushima accident. However, where possible this selection should be linked to analyses and risk studies carried out for nuclear power plants in operation in Germany.

A reference source term is indicated by the quantity of released radioactive substances (release quantity), duration of release, and location of release. The duration of the pre-release phase, i. e. the time between identification and commencement of a major radionuclide release from a plant, is important in terms of emergency response.

The SSK defined the following requirements for the reference source term:

– The release quantity should include INES level 7 releases. It should be possible to view the scenarios used here as representative of the state of the art in science and technology for plants in Germany
– It should involve a source term to be expected in the event of accidents involving a core meltdown and failure of the protection measures in place
– The “Fukushima source term” should be covered by the release quantity
– The reference source term should be applicable as a posit for all nuclear power plants included in the scope of this recommendation
– Prolonged release scenarios should be included
– The location of release should be typical of releases in the event of failure or bypassing of containment.

A check was performed to see whether accident analyses that comply with the above requirements are available in Germany.

At the end of 2010, the GRS carried out a research project to ascertain representative events for pressurised and boiling water reactors whose source terms were added to the RODOS (Real-time Online Decision Support System) source term library (Löffler et al. 2010). Table 4 shows the scenarios devised for pressurised water reactors.

Table 4: Release categories in the source term library of the RODOS decision support system as set out in (Löffler et al. 2010)
(for comparison the Fukushima accident source term ascertained in (GRS 2013) is included)

Name	**Description**	**Release I-131** [Bq]	**Release Cs-131** [Bq]	**Start of major releases** in hours after reactor shutdown	**Calculated frequency** [10^{-7} per year]
FKA	Uncovered steam generator heat pipe leak	$3.1 \cdot 10^{17}$	$2.9 \cdot 10^{16}$	approx. 21	2.1
Fukushima	Cooling system failure in several reactors	$1 \cdot 10^{17}$ - $2 \cdot 10^{17}$	$1 \cdot 10^{16}$ - $2 \cdot 10^{16}$	approx. 13	-
FKI	Filtered pressure release via the ventilation stack	$2.8 \cdot 10^{15}$	$2.8 \cdot 10^{11}$	approx. 57	8.8
FKH	Filtered pressure release via the roof	$2.8 \cdot 10^{15}$	$2.8 \cdot 10^{11}$	approx. 57	2.6
FKF	Unfiltered pressure release via the roof	$2.3 \cdot 10^{16}$	$2.8 \cdot 10^{14}$	approx. 57	2.1
FKE	Suction pipe failure	$1.8 \cdot 10^{17}$	$9.4 \cdot 10^{14}$	approx. 33	1.4

The “FKA scenario” is considered suitable for determining planning areas for emergency preparedness and emergency response plans. The given parameters are met, despite it not being a scenario with a prolonged release. In order to determine whether an additional release scenario representing prolonged releases is required to stipulate planning areas, comparative calculations were performed using RODOS where the “FKA source term” was extended to a release period of 15 days for an additional release scenario. These calculations showed that the shorter release leads to larger planning areas, meaning that calculations involving the “FKA source term” with a release period of 50 hours was considered sufficient for determining planning areas.

The selected reference source term should not be considered as a source term specific to certain plants or certain types of plants; instead it should be applied to every plant of relevance to emergency response planning in Germany. This is both reasonable, justifiable and necessary in terms of precision of accident analyses as the bases and methods for sizing the planning areas should be the same at every plant in order to ensure that plans are standardised. Only the duration of the pre-release phase takes account of the fact that, in the event of a core meltdown, releases may occur earlier with certain reactor types than with the investigated pressurised water reactors. A pre-release phase of 6 hours was therefore assumed. According to the present FKA event sequence analysis, the main release requiring extensive emergency response measures would commence approximately 21 hours after reactor shutdown. However, a much shorter pre-release period was defined for other reactor types, including the type 72 boiling water reactors in operation in Germany. In the vast majority of potential events, a much longer period of time would be available to carry out immediate protective measures.

8.2 RODOS calculations

This source term was used as a basis for performing calculations with RODOS (Real-time Online Decision Support System), which the Federal Office for Radiation Protection (BfS) has been using operationally since 2003. Together with the Integrated Measurement and Information System (IMIS) and state-specific systems, RODOS forms the basis for decision-making in the event of nuclear incidents or accidents in Germany.

Three areas representing the various climatological conditions in Germany were defined in order to perform these calculations. The following areas were chosen:

- A flat orography, on average with high wind speeds
- A moderately structured orography in a valley, on average with moderate wind speeds, and
- A pronounced valley with a moderate orography, on average with low wind speeds and frequent inversions.

Nuclear power plants in such areas were then selected (Unterweser, Grohnde and Philippsburg) and calculations were performed using these locations.

To this end, the Remote Monitoring of Nuclear Power Plants (KFÜ) has meteorological measurements and statistical evaluations of this data stretching back many years. The BfS then evaluated this data as a monthly average for several years in order to show that the period for which calculations were performed can also be seen to be representative and not of limited value due to certain meteorological conditions.

The period from 1 October 2011 to 30 September 2012 was selected as the period to be used for the (annual) calculations. This ensures that every season and their specific meteorological characteristics are sufficiently accounted for. Investigation of the KFÜ's meteorological data for each plant over a number of years also showed that the investigated period does not significantly differ from other years, meaning that it can be seen to be a typical year. In order to achieve a sound statistical basis for every day and every plant within the given period, a dispersion calculation based on the reference source term was started using RODOS. This produced a total of 1,095 calculations for 365 days and 3 plants. Individual calculations were initiated at precisely midnight on the respective day. By starting the calculation at this time, the results were conservative as night-time weather with its stable stratification leads to a reduction in the vertical exchange of contaminated air masses at the start of the emission where it is at its highest.

The data from the German Weather Service's (DWD) COSMO-EM System (Consortium for Small-scale Modelling – European model) is available as a meteorological database for flow fields. The German Weather Service (DWD) sends this data to the BfS every day. Also available as an alternative is the meteorological data for the respective plant provided by the Remote Monitoring of Nuclear Power Plants (KFÜ). Here considerations needed to be made as to whether more accurate plant data with meteorological measurements at the point of emission would be of greater benefit than the DWD data which represent the entire simulation area. The DWD data was given preference as a dispersion of over 100 kilometres with relevant exposure based on the reference source term was to be expected when performing calculations for the simulation area.

When using RODOS, the user can choose between the ATSTEP and RIMPUFF dispersion models. ATSTEP is a model designed for rapid calculation results, which is why a simple calculation algorithm was used. As the calculation time only plays a minor part in these investigations, the RIMPUFF model was chosen as it provides more detailed modelling and a better reproduction of the meteorological processes. The only downside to the RIMPUFF model is that it takes longer to produce results, but this was of no importance to these investigations.

During each calculation for the respective area, doses were calculated as effective doses via the exposure pathways external radiation from the cloud and from contaminated soil and inhalation for all radionuclides. The organ dose for the thyroid gland due to radioactive iodine was also calculated at the same time. The doses were determined for an integration period of 7 days (external dose from contaminated soil) using the conservative assumption of people being permanently outdoors. A release lasting for a period of 50 hours was assumed. The results of these calculations were then compared with the emergency reference levels for the below measures to determine the respective areas of action:

- Staying indoors
- Evacuation
- Consumption of iodine tablets

Areas in which the calculated doses exceeded the 1,000 mSv effective dose (1,000 mSv criterion) were also determined.

All of the calculations were performed and evaluated for adults and small children (aged 1 to 2). Individual calculation evaluations were performed such that for each measure, the maximum distance from the point of emission was determined up to which a measure would have to be carried out upon application of the respective emergency reference level.

In order to determine the area where major deterministic effects could occur, additional calculations of the red bone marrow dose were performed for adults and small children (aged 1 to 2) along with the dose for the fetus. To this end, RODOS was used to carry out a dispersion calculation for the Grohnde nuclear power plant based on the reference source term. This calculation was performed every fourth day between 1 October 2011 and 30 September 2012. For each calculation the maximum distance from the point of emission up to which the calculated doses exceed 1,000 mGy (red bone marrow) in adults and small children was determined.

Calculations for the fetus have to take account of the various development stages of the fetus which lead to differing levels of sensitivity to radiation. This is why separate considerations of organogenesis (weeks 2 to 7; period of induction of anomalies due to ionising radiation) and early fetogenesis (weeks 8 to 15; main period of risk for mental retardation due to ionising radiation) are required. As organogenesis does not provide any calculation options for fetus organ doses, the effective dose is used as the equivalent dose (ICRP 2001). In the event of early fetogenesis, however, the organ dose to the brain can be determined (ICRP 2001). Radioactive iodine is the main contributor to the dose. Here it should be noted that the embryo/fetus does not store any iodine up to around the 10th week of pregnancy as the thyroid gland has not yet formed. The fetal thyroid gland is also not fully formed during weeks 8 to 15 of pregnancy, which is why a threshold dose of 100 mGy was adopted for weeks 2 to 7 of pregnancy and a threshold dose of 300 mGy for weeks 8 to 15 of pregnancy when evaluating calculations. For each calculation the maximum distance from the point of emission up to which the calculated doses exceed the above thresholds for the fetus was determined.

8.3 Evaluation methods

For each plant and emergency response measure, a statistical distribution of the measure’s maximum distance can be plotted. The cumulative frequency is used to determine the distance up to which a certain measure should be planned and also provides the percentage of calculated weather situations in which the areas where the respective emergency reference level is exceeded are within the given distance. When choosing a percentile of cumulative frequency for determining planning radii, the SSK based its decision on the following aspects:

– In terms of frequency of occurrence and impact, the reference source term represents a highly unfavourable accident constellation that also covers major accidents
– When calculating radiation exposure, conservative assumptions and parameters were used as a basis, including in particular the assumption of spending 7 days outdoors without protection
– When determining radiation exposure, the normal behaviour and habits of people near the nuclear power plant were not taken into account, meaning that protective measures such as shielding were not included
– Radiation exposure levels were determined by performing calculations involving the meteorological dispersion characteristics and occasionally highly unfavourable weather conditions present at the nuclear power plants in Germany
– When sizing planning areas, it must be considered whether as large an area as possible should be covered, or whether areas likely to be most affected are accorded prioritised protection. Creating planning areas based on highly improbable scenarios of radiological consequence would reduce the number of protection options available to potentially highly affected areas near the plant, which is therefore not conducive to meeting the intended objectives.

Taking these aspects into account, the SSK stipulated the 80th percentile as the cumulative frequency for the maximum distance of a specific measure. In order to derive the planning radius for the top-priority area, the mean value of all three plants was calculated for adults and children. For the fetus, this process also included the results of the various stages of development that were determined for a plant. The mean values of all locations for adults were used as a basis for determining a planning area where the emergency reference levels for all designated protective measures may be exceeded. The determined maximum distances for administering iodine blockade to adults and children are relevant to planning areas situated further away from the plant.

9 Results of calculations

The calculations and evaluations carried out led to the following results:

– Major deterministic effects can be avoided with a high degree of certainty if an area around a nuclear plant with an approximate outer radius of 5 kilometres from the plant can be swiftly evacuated. This also applies to a fetus, which is far more sensitive in comparison to adults. Following exposure, the threshold doses of around 100 mGy for anomalies which can be triggered during weeks 3 to 7, and the threshold doses of around 300 mGy for mental retardation in weeks 8 to 15 (ICRP 2007) will no longer be reached beyond the 5-kilometre radius.
– The top-priority area determined using the 1,000 mSv criterion covers an area of up to around 5 kilometres away from the plant.
– Up to a distance of approximately 20 kilometres away from the plant, the emergency reference levels for “evacuation”, “consumption of iodine tablets” and “staying indoors” may well be exceeded.

- Up to a distance of approximately 100 kilometres from the plant, the emergency reference levels for “consumption of iodine tablets” and “staying indoors” may be reached. Measurement programmes should also be prepared for this area to ensure that the radiological situation can be quickly determined and any necessary measures implemented (e.g. further evacuation of areas more than 20 kilometres away from the plant).
- It may be necessary to administer iodine blockade to children, young people and pregnant women who are much further away from the plant (>100 kilometres) but within the dispersal direction. These calculations prove that dose levels may be exceeded at distances of up to 200 kilometres away from a plant. Distances of over 200 kilometres were not investigated as a radius of 200 kilometres around German plants and plants located near international borders would cover almost the whole of Germany. This is why sufficient preparations should be made throughout Germany.

10 Planning areas within the context of international developments

The SSK investigated whether the stipulation of new planning areas corresponds with the plans in place in other countries. There are no fixed plans at present in the assessed countries. The International Atomic Energy Agency (IAEA) is currently in the process of drafting guidelines on this topic. However, based on the current state of discussion within the IAEA and the EU at the time of preparing this recommendation, the SSK assumes that the planning areas determined for Germany will meet international requirements.

11 Literature

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Updated emergency planning zones in Germany and the importance of release source term

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Federal Office for Radiation Protection (BfS)

0903

Nuclear Power Plants in Germany – after Fukushima

- in operation
- decommissioned

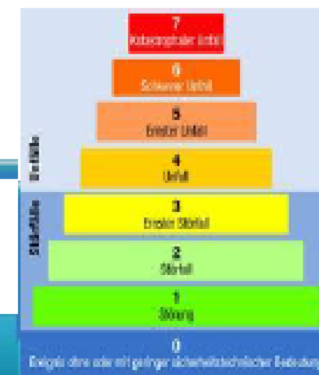
0905

Bundesamt für Strahlenschutz

German lessons learned from the Fukushima accident

Lesson learned from Fukushima:

Nuclear accidents even those of the INES Level 7 happen. Despite high safety requirements and the low calculated probability for such cases we can never be sure, that severe nuclear accidents do not happen.



Consequence:

Detailed Planning of emergency response is necessary even for Level 7 Accidents!

German lessons learned from the Fukushima accident

Recommendation of the German Commission on Radiological Protection:

Reference source terms are required as a basis for detailed planning.

Name	Release of Iod-131 Bq	Release of Cs-137 Bq	Assumed Start of major releases (only for planning purposes) Hours [h] after shutdown of the reactor	Duration of releases	Release via	
Q1	3.0×10^{17}	3.0×10^{16}	6	48 Hours	Building Roof	INES 7
Q1L	3.0×10^{17}	3.0×10^{16}	6	14 Days	Building Roof	INES 7 long
Q2	2.0×10^{16}	3.0×10^{14}	12	48 Hours	Building Roof	INES 6
Q2L	2.0×10^{16}	3.0×10^{14}	12	14 Days	Building Roof	INES 6 long
Q3[6]	3.0×10^{15}	3.0×10^{11}	12	48 Hours	Stack	INES 5
Q3L[6]	3.0×10^{15}	3.0×10^{11}	12	14 Days	Stack	INES 5 long

0907

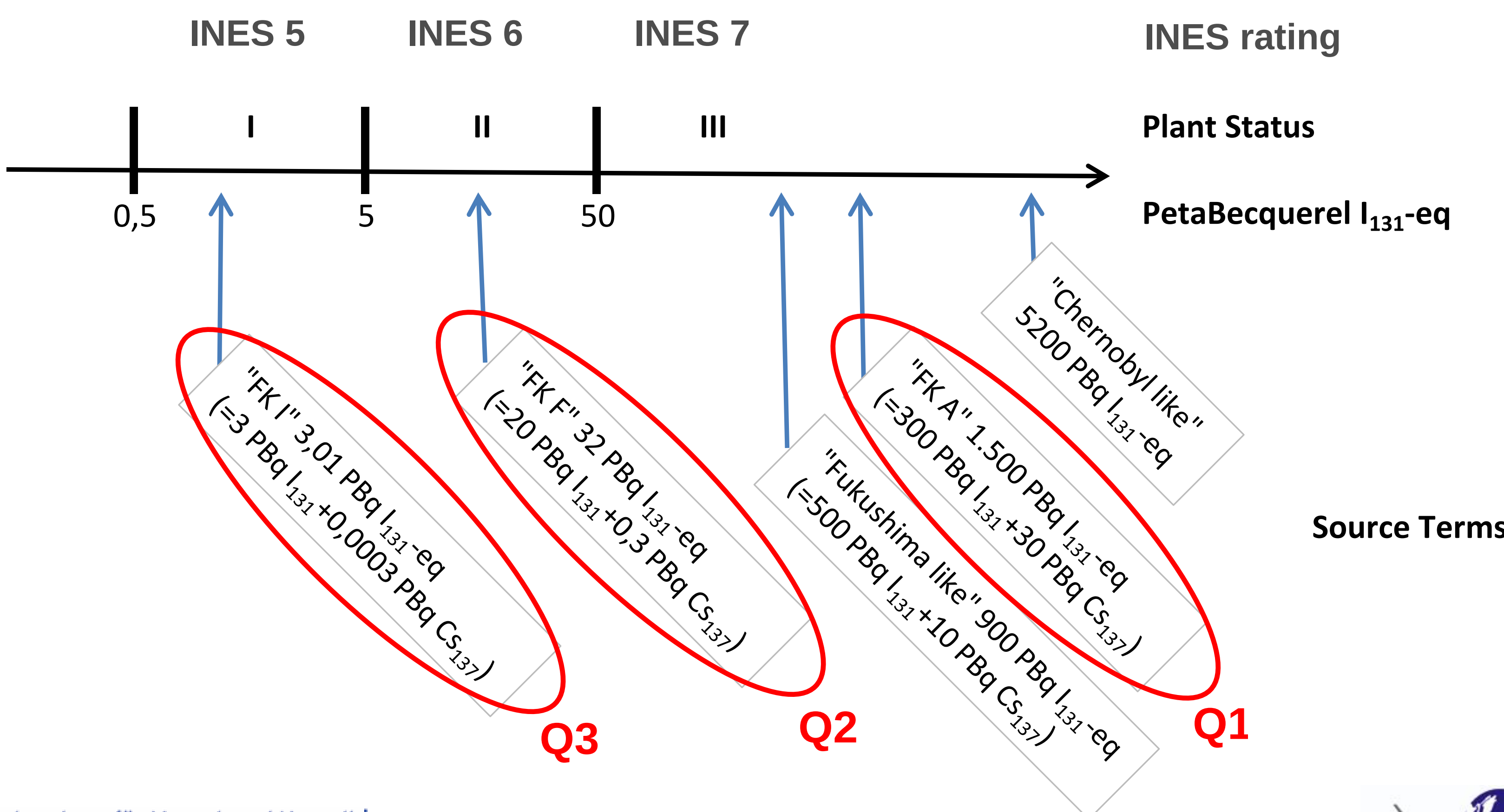
I V

Source terms used as basis for NPP emergency planning

„could lead to core melt, no indication of loss of contain.“

„could lead to core melt, loss of containment“

[AtHLET description]

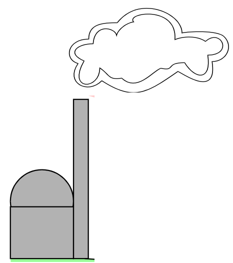


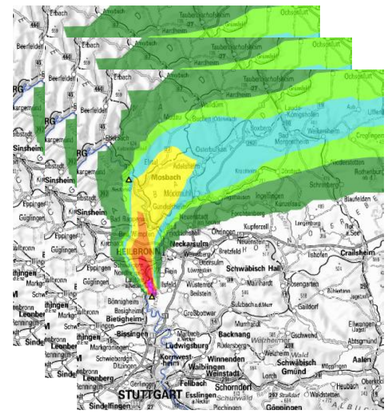
0908

Assessment of potential consequences of an emergency

Scenario list	Source terms (for planning)	Radiological consequences	Emergency response plans

1. NPP accident in Germany



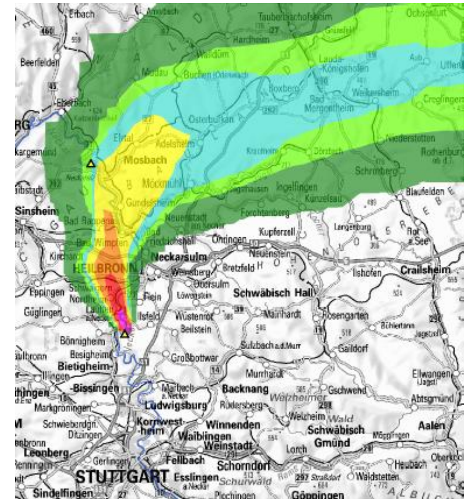


Optimised strategy (including EPZ)

0909

Assessment of potential consequences

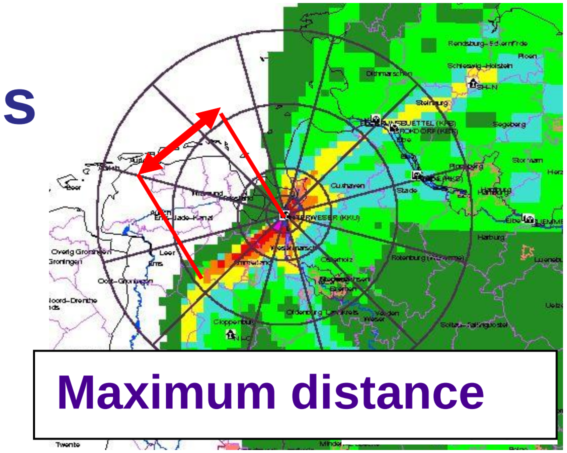
- **Selection of „reference source terms“ for each accident/release category**
- **Selection of representative NPP sites (Unterweser, Grohnde, Philippsburg)**
- **Simulations performed with RODOS based on numerical weather prediction data (Nov. 2011 - Oct. 2012; releases for each day)**

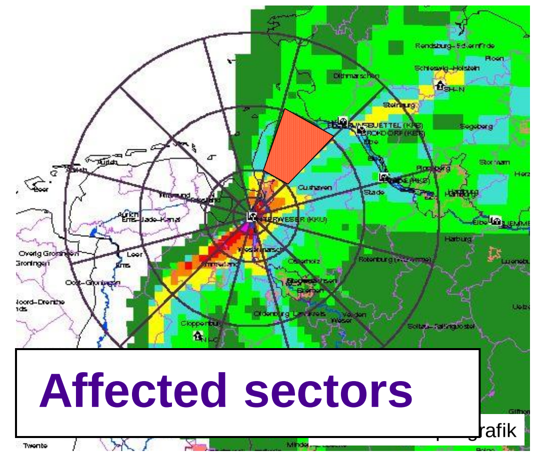


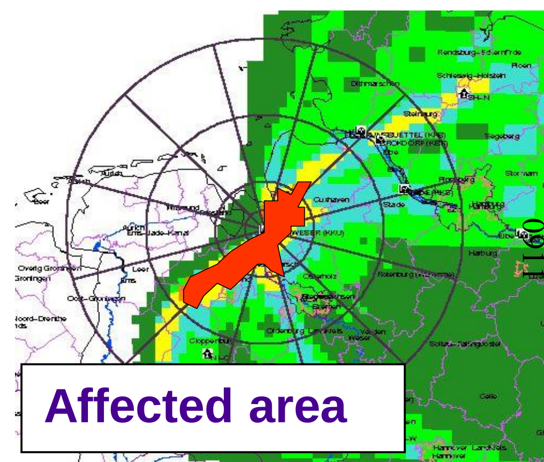
0910

Assessment of potential consequences

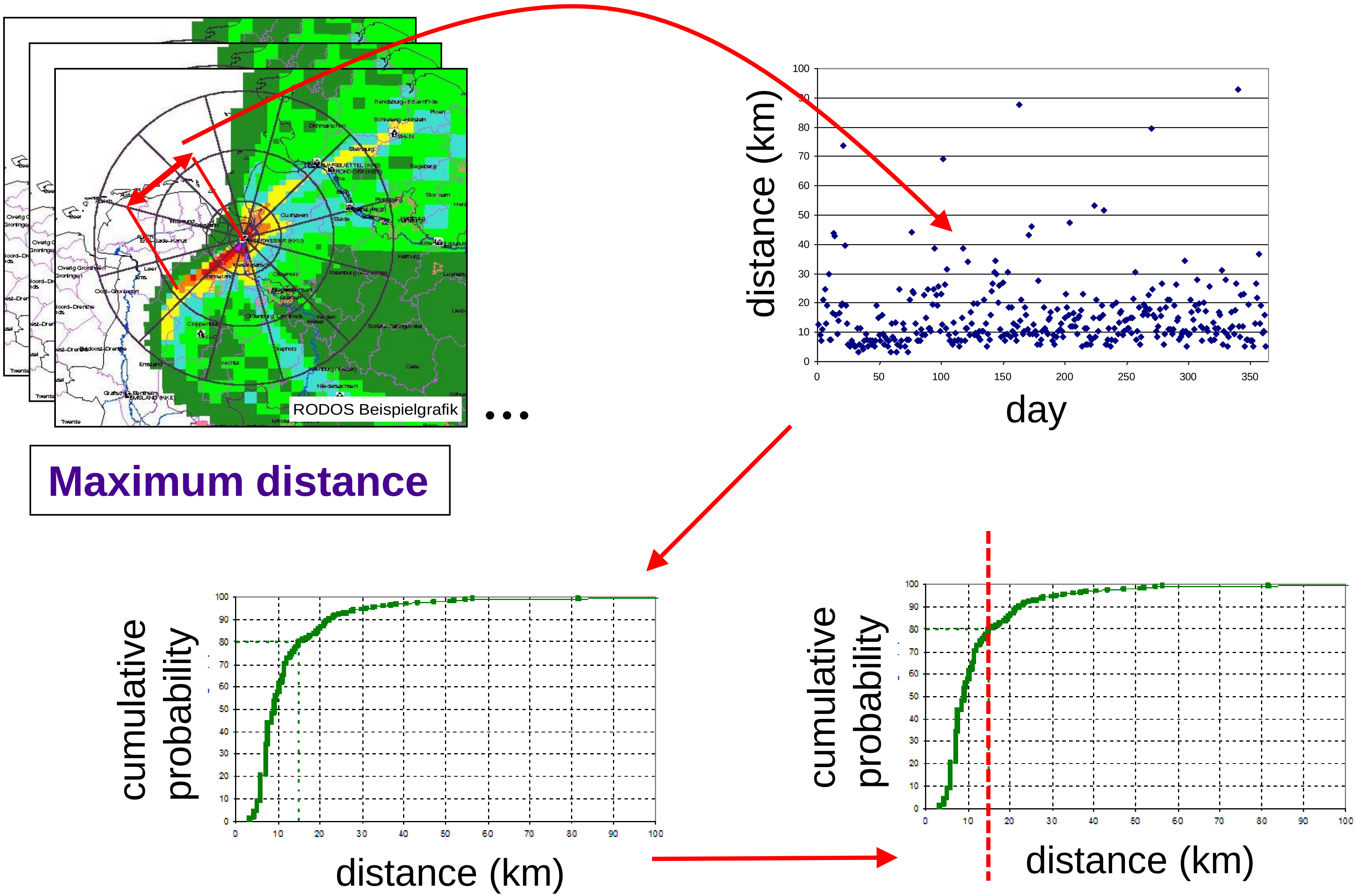
- Selection of „reference source terms“ for each accident/release category
- Selection of representative NPP sites (Unterweser, Grohnde, Philippsburg)
- Simulations performed with RODOS based on numerical weather prediction data (Nov. 2011 - Oct. 2012; releases for each day)
- More than 5000 separate simulations
- Definition of analysis procedures (Statistical analysis based on national and generic dose intervention limits)







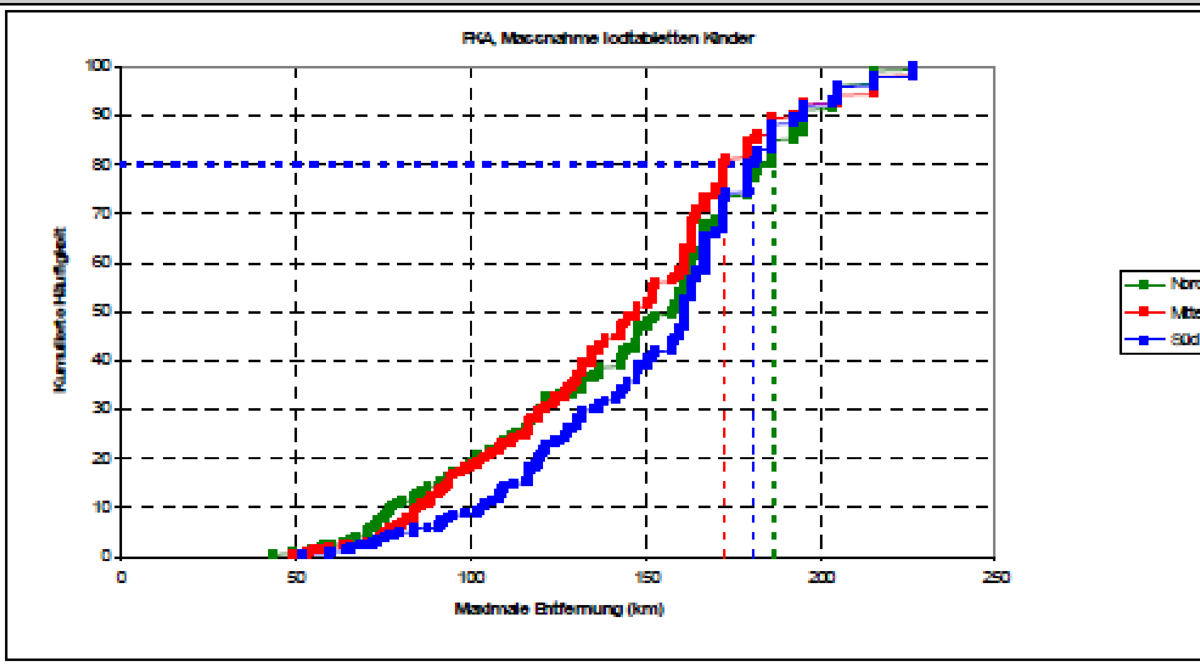
Assessment of potential consequences

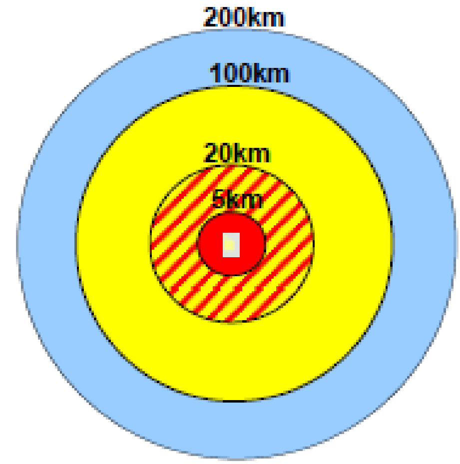


Results of the assessment of potential consequences

E.g., maximum distances in which ITB for children is required („FKA source term / Q1“)

Maßnahme Iodblockade Kinder und Schwangere



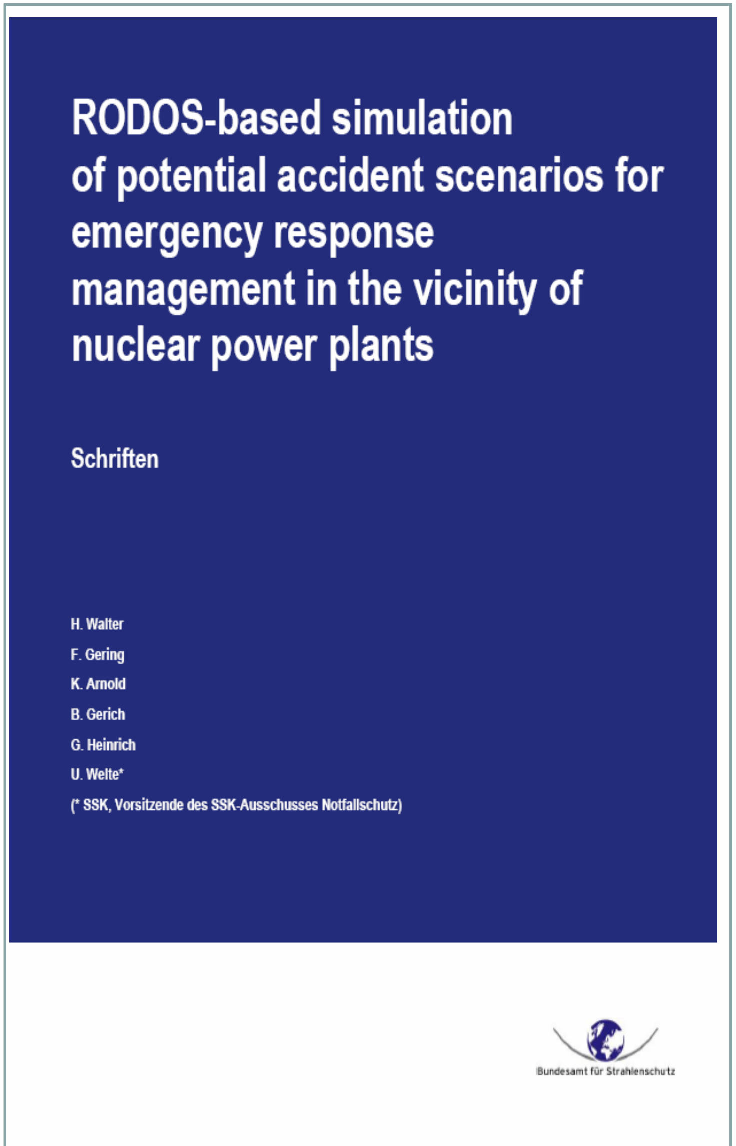


Results of the RODOS simulation

Maximum distance for evacuation, source term FKA / Q1

Adult	Maximum distance (km) in which intervention level for **evacuation** is exceeded		
	50%-Percentile	**80%-Percentile**	**90%-Percentile**
North (Unterweser)	9	**15**	22
Central (Grohnde)	11	**20**	26
South (Philippsburg)	18	**25**	31
Central (Grohnde) - FKF	0	0	0
Central (Grohnde) - FKI	0	0	0

Results of RODOS simulations


RODOS-based simulation of potential accident scenarios for emergency response management in the vicinity of nuclear power plants

Schriften

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Bundesamt für Strahlenschutz

Now available in English on request:
fgering@bfs.de

Will be published on BfS website soon

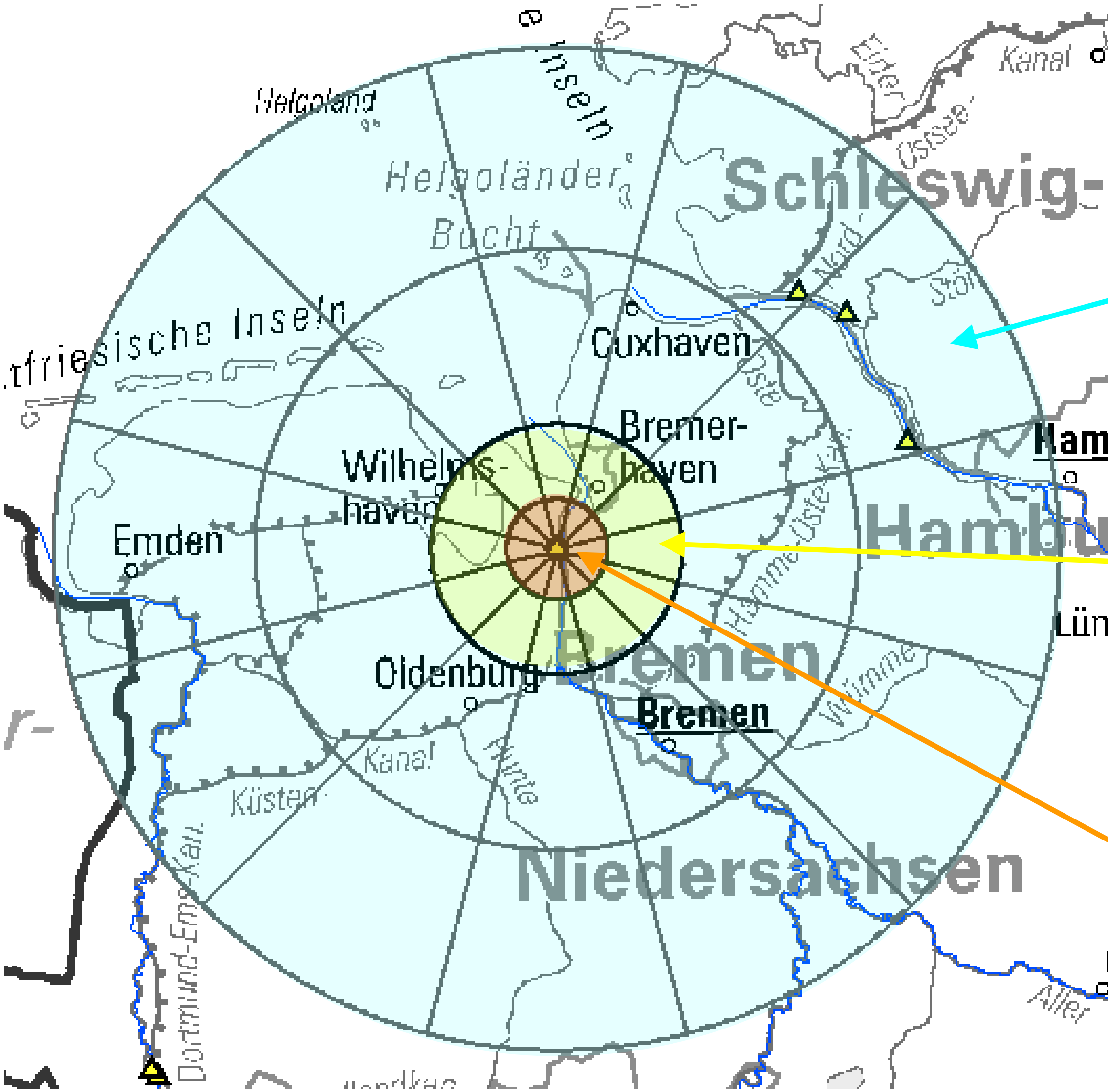
0915

Changes in emergency planning zones in Germany

Recommendation by the German Commission on Radiological Protection:
Planning areas for emergency response in the vicinity of nuclear power plants (www.ssk.de)

Previous	New
Central zone with a radius of **2 km** Sheltering, evacuation (6h), ITB (6h)	Central zone extends up to about **5 km** around NPPs
Middle zone with a radius of **10 km** Sheltering, evacuation (24h), ITB (12h)	Middle zone extends up to about **20 km** around NPPs
Outer zone with a radius of **25 km** Sheltering, ITB	Outer zone extends up to about **100 km** around NPPs
Remote zone with a radius of 100 km ITB only for children and pregnant women	Entire Territory of Germany

Emergency planning zones for NPPs (before 2014)



Emergency planning zones:

<100 km:
ITB for children and pregnant women

<25 km:
ITB for all persons < 45 years

<10 km:
Evacuation, Sheltering

Emergency planning zones for NPPs (since 2014)

Emergency planning zones:

<100 km:
ITB for all persons < 45 years, sheltering

<20 km:
Evacuation, Sheltering

<5 km:
Evacuation (priority), Sheltering

German lessons learned from the Fukushima accident

Lesson learned from Fukushima:

Consequences of severe accidents are always international!

Lessons learned from Fukushima (in Germany!):

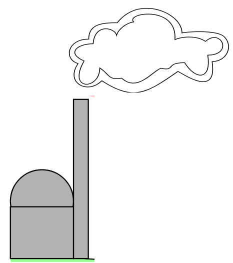
Regulations and plans for measures to be taken in case of accidents outside of Europe are not available!

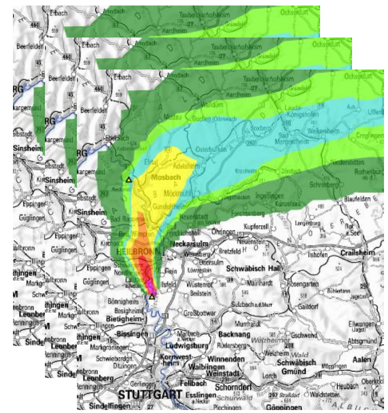
Consequence:
Definition of Szenarios
which have to be covered up by regulations

Development of enhanced list of planning scenarios

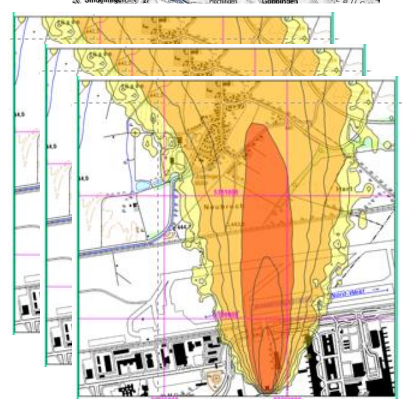
Scenario list	Source terms (for planning)	Radiological consequences	Emergency response plans

0. Unclear situation
1. NPP accident in Germany
2. NPP accident in neighbouring countries
3. NPP accident within Europe
4. NPP accident outside Europe
5. Accident in a nuclear facility
6. Terroristic attack
7. Transport accident
8. Radiological emergency situations
9. Satellite crash





Optimised strategy



Optimised strategy

... ...

... ...

German lessons learned from the Fukushima accident

Lesson learned from Fukushima:

Planning is necessary for all phases of an accident.

In particular, the planning for the Post-accident-phase must be improved so that the lives of people affected can be normalized as quickly as possible!

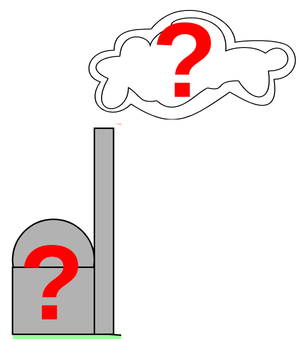
Consequence:
Enlargement of planning to all phases of accidents!

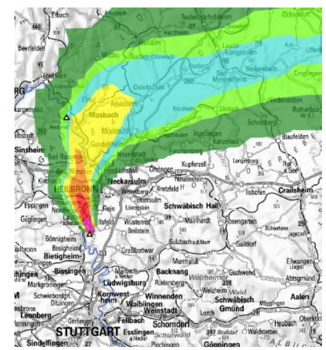
Thank you for your attention!

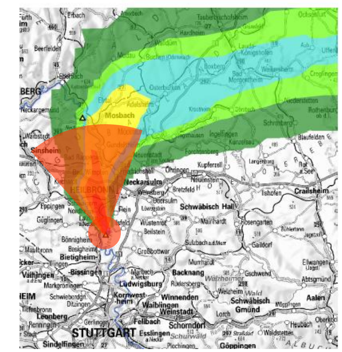
Decision about protective actions

Source term assessment → Dispersion modelling → Intervention limits: protective actions

„Standard approach“:

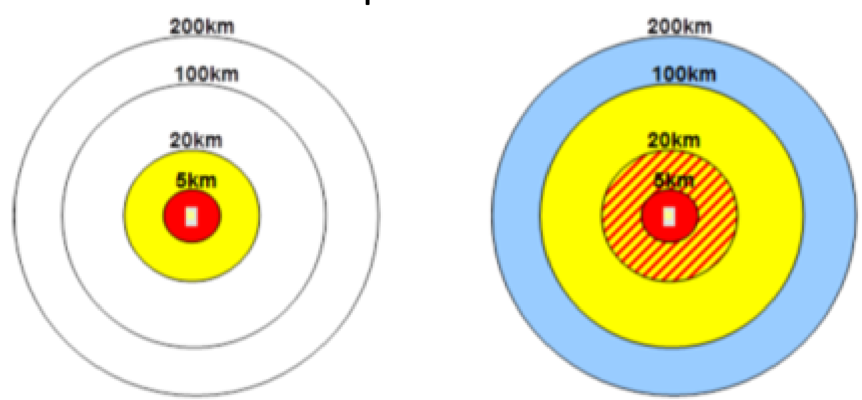






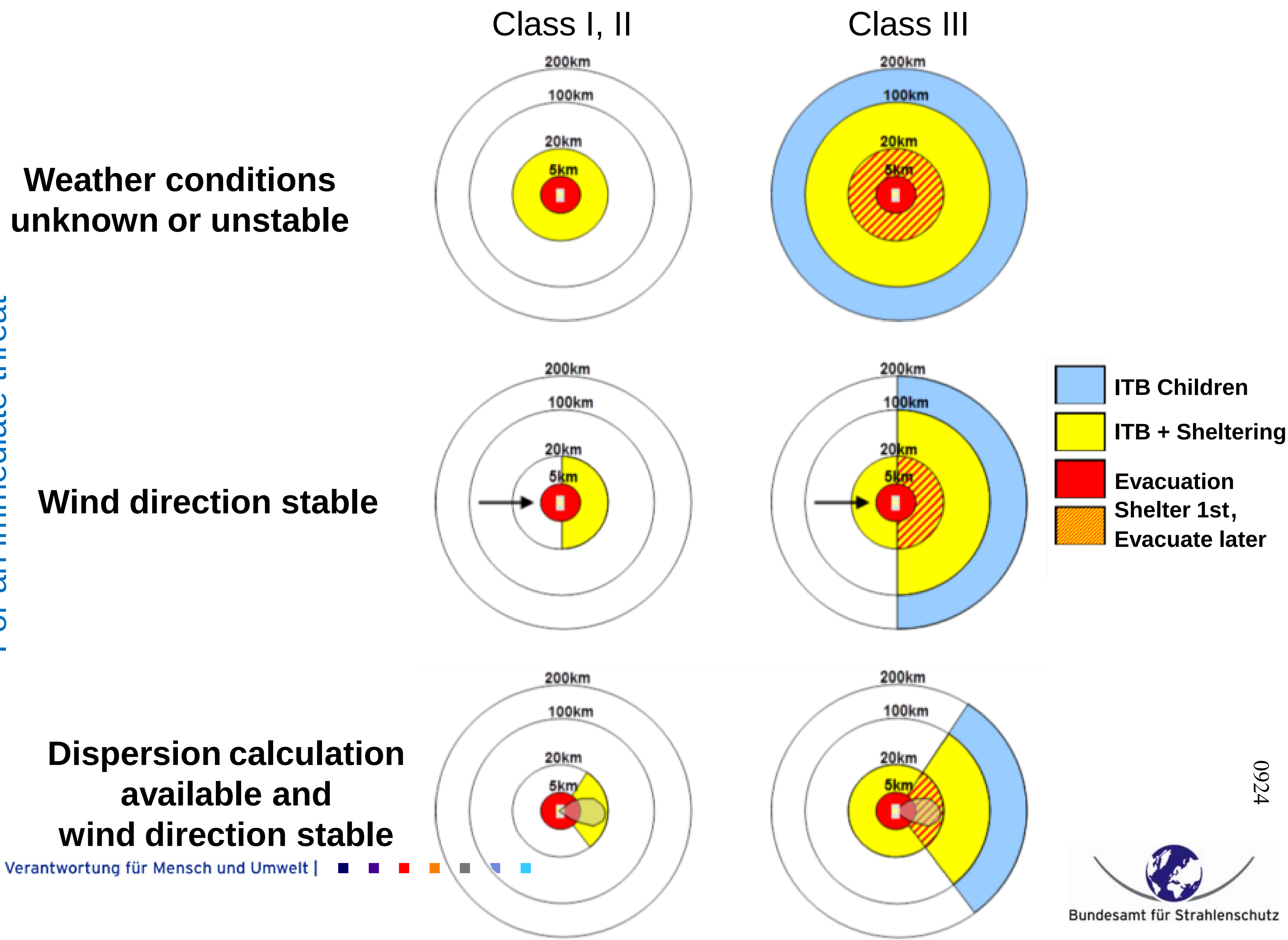
Protective actions to be recommended to the decision makers be decided on the basis of the plant status and weather conditions:

Supplementary NERDA approach:



Identifying actions (graded approach)

For an immediate threat



0924

New published or reviewed publications by SSK 1

- Kriterien für die Alarmierung der Katastrophenschutzbehörde durch die Betreiber kerntechnischer Einrichtungen (Empfehlung, 2013, together with RSK)
  Criteria for the alert of emergency response authorities by the operators of nuclear plants
- Rahmenempfehlungen für die Planung von Notfallschutzmaßnahmen durch Betreiber von Kernkraftwerken (Empfehlung, 2014, together with RSK)
  Guidelines for planning of emergency measures by operators of NPPs (only in German)
- Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei Ereignissen mit Freisetzungen von Radionukliden (Empfehlung, 2014)
  Basic radiological principles for decisions on measures for the protection of the population against incidents involving releases of radionuclides
- Planungsgebiete für den Notfallschutz in der Umgebung von Kernkraftwerken (Empfehlung, 2014)
  Planning areas for emergency response near nuclear power plants
- Fragestellungen zum Aufbau und Betrieb von Notfallstationen (Stellungnahme, 2014)
  Questions regarding set-up and operation of emergency care centres (only in German)

New published or reviewed publications by SSK 2

- Kriterien für die Alarmierung der Katastrophenschutzbehörde durch die Betreiber kerntechnischer
  Planung der Jodblockade in der Umgebung stillgelegter Kernkraftwerke (Empfehlung, 2014)
  Planning iodine thyroid blocking in the vicinity of decommissioned nuclear power plants
- Prognose und Abschätzung von Quelltermen bei Kernkraftwerksunfällen (Empfehlung, 2014)
  Prognosis and estimation of source terms at accidents of NPPs (only in German)
- Planungsgebiete für den Notfallschutz in der Umgebung stillgelegter Kernkraftwerke (Empfehlung, 2014)
  Planning areas for emergency response in the vicinity of decommissioned NPPs (only in German)
- Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen (Empfehlung, 2015)
  Guidelines for disaster control in the vicinity of nuclear plants (only in German)
- Weiterentwicklung des Notfallschutzes durch Umsetzen der Erfahrungen aus Fukushima (Empfehlung, 2015)
  Enhancements of emergency preparedness and response through implementation of lessons learned after Fukushima (only in German)

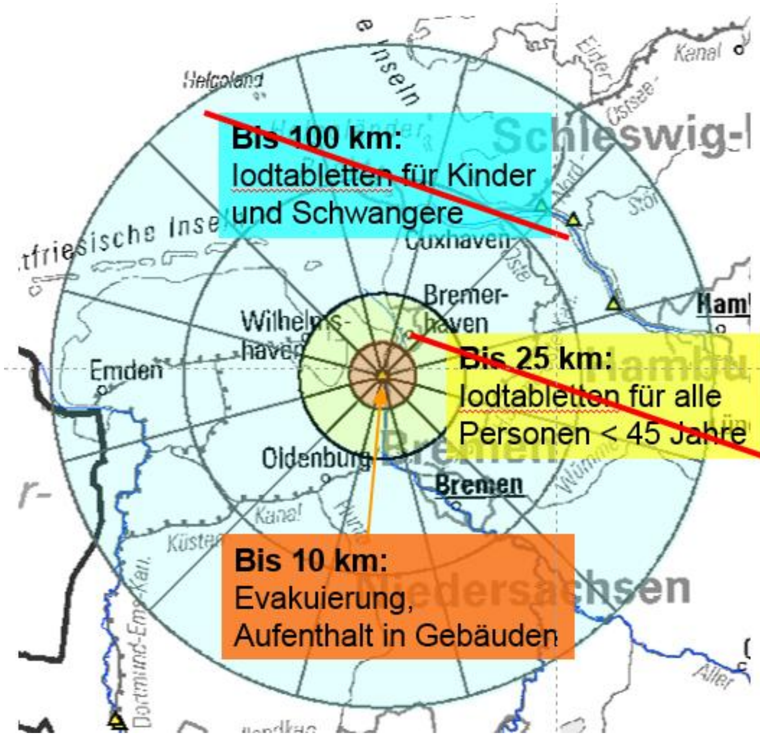
0926

Planungsgebiete für den Notfallschutz in der Umgebung bereits stillgelegter Kernkraftwerke

Die Planungsgebiete, die in der Umgebung der in 2011 stillgelegten Kernkraftwerke entsprechend **BMU 2008** ausgewiesen sind, können beibehalten werden.

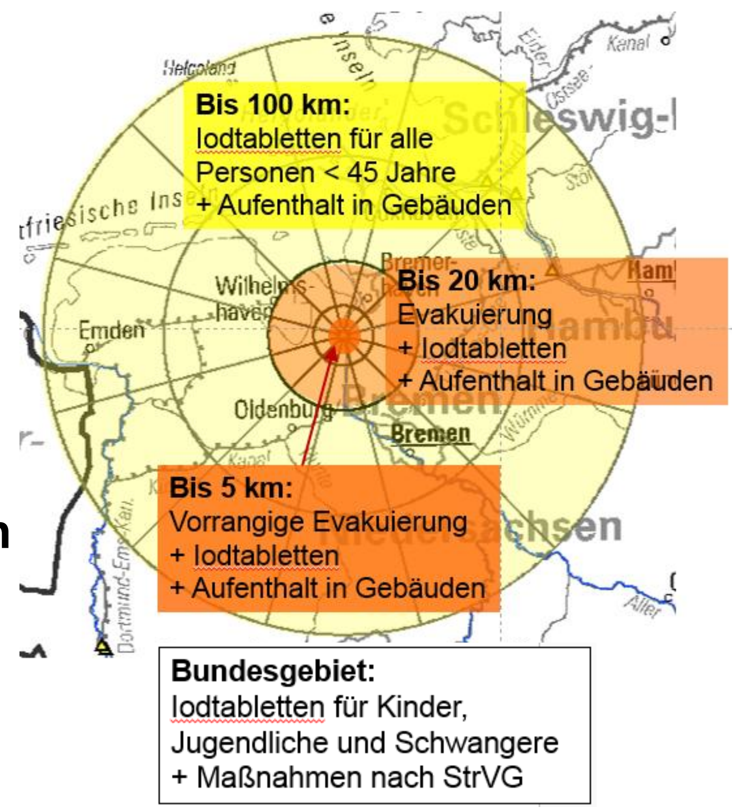
Die **Fernzone** kann aufgehoben werden.

Die Planung der **Iodblockade** für die Umgebung der in 2011 endgültig stillgelegten Kernkraftwerke muss nicht mehr aufrechterhalten werden.



Planungsgebiete für den Notfallschutz in der Umgebung zukünftig stillzulegender Kernkraftwerke

Für die Umgebung der künftig in Deutschland endgültig stillgelegten Kernkraftwerke empfiehlt die SSK, dass die **Planungsgebiete entsprechend SSK 2014-2** solange aufrechterhalten werden, solange Brennstoff in der Anlage verwahrt wird jedoch **längstens für die Dauer von drei Jahren** ab dem Tag der letzten Abschaltung.

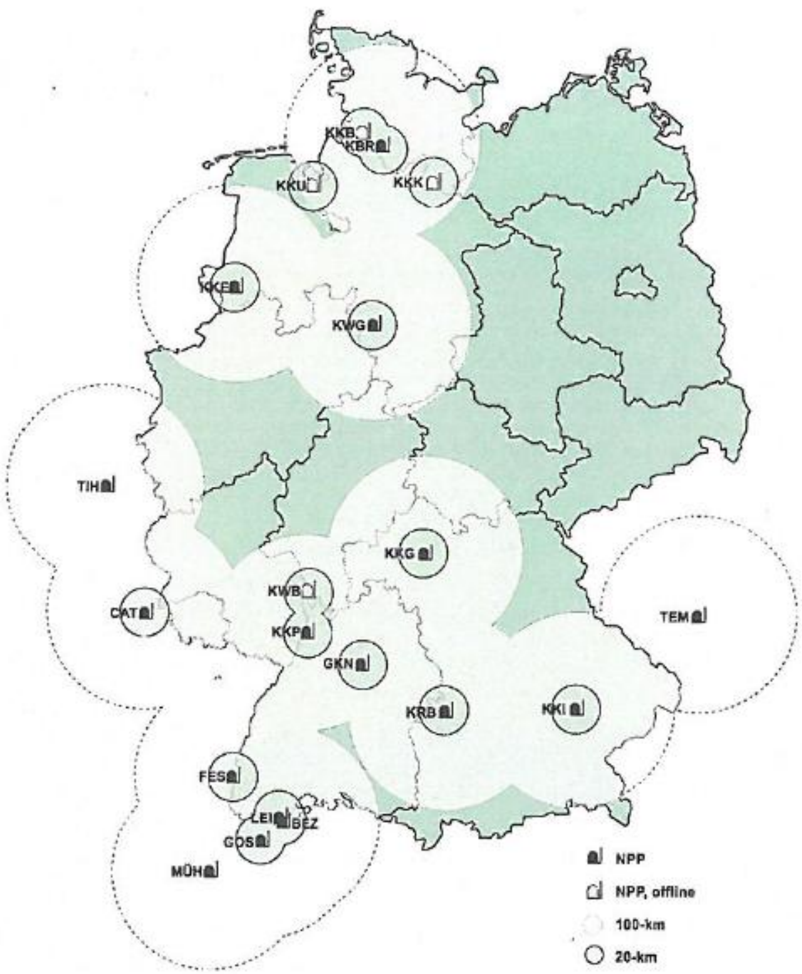


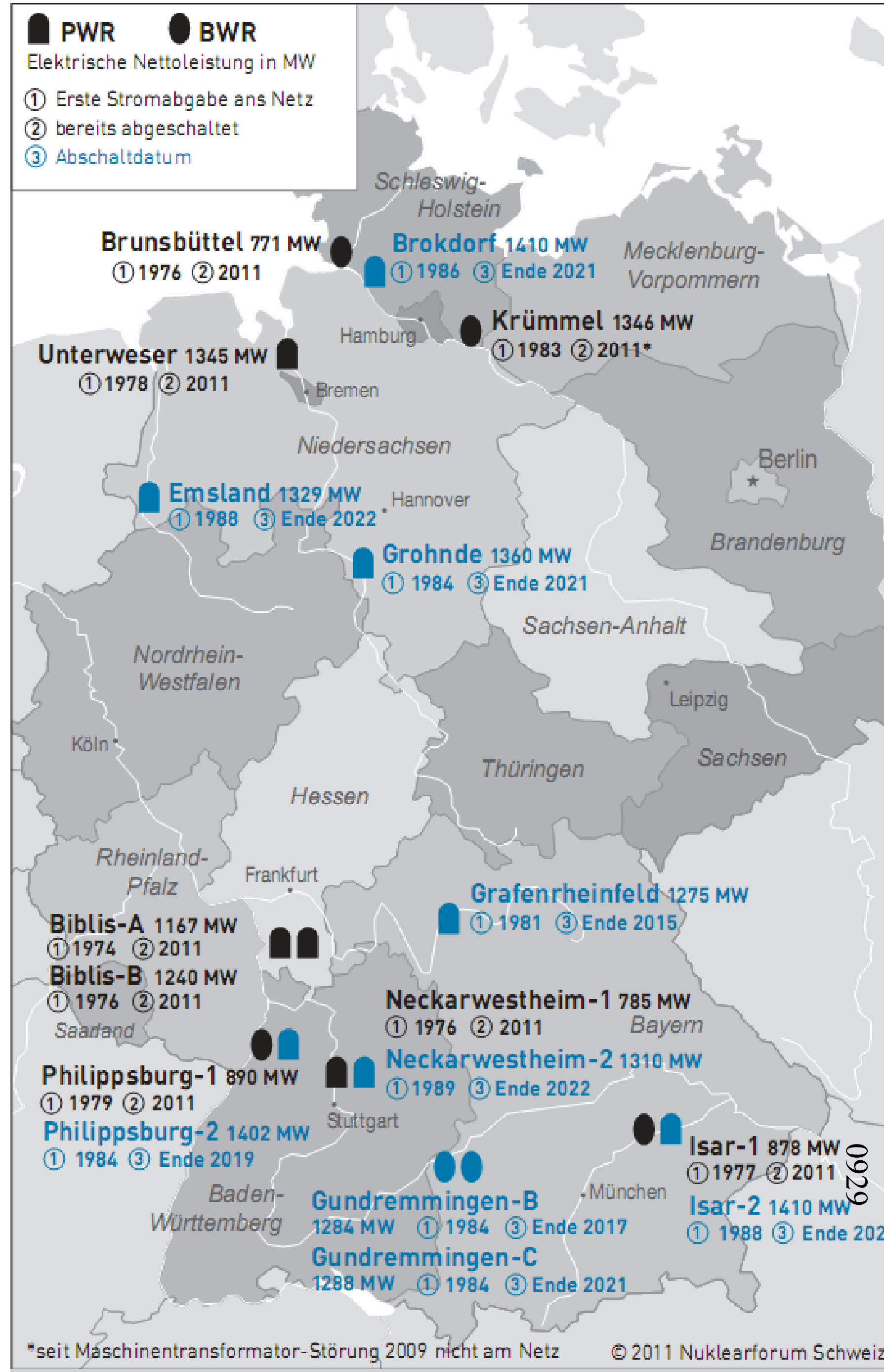
Für den Fall, dass **nach Ablauf von drei Jahren noch Brennstoff** in der Anlage vorhanden ist, können die Planungsgebiete entsprechend den o.g. **Regelungen für heute bereits stillgelegte Kernkraftwerke** festgelegt werden.

Für die Umgebung aller künftig in Deutschland endgültig stillgelegten Kernkraftwerke empfiehlt die SSK, dass die **Planung der Iodblockade für die Dauer eines Jahres** entsprechend 12 Monaten ab dem Tag der letzten Abschaltung beibehalten werden muss.

0928

Nuclear Power in Germany and Neighboring States





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| Verantwortung für Mensch und Umwelt |

The Use of Frequency-Consequence Curves in Future Reactor Licensing

by

Laurène Debesse

Diplôme d'ingénieur
Ecole Polytechnique, France, 2005

Submitted to the Engineering Systems Division and the Department of Nuclear Science and Engineering in Partial Fulfillment of the Requirements for the Degrees of

Master of Science in Technology and Policy and
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Abstract

The licensing of nuclear power plants has focused until now on Light Water Reactors and has not incorporated systematically insights and benefits from Probabilistic Risk Assessment (PRA). With the goal of making the licensing process more efficient, predictable and stable for advanced reactors, the U.S. Nuclear Regulatory Commission (USNRC) has recently drafted a risk-informed and technology-neutral framework for new plant licensing. The Commission expects that advanced nuclear power plants will show enhanced margins of safety, and that advanced reactor designs will comply with the Commission's Safety Goal Policy Statement. In order to meet these expectations, PRA tools are currently being considered; among them are frequency-consequence (F-C) curves, which plot the frequency of having C or more consequences (fatalities, injuries, dollars, dose...) against the consequences C. The present research analyzes the role and the usefulness of such curves in risk-informing the licensing process in the U.S., and shows that their use allows the implementation of both structuralist and rationalist Defense-In-Depth. The second part of this work concentrates on F-C curves as a mean to assess and limit societal risk. Such tools would improve the safety of current plants by allowing the regulator to focus its attention on the plants that pose the highest societal risks in events such as power uprates.

Thesis Supervisor: George E. Apostolakis, Professor of Nuclear Science and Engineering and of Engineering Systems

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List of acronyms

ACRS	Advisory Committee on Reactor Safeguards
AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
BWR	Boiling Water Reactor
CCDF	Complementary Cumulative Density Function
CDF	Core Damage Frequency
CFR	Code of Federal Regulations
DBA	Design-Basis Accident
ECCS	Emergency Core Cooling System
EI	Exposure Index
ESP	Early Site Permit
F-C	Frequency-consequence
GEIS	Generic Environmental Impact Statement
GFR	Gas-cooled Fast Reactor
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
IE	Initiating Event
LBE	Licensing Basis Event
LERF	Large Early Release Frequency
LOCA	Loss of Coolant Accident
LPG	Liquefied Petroleum Gas
LPZ	Low Population Zone
LWR	Light Water Reactor
MACCS	Melcor Accident Consequence Code System
MCA	Maximum Credible Accident
MIT	Massachusetts Institute of Technology
MYR	Middle Year of Relicense
NEA	Nuclear Energy Agency
PBMR	Pebble Bed Modular Reactor

PRA	Probabilistic Risk Assessment
PSAR	Preliminary Safety Analysis Report
QHO	Quantitative Health Objective
RY	Reactor Year
SAR	Safety Analysis Report
TMI	Three Mile Island
USNRC	U.S. Nuclear Regulatory Commission

Part I. Introduction

Nuclear electricity accounts today for approximately 17 percent of worldwide electricity generation. Once regarded as the most promising source of energy, nuclear energy has faced major public opposition heightened by the accidents of Three Mile Island and Chernobyl, which contributed to a slowing down of the whole industry in the United States. Recently, advantages of nuclear power have been given more light and publicity, which fosters the rebirth of nuclear power: among them is the fact that nuclear energy does not contribute to the emission of greenhouse gases. However, fears raised with Three Mile Island and Chernobyl accidents are still vivid. The 2003 Massachusetts Institute of Technology (MIT) study on the Future of Nuclear Power shows that safety is a key discriminating factor to be considered for the growth of nuclear power. In order to address this issue, major changes in the safety approach, for instance the increased use of Probabilistic Risk Assessment (PRA), have been made and contribute to the emergence of a safer fleet of reactors.

All commercial reactors in operation today belong to the Generations II and III. The U.S. Department of Energy's Office of Nuclear Energy, Science and Technology has launched several programs aimed at developing the next generation of nuclear energy systems. Part of the research effort is focused on new reactor concepts, the Generation IV reactors, such as the Gas-Cooled Fast Reactor (GFR), currently designed at MIT. In parallel to the design process currently underway, regulatory authorities are moving forward to define new licensing rules for future plants. Indeed, regulations of nuclear power plants have focused until now on Light Water Reactors only, and have not systematically incorporated insights and benefits from PRA methods. Part II of this work provides an overview of the current licensing process. In Part III, the main concepts of the safety philosophy of nuclear reactors are introduced. Among them is Defense-In-Depth, which will remain a fundamental tenet of the safety approach for advanced reactors.

So, the US Nuclear Regulatory Commission (USNRC) has defined as a goal to risk-inform the regulations and make the licensing process more efficient, predictable, and stable. Indeed, when Title 10 of the Code of Federal Regulations (CFR) Part 50 is used to license a design differing from the Light Water Reactor (LWR) design, the applicability of the regulations must be reviewed, exemptions documented, and additional requirements justified. This case-by-case analysis entails inefficiency. As for the predictability and stability of licensing processes, they pertain to the timing and outcome of the case-by-case review under 10 CFR 50: without a systematic set of rules applicable to all reactors, similar issues might be treated differently and uncertainty on the result of the review arises. To overcome these difficulties, the USNRC has recently drafted a technology-neutral framework for new plant licensing, which should in the long term replace 10 CFR Part 50. An Advance Notice of Proposed Rulemaking was issued by the Commission in May 2006. Similarly, the International Atomic Energy Agency has started giving guidance for developing a set of requirements that would be applicable to any kind of nuclear reactor. An objective of this research work is to analyze the use of specific risk assessment tools known as frequency-consequence (F-C) curves in future reactor licensing. Part IV presents a discussion of frequency-consequence curves in future reactor licensing and shows how such tool allows a risk-informed licensing process.

The question of including societal risk in the regulations has been regularly raised and it is legitimate in the context of the new framework to ask if societal risk should be included in the new licensing approach, and how F-C curves could contribute to societal risk assessment. Part V and VI introduce a different use of frequency-consequence curves as a mean to assess and limit societal risk. Part VII finally discusses the possibility of introducing such societal risk assessment tool in the U.S. regulations.

Part II. Overview of the licensing of nuclear power plants in the United States

The purpose of this part is to present the current licensing process of nuclear power plants. There are two processes for current plants, codified under Code of Federal Regulations (CFR) Title 10 Parts 50 and 52. An alternative licensing process for advanced nuclear plants is currently drafted at the USNRC.

II.A. The Atomic Energy Act and the Energy Reorganization Act

In 1954, Congress amended the 1946 Atomic Energy Act making possible the development of nuclear commercial activities.

The overall policy of the United States towards nuclear energy was defined in Section 1 of the 1954 Atomic energy Act (42 USC 2011), and consisted of two objectives:

> "(a) The development, use, and control of atomic energy shall be directed so as to make the maximum contribution to the general welfare, subject at all times to the paramount objective of making the maximum contribution to the common defense and security;
> (b) The development, use, and control of atomic energy shall be directed so as to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise."

The Atomic Energy Commission (AEC) was authorized by Section 161(b) of the Act to:

> "establish by rule, regulation or order, such standards and instructions to govern the possession and use of special nuclear material, source material, and byproduct material as the Commission may deem necessary or desirable to promote the common defense and security or to protect or minimize danger to life or property" (42 USC 2201).

The 1974 Energy Reorganization Act established the Nuclear Regulatory Commission (USNRC) to regulate the civilian use of nuclear materials. The Commission, which assumed the regulatory responsibilities of the Atomic Energy Commission, was assigned three regulatory functions: rulemaking, licensing and inspection.

II.B. Current licensing process

Licensing nuclear power plants is under the responsibility of the USNRC. Nuclear power plants currently in operation, all Light Water Reactors (LWRs), have been licensed using a two-step process. They must obtain both a construction permit and an operating license. This process is detailed in 10 CFR Part 50 and briefly summarized below:

- In order to construct or operate a nuclear power plant, the applicant must submit a Safety Analysis Report (SAR), which contains the design information and criteria for the proposed plant, comprehensive data on the proposed site, and also a discussion of hypothetical accident situations and the safety features available for both preventing and mitigating these accidents, should they occur. The application also includes an assessment of the environmental impact of the proposed plant and information for antitrust reviews.
- The USNRC staff reviews the application to determine if the plant design meets all the applicable regulations contained in 10 CFR Parts 10, 50, 73, and 100. This step includes a review of the design of the nuclear plant, the anticipated response of the plant to hypothetical accidents, the emergency plans, and the characteristics of the site. The results of this review are summarized in a Safety Evaluation Report. The Advisory Committee on Reactor Safeguards (ACRS), an independent committee of experts, also reviews the application and submits its results to the Commission.
- If the construction permit is issued, the applicant must then submit a Final Safety Analysis Report to support its application for an operating license.
- The USNRC then prepares a Final Safety Evaluation Report, and the ACRS provides an independent evaluation.

Based on the Atomic Energy Act, commercial power reactor licenses are issued for a 40 year period, with the possibility of renewing the license for 20 years. The first 40-year operating license will expire in 2009. The USNRC has established strict requirements codified in 10 CFR 51 and 10 CFR 54 for license renewal.

In 1989, USNRC established an alternative licensing process codified in 10 CFR 52 in order to improve regulatory efficiency and a greater predictability in the licensing process. An early site permit (ESP) gives a company approval for a plant site before a decision is actually made to build the plant; and resolves site safety, environmental protection and emergency preparedness

issues independently of a particular design. In the design certification process, USNRC examines if the design meets regulatory safety standards. If accepted, the Commission drafts a rule to issue the standard design certification as an appendix to 10 CFR 52.
Finally, a combined license authorizes construction and operation of the facility in a manner similar to a construction permit under the two-step licensing process.

The USNRC Office of Nuclear Regulatory Research is currently taking a step ahead by drafting an alternative to 10 CFR 50, which would be technology neutral, i.e. applicable to all reactor technologies, and risk-informed (USNRC, 2006). Such task calls for new risk assessment tools, such as frequency-consequence curves (F-C curves), for which no previous experience is available. At the same time, the new licensing process must rely on fundamental safety principles such as Defense-In-Depth that have greatly contributed until now to the safety of power plants.

Part III. Safety philosophy of nuclear power plants

The requirements a power plant must fulfill in order to get an operating license have evolved greatly since the licensing of the first plant. They reflect today the two tenets of the safety philosophy: the implementation of Defense-In-Depth and the existence of safety margins, which are an integral part of the Defense-In-Depth concept, but are often discussed separately. Risk-informing the licensing process calls for a greater reliance on risk quantification tools such as F-C curves. In this part, we will describe these two safety principles to later be able to demonstrate how F-C curves maintain both Defense-In-Depth principles and enhanced safety margins.

III.A. Defense-In-Depth

III.A.1. Definition

The concept of Defense-In-Depth has greatly evolved from a "narrow application to the multiple barrier concept to an expansive application as an overall safety strategy" (Sorensen et al, 1999). It is currently interpreted as follows:

- High-level protective strategies are implemented: preventing accident initiators from occurring, terminating or mitigating accidents adequately, preventing degradation or failure of barriers designed to contain radionuclides, and accident management plans to protect the offsite public in case radionuclides penetrate the barriers.
- Multiple physical barriers are required (the "historical" approach).

In a 1999 White Paper on risk-informed and performance-based regulations (USNRC, 1999), the Commission reaffirmed the crucial importance of Defense-In-Depth in its approach to safety:

> "The concept of defense-in-depth has always been and will continue to be a fundamental tenet of regulatory practice in the nuclear field. Risk insights can make the elements of defense-in-depth clearer by quantifying them to the extent practicable. Although the uncertainties associated with the importance of some elements of defense may be substantial, the fact that these elements and uncertainties have been quantified can aid in determining how much defense makes regulatory sense. Decisions on the adequacy of or the necessity for elements of defense should reflect risk insights gained through identification of the individual performance of each defense system in relation to overall performance."

III.A.2. Rationalist and Structuralist Defense-In-Depth

A useful distinction between a "structuralist" model of Defense-In-Depth and a "rationalist" one has been proposed (Sorensen et al, 1999):

- In the *structuralist* approach, "Defense-In-Depth" is embodied in the structure of the regulations and in the design of the facilities built to comply with those regulations. The requirements are derived by constantly asking the question: "what if this barrier fails?" no matter what the probability of failure of the barrier is. Hence, emphasis is put on both accident prevention and accident mitigation. The current safety approach, based on deterministic principles, has relied on the structuralist Defense-In-Depth.
- The *rationalist* model asserts that "defense in depth is the aggregate of provisions made to compensate for uncertainty and incompleteness in our knowledge of accident initiation and progression." This model relies on quantitative acceptance criteria and requires that the system be analyzed using risk assessment methods and the uncertainties be quantified before being managed appropriately.

III.B. Safety Margins

As part of Defense-In-Depth, the main purpose of safety margins is to cope with uncertainties.

III.B.1. Epistemic and aleatory uncertainties

A useful classification of uncertainties into two categories is available in the literature (Apostolakis, 1990, 1993): aleatory uncertainties, which are uncertainties in the model of the world, and epistemic uncertainties, which are uncertainties in the state of knowledge. Such categorization should not be interpreted as if there were in theory two types of probability intended to represent these uncertainties, even if the distinction has useful implications in the modeling of complex systems (Winkler, 1996).

Aleatory uncertainties deal with observable quantities (for instance the time to failure of a component); they come from the fact that events can happen in a random or stochastic manner.

For instance, a pump can fail to start due to a random failure. This type of uncertainty cannot be reduced by further studies, but can be better characterized by additional research. It is usually managed by probabilistic methods.

As opposed to aleatory uncertainties, *epistemic uncertainties* deal with non-observable quantities and arise from our lack of knowledge or lack of scientific understanding. They can be reduced by additional studies and fall into three categories:

- The first category consists of *parameter uncertainty*, which is uncertainty associated with the values of the parameters of the Probabilistic Risk Assessment (PRA) models and the basic data used in safety analysis such as failure rates, ultimate strength, etc. The values of these parameters are not perfectly known.
- The second category of uncertainties, the *model uncertainties*, deals with the uncertainties associated with the data limitations, analytical physical models, and acceptance criteria used in the safety analysis. Experts may formulate different models in order to be as close to reality as possible, even though these models are an approximation of the real phenomena. For instance, model uncertainties arise when modeling human performance or common cause failures such as fires.
- As for the third category, *completeness uncertainty* is the uncertainty associated with factors not accounted for in the safety analysis, such as safety culture, unknown or unanticipated failure mechanisms, etc. It can be considered a scope limitation, whose magnitude is difficult to assess since it reflects an unanalyzed contribution to risk. It has often been referred to as the "unknown unknown".

Let's consider an example to illustrate the differences between these types of uncertainties. A designer might need to assess the values of a certain parameter in a given system or a component on duty, for example the maximum pressure in the containment during a Loss of Coolant Accident (LOCA). Even if the designer had a perfect knowledge of the system, his assessment of the parameter would still be uncertain due to the existence of random phenomena. Moreover, the uncertainties due to its lack of knowledge make the assessment of the parameter even more uncertain: only a probability density function can capture the values of that parameter.

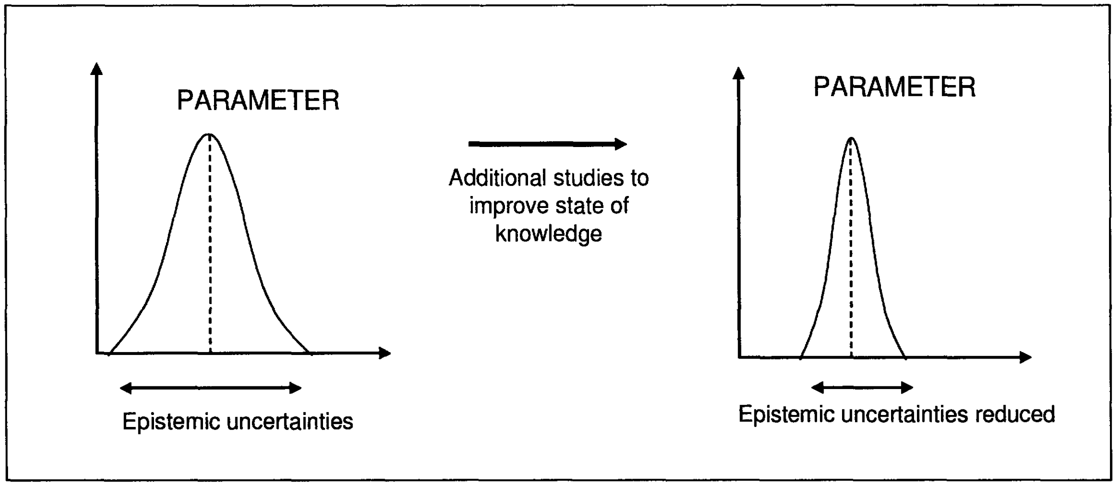

Figure 1: Illustration of epistemic uncertainties

III.B.2. Quantification of safety margins

Safe operation is ensured if safety variables (e.g. peak clad temperature, containment pressure) remain within the capacity limits, defined as the values above or under which the system fails. Safety margin is then defined as the difference between the characteristic value (e.g. the mean value) of the safety variable and the characteristic value of the capacity.

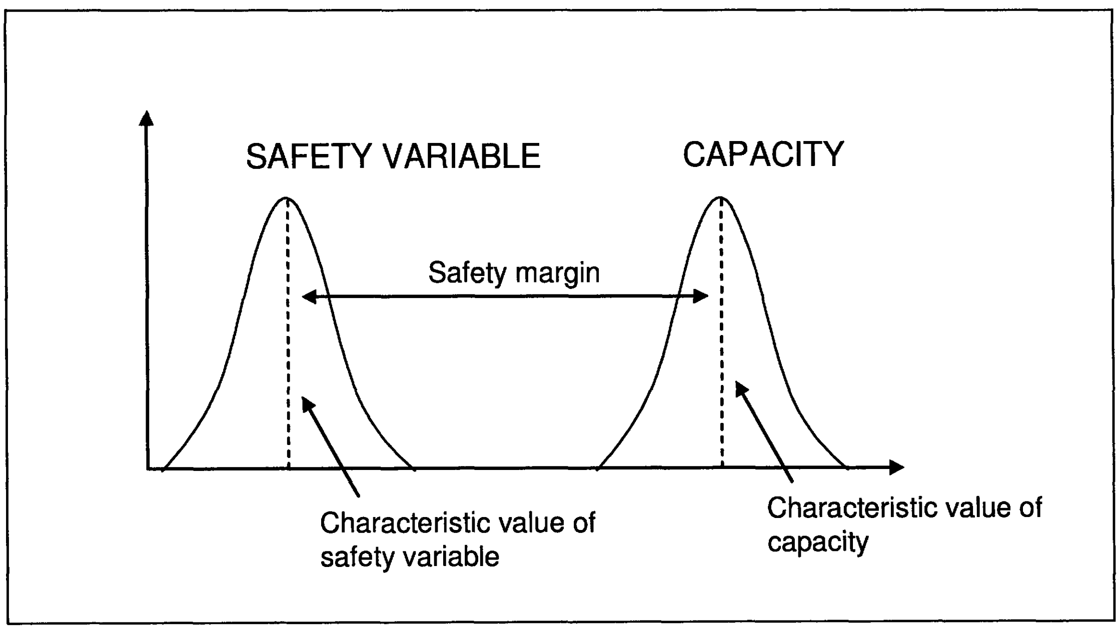

Figure 2: Definition of safety margin

The capacity is often uncertain, and the regulator may choose to define a regulatory limit well below the capacity. The definition of safety margin can then be defined as the sum of the design margin and the regulatory margin. The design margin is the difference between the regulatory limit and the characteristic value of the safety variable; and the regulatory margin is the difference between the characteristic value of the capacity and the regulatory limit.

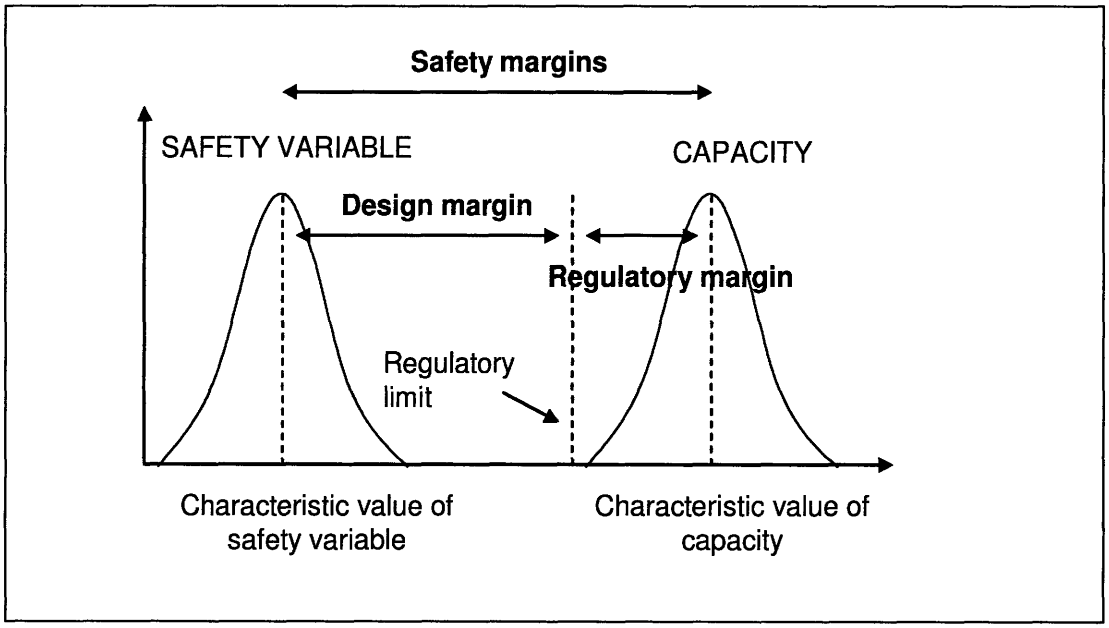

Figure 3: Design and regulatory margins (USNRC, 2006)

To calculate the characteristic value of the load: one can either do a best estimate calculation using realistic codes and analyses, or one can make conservative assumptions to calculate a value, that if below the acceptance criterion, ensure that adequate safety margin is provided without having to quantify it. Table 1 summarizes the characteristics of the conservative and best estimate approaches.

Applied codes	Input & Boundary and initial conditions	Assumptions on system availability	Approach
Conservative codes	Conservative input	Conservative	Deterministic
Best estimate (realistic) codes	Conservative input	Conservative	Deterministic

Best estimate codes + Uncertainties	Realistic input + uncertainties	Conservative	Deterministic
Best estimate codes + Uncertainties	Realistic input + uncertainties	PRA-based	Deterministic + Probabilistic

Table 1: "Conservative approach" versus "Best estimate approach" (IAEA, 2001)

Adequate safety margins are currently ensured by requiring that the conservative value for the safety variable be below the regulatory value for the capacity. For instance, 10 CFR Part 50.46 stipulates that the peak clad temperature during transients for a Light Water Reactor (LWR) cannot exceed 2200°C during a LOCA. The designer uses conservative assumptions to ensure that this requirement is met. The "real" safety margin is not quantified. Research efforts are currently undertaken to improve computer codes to allow best estimate calculations and uncertainty analyses.

III.C. The trend towards risk-informing regulations

III.C.1. Defining risk quantitatively

Risk analysis is the discipline that has the objective of capturing risk by answering three questions (Kaplan and Garrick, 1981): (1) what can happen?, (2) how likely is it that it will happen?, and (3) if it does happen, what are the consequences? A risk analysis consists therefore in identifying all the possible scenarios, for which both the probability and consequences are assessed.

The *"level-1"* definition of risk by Kaplan and Garrick is a set of triplets that express for each possible outcome its probability and consequence: R=$\{\langle S_i, P_i, X_i \rangle, i = 1,2...N\}$, with P_i being the probability of the scenario S_i, and X_i the measure of damage or consequence measure of the scenario. The integration of uncertainties leads to the *"level-2"* definition of risk.

There are several ways to display the risk of a system. Among them are risk-curves, which express the frequency of exceeding a certain consequence (Complementary Cumulative Density

Function). Epistemic uncertainties can be displayed on risk-curves (Figure 4). These curves have to be read vertically: the frequency of exceeding a certain consequence is uncertain and the different confidence levels for the frequency can be read vertically, as shown on the following figure.

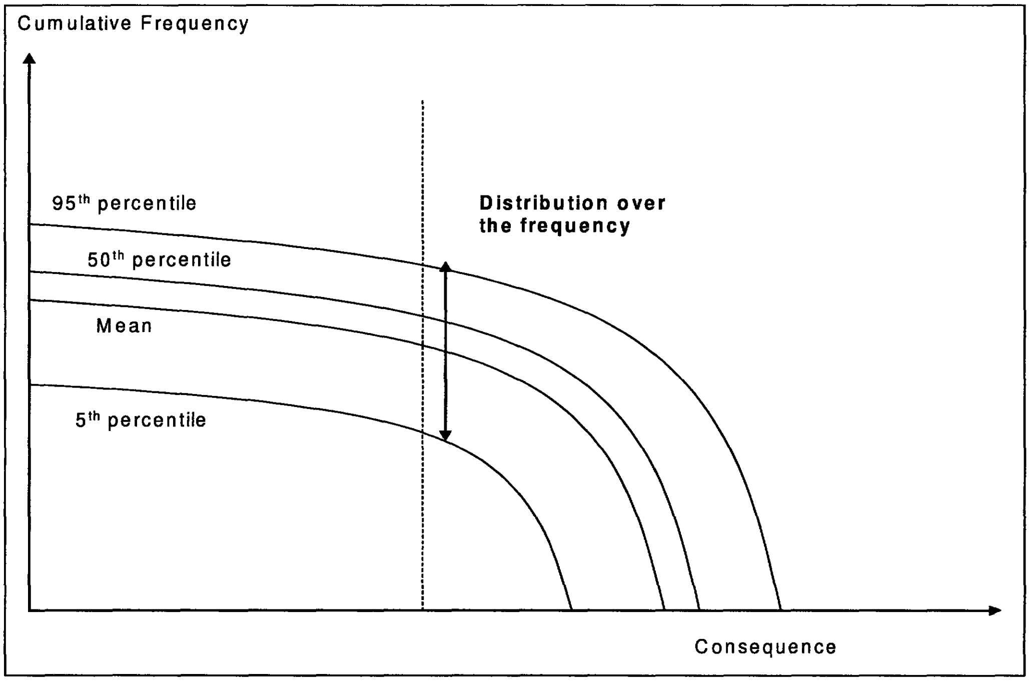

Figure 4: Display of uncertainties on F-C curves

Probabilistic Risk Assessment (PRA) is an analytical technique for systematically identifying potential outcomes of a known initiating event. Major PRA studies include the 1975 Reactor Safety Study and the 1990 NUREG-1150 study, which assessed the risk of severe accidents for five nuclear power plants. There are several levels of PRA:

- Level-1 PRAs quantify the frequency of having core damage (CDF);
- Level-2 PRAs quantify the frequency of a large early release of radioactive material (LERF). Figure 5 illustrates the different items that need to be assessed and quantified for a level-2 PRA;
- Level-3 PRAs calculate the off-site consequences of potential accidents. This latter level is the most uncertain since it requires the modeling of radioactive plume dispersion and the modeling of health effects.

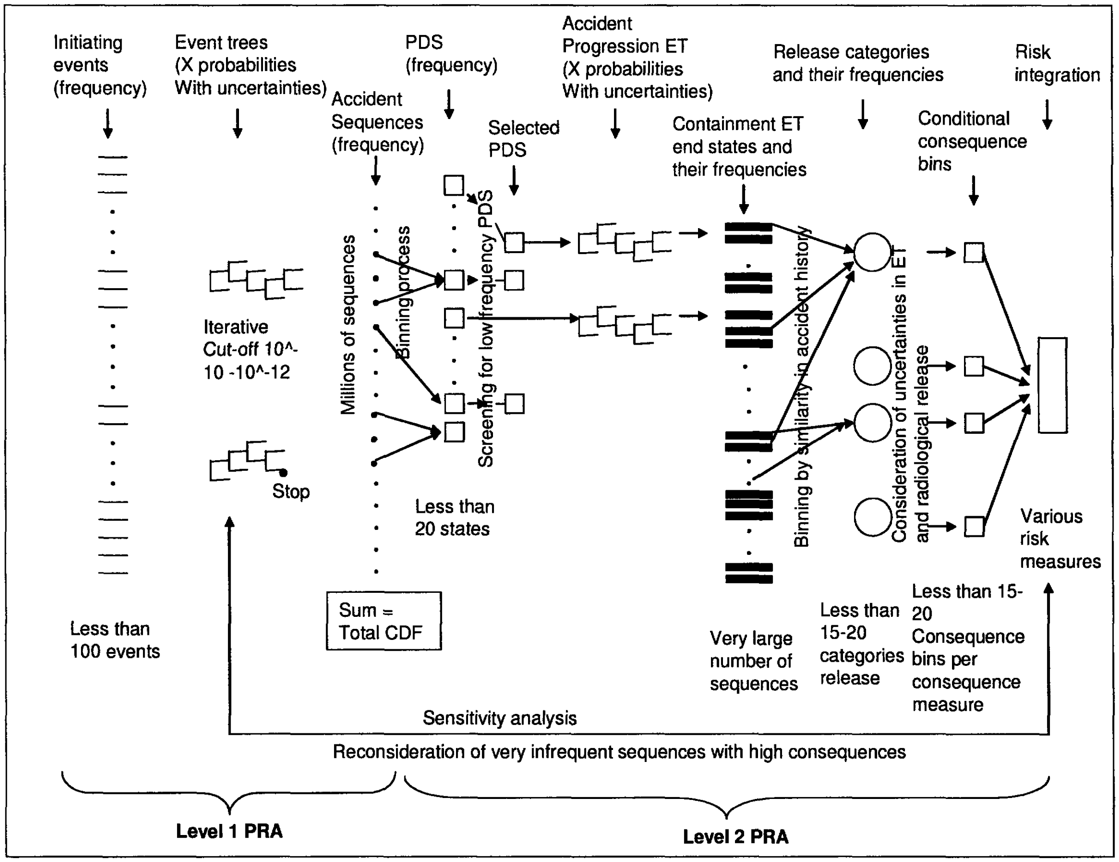

Figure 5: PRA modeling

(Cazzoli et al, 1993)

III.C.2. Quantification of risk in the regulations

In parallel to the maturation of risk assessment tools, the USNRC started quantifying risk acceptance criteria. In 1986, the USNRC issued the Safety Goal Policy Statement (USNRC, 1986), in which it stated what it judged to be an acceptable level of risk from nuclear power plants. Two Quantitative Health Objectives (QHOs) were defined:

> "The risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of one percent (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.
> The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of

one percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes."

In August 1995, the Commission issued a policy statement on the use of PRA methods in nuclear regulatory activities (USNRC, 1995). The policy statement recommended that the use of PRA technology be "increased in all regulatory matters in a manner that complements the USNRC's traditional defense-in-depth philosophy." It also recommended that PRA and associated analyses be used to reduce unnecessary conservatism associated with current regulatory requirements and guides, license commitments, and staff practices, in order to focus the regulatory actions on where the risk is the highest.

Significant change has been introduced in the past decades in the regulations and we can observe an increasing reliance on risk quantification. However, there are still wide parts of the regulations, such as licensing requirements, that haven't benefited fully from PRA insights.

III.D. Justifications for a new licensing approach

There are three types of issues associated with the current licensing approach:

- *Current regulations focus on LWR design.* This issue has already been raised at the USNRC for reactor technologies such as the Pebble Bed Modular Reactor (PBMR), for which risk metrics such as the Core Damage Frequency might not be applicable. Getting exempted from LWR requirements is a long process, which necessarily creates unpredictability in licensing and might discourage investment in new reactor designs.

- *Deterministic requirements may cause unnecessary burden and may miss critical safety issues.* Regulators placed additional barriers and imposed new requirements asking the question: What if we are wrong? What if barriers fail? This led to the addition of safety features that did not necessarily increase plant safety. For instance, the "Reactor Safety Study: An assessment of Accident Risks in U.S. Commercial Nuclear Power Plants", known as WASH-1400 (USNRC, 1975), found that small LOCAs and transients were dominant contributors to the risk of a plant, contradicting the previous purely deterministic approach that only considered very large pipe breaks in the reactor coolant system.

- *Unnecessary requirements may be very costly and therefore are a major drawback to nuclear power development.* In an article entitled "Who Killed U.S Nuclear Power?" Marsha Freeman, associate editor of the magazine 21st Century Science Technology, points out the role of nuclear regulatory actions in the seventies: "Billions of dollars were spent by nuclear utilities to retrofit plants for increased safety, much of which retrofitting was known by many in the industry to be unnecessary" (Freeman, 2001). Charles Komanoff, an energy economist and environmental activist, released a study in 1981 (Komanoff, 1981) proposing that the real cost in constant "steam-plant" dollars per kilowatt to complete nuclear power plants in the United States increased by 142% from the end of 1971 to the end of 1978, taking into account the inflation in the costs of standard construction inputs such as labor, equipment, and materials.

  Note however that quantification of the role of regulations on cost increases is a difficult task and studies are scarce. Nuclear power plants are very complex systems, which makes it difficult to directly relate one regulation to an increase in costs. However, even if figures are exaggerated, most experts agree that the tremendous increase in requirements has had a very strong impact on costs, while not all the new requirements were justified.

  George Apostolakis, chairman of the ACRS PRA subcommittee, states that PRA has a great role to play regarding "the regulatory burden that was created in some instances, such as in quality assurance requirements" (Apostolakis, 2000). He further says that "one utility has indicated that if it implemented graded quality assurance guidance, its savings would be up to $ 2 million a year". Regulatory Guide 1.176 "An Approach for Plant-Specific, Risk-Informed Decision making: Graded Quality Assurance" provides guidance on how to risk-inform the regulations and requires quality assurance adjusted to the level of safety needed.

III.E. Conclusion

The objective of the framework drafted by the USNRC is to produce a risk-informed and technology-neutral licensing process, which constitutes a major change in the regulations since it calls for an increase reliance on risk assessment tools while maintaining a high-level Defense-In-Depth. Such task represents a tremendous challenge for both the regulator in charge of defining the process and the industry, which will have to comply eventually.

F-C curves are a good example of the combination of probabilistic and deterministic principles: They allow both a quantification of risk and the implementation of structuralist and rationalist Defense-In-Depth through the quantification and implementation of safety margins.

Part IV. Use of frequency-consequence curves in new reactor licensing

Regulations of nuclear power plants have focused until now on Light Water Reactors and have not systematically incorporated insights and benefits from probabilistic risk assessment methods. With the goal of risk-informing the regulations and making the licensing process more efficient, predictable and stable for advanced reactors, the US Nuclear Regulatory Commission has recently drafted a technology-neutral framework for new plant licensing. The new licensing rules would be applicable to Generation IV commercial nuclear power plants only, and would constitute an alternative to 10 CFR Part 50. The current working draft released by the USNRC in August 2006 (USNRC, 2006) envisions two major uses of F-C curves: a tool to ensure implementation of the USNRC's safety expectations as well as a tool to identify and select the Licensing Basis Events (LBEs), intended to replace the Design-Basis Accidents (DBAs).

The objective of this part is two-fold: first, present the F-C curve concept proposed by the USNRC, and, second, understand the extent to which Licensing Basis Events constitute an improvement over Design-Basis Accidents.

IV.A. Expected level of safety for future plants

The level of safety that new plants are expected to meet, captured by the framework, has been defined in the policy statement on the regulation of advanced nuclear power plants (USNRC, 1994), in which the Commission has expressed two expectations:

- That advanced nuclear power plants will show enhanced margins of safety.
- That advanced reactor designs will comply with the Commission Safety Goal Policy Statement, i.e. that plants will comply with the Quantitative Health Objectives.

A three-region approach to risk acceptability has been developed. The requirements developed through the framework will ensure that the risk lies in the lower region, and that there is only a small chance that the risk can be in the intermediate region, and a negligible probability that it lies in the unacceptable region.

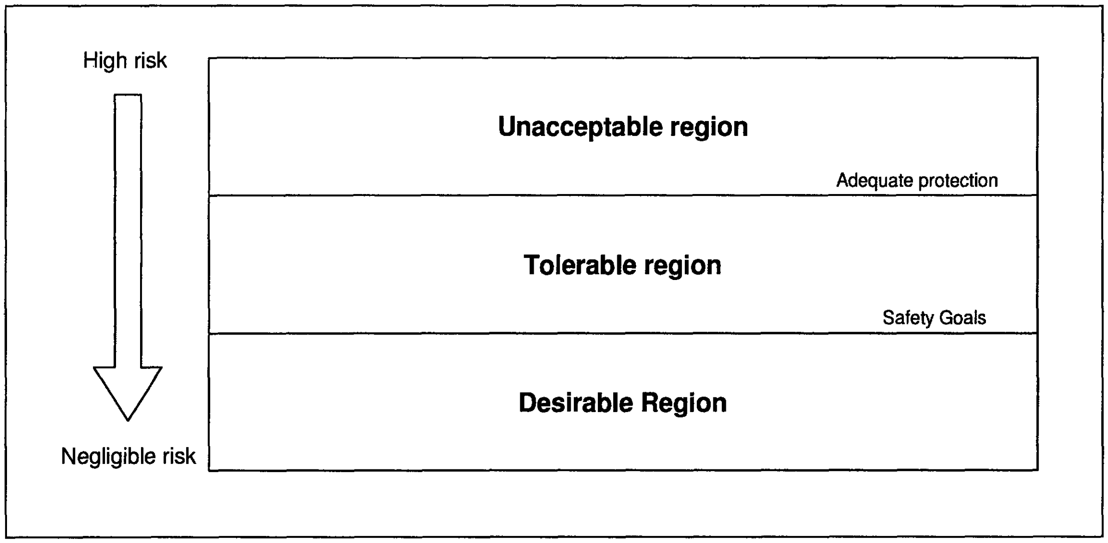

Figure 6: Three Region Approach to Risk Tolerability

IV.B. Definition of frequency-consequence curves in the framework

The F-C curve proposed for use by the Commission's staff relates the frequency of potential accidents to acceptable radiation dose released by these potential accidents for an individual at the site boundary. The underlying principle is that the higher the consequence of an event, the lower the frequency of the event must be. The F-C curve is derived from current regulatory requirements that can be found in 10 CFR Parts 20, 50 and 100.

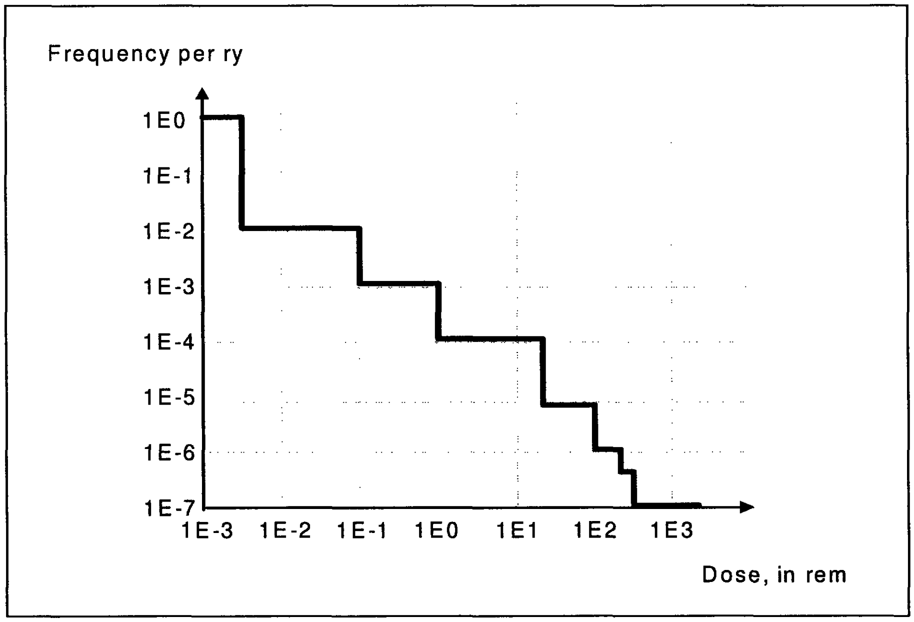

Figure 7: Frequency-consequence curve proposed in the USNRC framework

As an example, 10 CFR § 20.1301 specifies the dose limits for individual members of the public:

> "Each licensee shall conduct operations so that the total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year".

Therefore, events resulting in doses of 100 mrem shouldn't have a frequency above 1. This is translated on Figure 7 by limiting the frequency of events resulting in doses of 5-100 rems to 0.01/ry. The figure presents the F-C curve proposed for use by the USNRC as of August 2006. One should note that 10 CFR § 20.1301 specifies a limit on the integrated risk, not from a single event; whereas the interpretation done for the F-C curve is on a single event basis.

IV.C. Use of the frequency-consequence curve to implement USNRC's high-level safety expectations

IV.C.1. Each event sequence must lie individually below the F-C curve

A PRA has to be completed (whose technical requirements are detailed in the framework). The PRA encompasses all internal and external events as well as all modes of plant operation. The PRA is used to generate a sufficiently complete set of accidents scenarios, whose frequencies and consequences are calculated with uncertainties accounted for: all accident sequences are identified in terms of a distribution of their frequencies and end states.

To implement USNRC's high-level safety expectations, each event sequence, defined by its mean frequency and mean consequence dose, must individually lie in the lower region of the F-C curve.

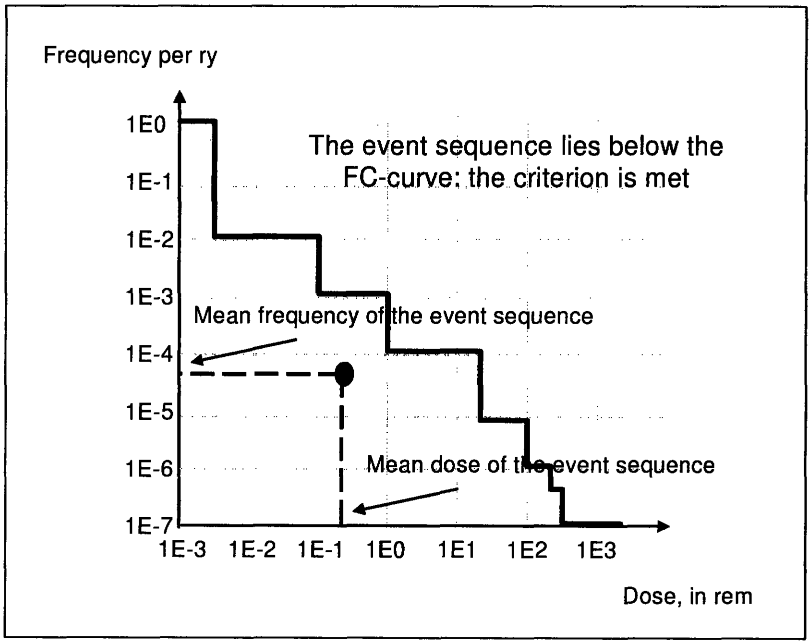

Figure 8: Criterion for individual event sequence

IV.C.2. The integrated risk is not assessed with the frequency-consequence curve

Each PRA sequence must meet individually the criterion imposed by the F-C curve on a mean value basis, which implies that each sequence meets individually the QHOs. However, the overall risk is not captured by the F-C curve and the PRA results must also demonstrate that the total integrated risk over all accident sequences satisfy both QHOs.

To show compliance with the QHOs, a level-3 PRA is needed unless surrogates objectives can be determined. For now, no surrogates similar to CDF and LERF have been defined on a technology-neutral basis for advanced reactors. However, even if surrogates were to be defined, sufficient experience and time would be needed in order to have confidence in their use.

IV.D. Use of frequency-consequence curves to identify and select Licensing Basis Events

IV.D.1. Design-Basis Accidents

The current fleet of U.S. reactors was licensed using a deterministic approach, which evolved from the licensing of the first commercial power plant on a case-by-case basis to the emergence in the mid sixties of generic criteria that the reactor design must meet.

A deterministic approach refers to the principle of "determinism", which holds that:

> "Specific causes completely and certainly determine effects of all sorts. As applied in nuclear technology, it generally deals with evaluating the safety of a nuclear power plant in terms of the consequences of a predetermined bounding subset of accident sequences" (USNRC Glossary, 2006).

Hence, the deterministic approach relies on the concept of design-basis accidents, which are postulated accidents

> "that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to assure public health and safety" (USNRC Glossary, 2006).

These accidents envelop the whole spectrum of accidents. If a power plant is able to withstand the design-basis accidents, which assume worst-case scenarios, then it is able to cope with all accident challenges:

> "The design basis accidents were not intended to be actual event sequences, but rather, were intended to be surrogates to enable deterministic evaluation of the response of a facility's engineered safety features. These accident analyses are intentionally conservative in order to compensate for known uncertainties in accident progression, fission product transport, and atmospheric dispersion" (USNRC Regulatory Guide 1.183, 2000).

Beyond design-basis accidents are, on the other hand, accident sequences that are possible, but are not fully considered in the design process because they are judged to be too unlikely. The redundancy of systems and extensive implementation of margins arising from Design-Basis Accident evaluations have resulted in plant designs that have considerable robustness and capability to mitigate potential severe accident scenarios (USNRC, 2004).

IV.D.1.a. The General Design Criteria

All the Light Water Reactors (LWRs) conceived and proposed to the AEC for construction permits, from the Shippingport reactor in 1953 to Dresden 2 in 1965, were generated without a set of safety criteria that the design must meet.

All Light Water Reactors (LWRs) conceived and proposed to the AEC for construction permits from the Shippingport reactor in 1953 to Dresden 2 in 1965 were generated without a set of safety criteria that the design must meet.

Prior to 1965, the individual design criteria evolved over the years on a case-by-case basis. New criteria were introduced as the result of rector-specific or site-specific issues and tended to emerge from questions about low-probability events not previously considered, or from unusual operating experience with generic implications.

In 1965, the AEC staff started developing general design criteria. The original criteria were revised in 1967 and again in 1971 when the AEC published a general set of design criteria that became Appendix A to 10 CFR Part 50.

Appendix A to 10 CFR 50 states that:

> "An application for a construction permit must include the principal design criteria for a proposed facility. The principal design criteria establish the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety; that is, structures, systems, and components that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public.
> These General Design Criteria establish minimum requirements for the principal design criteria for water-cooled nuclear power plants similar in design and location to plants for which construction permits have been issued by the Commission"

One of the most famous criteria is the single failure criterion. Appendix A to 10 CFR Part 50 defined "single failure" as:

> "An occurrence which results in the loss of capability of a component to perform its intended safety functions. Multiple failures resulting from a single occurrence are considered to be a single failure. Fluid and electric systems are considered to be designed against an assumed single failure if neither (1) a single failure of any active component (assuming passive components function properly) nor (2) a single failure of a passive component (assuming active components function properly), results in a loss of the capability of the system to perform its safety functions."

Other criteria, such as criterion 35 on the Emergency Core Cooling System (ECCS) refer to the concept of single failure. Criterion 35 states that the emergency cooling system should be designed to withstand a postulated Loss of Coolant Accident (LOCA) defined as double-ended rupture of the largest pipe of the reactor coolant system, the concurrent loss of offsite power, and a single failure of an active EECS component in the worst possible place.

IV.D.1.b. Design-basis accidents as a tool to show compliance with licensing requirements

The design-basis accidents stem from the General Design Criteria.
10 CFR 50.34 requires that each application for a construction permit for a nuclear reactor facility include a Preliminary Safety Analysis Report (PSAR) and that each application for a license to operate such a facility include a Final Safety Analysis Report (FSAR). Section 50.34 specifies in general terms the information to be supplied in these Safety Analysis Reports (SARs). Regulatory Guide 1.70 describes in more details the information that should be provided in the SAR. Chapter 15 of the Safety Analysis Report focuses on accident analyses and provides guidance on the classification of events and on the methodology that should be used. As mentioned earlier, the applicant must show that its design conforms to the General Design Criteria and that the plant is able to withstand the postulated design-basis accidents

For instance, an applicant can postulate a LOCA inside the containment, assuming a worst case of piping break in order to represent an envelope evaluation for liquid or steam line failure inside the containment. The assumptions and calculations should be conservative.

As an example, Regulatory Guide 1.3 indicates what type of conservative assumptions should be done (e.g. "infinite cloud" assumption). Regulatory Guide 1.70, that provides guidance for the SAR, acknowledges that "there may be instances in which the applicant will not agree with the conservative margins inherent the design basis approach approved by the USNRC staff" and in which the applicant might want to do a realistic analysis. The applicant may present his analysis but he is reminded that "the known USNRC assumptions should nevertheless be used in the design basis analysis."

IV.D.1.c. The "Maximum Credible Accident" concept

Another postulated accident, which plays a fundamental role in the licensing process, is the "Maximum Credible Accident", postulated for siting purposes.

According to David Okrent, former ACRS member and author of a book on the history of the regulatory process (Okrent, 1981), the principle was mentioned by Clifford Beck, member of the regulatory staff, in a nuclear congress in Rome in 1959. The philosophy behind Design-Basis Accidents was summarized then as follows:

> "If the worst conceivable accidents are considered, no site except one removed from population areas by hundreds of miles would offer sufficient protection. On the other hand, if safeguards are included in the facility design against all possible accidents having unacceptable consequences, then it could be argued that any site, however crowded, would be satisfactory... assuming of course that the safeguards would not fail and some dangerous potential accidents had not been overlooked. In practice, a compromise position between these two extremes is taken. Sufficient reliance is placed on the protective features to remove most of the concern about the worst conceivable accidents, though there is seldomly sufficient confidence in the facility safeguards to be sure that all hazards have been eliminated. Thus, a possible reactor site is reviewed against the possibility of credible accidents, and their consequences, which might occur despite the safeguards present.
> It is inherently impossible to give an objective definition or specification for "credible accidents" and thus the attempt to identify these for a given reactor entails some sense of futility and frustration, and further, it is never entirely assured that all potential accidents have been examined."

Clifford Beck, in this speech, puts the emphasis on the difficulty of defining credible accidents and on the need for additional barriers due to lack of knowledge (epistemic) uncertainties, laying the ground for the concept of defense-in-depth.

Following up on this idea in 1961, the AEC, under the leadership of Clifford Beck, published for comment in the Federal Register, siting criteria that included concepts such as a low-population zone, an exclusion area, and a population center distance:

> "For purposes of site evaluation, an accident was postulated in which the noble gases and half the radioiodine were released to a containment building that was assumed to maintain its integrity, and in which guideline doses of 25 rem whole body and 300 rem to the thyroid were not to be exceeded under the specified conditions. This postulated accident (the maximum credible accident or MCA) whose consequences were not to be exceeded by any credible accident, became the focus of siting evaluation. [...] Most safety improvements which developed were related to meeting the requirements of the postulated MCA."(Okrent, 1981)

The use of postulated accidents to show compliance with siting requirements is still in the regulations. Section 100.11 of 10 CFR Part 100 provides criteria for determining the Exclusion Area, Low Population Zone, as well as the Population Center Distance. To evaluate a proposed site, the applicant should assume a fission product release, "based upon a major accident, hypothesized for purposes of site analysis or postulated from considerations of possible accidental events that would result in potential hazards not exceeded by those from any accident considered credible. Such accidents have generally been assumed to result in substantial meltdown of the core with subsequent release of appreciable quantities of fission products."

IV.D.1.d. The difficulty of dealing with incredible accidents

Although the notion of "credibility" seems to refer to the concept of likelihood and probability, expert judgment and experience were the basis for defining credible accidents. The question of how to deal with incredible accidents has always been a thorny issue. It is important to note that the Maximum Credible Accident was assumed to be contained.

The difficulty of dealing with incredible accidents can be illustrated by the question of the reactor pressure vessel integrity that arose in 1965 (Okrent, 1981). The AEC regulatory staff was unwilling to consider accidents it qualified as incredible. The issue of the integrity of the reactor pressure vessel had been raised several times by the ACRS before 1965. For instance, in a 1961 report to the AEC, it recommended the development of adequate codes and standards for the pressure vessel and other parts of the primary systems of power plants. However, failure of the reactor pressure vessel was considered as "incredible" for the LWR and BWR reviewed before 1965. No protection against gross vessel failure was provided, even though the possible consequences of such failure would have potentially led to a major uncontrolled release of radioactivity.

The issue was especially complex since there did not seem to be clearly feasible way to prevent core melt and ensure containment integrity in case of a catastrophic pressure vessel failure. At an ACRS subcommittee meeting dedicated to the Dresden II reactor licensing application, the vendor representative, asked about the consequences of a potential pressure vessel, replied, "The containment could withstand a larger break than the maximum credible accident but not a complete break of the pressure vessel." In November 1965, the ACRS recommended in a letter to the AEC that some provisions be made against the unlikely accidents and that means be developed to ameliorate the consequences of a major vessel pressure rupture (Okrent, 1981).

In a 1967 paper presented to the IAEA, Farmer criticized the approach taken in differentiating credible accidents from incredible ones:

> "No engineering plant and no structure is entirely risk free, and there is no logical way of differentiating between credible and incredible accidents. The incredible is often made up of a combination of very ordinary events – for example the breakdown or the deterioration that occurs in normal plants and their measuring instruments – and the credible may actually be exceedingly improbable. The logical way of dealing with this situation is to seek to assess the whole spectrum or risks in a quantity-related manner" (Farmer, 1967).

IV.D.1.e. Licensing Basis Events should replace Design-Basis Accidents

Design Basis-Accidents (DBAs) are inherited from a purely deterministic approach to safety. Furthermore, they might not be applicable anymore to reactors different from LWRs. They must be therefore replaced.

The identification and selection of Licensing Basis Events (LBEs) is a fundamental difference between the previous licensing process and the one proposed in the new framework. LBEs are accidents that must be considered in the plant safety analysis and that represent a challenge to safety. They play a role in the licensing process similar to the DBAs, for they provide assurance that the design meets various accident challenges with adequate margins. However, LBEs encompass a much broader range of events since they also include, for instance, some events that do not involve radioactive release. There are two ways of selecting LBEs: a *probabilistic* selection from the PRA sequences, as well as a *deterministic* selection process that ensure that all uncertainties are accounted for. LBEs are chosen so that their aggregate represents the whole frequency range of the F-C curve.

IV.D.2. Probabilistic selection of Licensing Basis Events

The probabilistic selection process of LBEs uses the results of the full scope PRA: once all the PRA sequences have been defined in terms of a distribution of their frequencies and end states, LBEs can be selected from the PRA sequences

IV.D.2.a. Steps for Licensing Basis Event selection

The PRA is first modified so as to credit the mitigating functions that are to be considered safety-significant: indeed, any function and the associated Systems, Structures, and Components (SSCs) included in the PRA and used to define the LBEs is considered safety-significant unless guaranteed failure has been assumed. The selection process of LBEs is as follows:

- The point estimate frequency for each resulting event sequence of the modified PRA is calculated. Only the event sequences with a point estimate frequency above 10^{-8} /ry are eligible for the LBE selection process.

- The mean and 95th percentile for all event sequences remaining is determined, and all the event sequences whose 95th percentile frequency is below 10^{-7} are screened out.
- Similar accident sequences, defined as sequences that "have a similar initiator and display similar accident behavior in terms of system failures and/or phenomena and lead to similar source terms" are then grouped together in event classes.
- For each event class, the event sequence with the bounding consequence is selected. The selected event sequence defines the accident behavior and consequence.
- Then, for each event class, the LBE frequency is determined by setting the LBE's mean frequency equal to the highest mean frequency of the event sequences, and the 95th percentile equal to the highest 95th percentile frequency. The parameters of LBEs are illustrated on Figure 9:

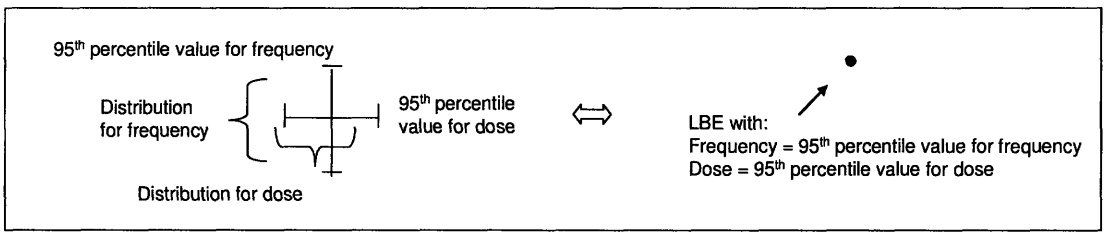

Figure 9: Parameters of Licensing Basis Events

One should not that such process might be difficult to implement for the highest event frequency category, since there is no release of radioactivity. Therefore, engineering judgment may be used.

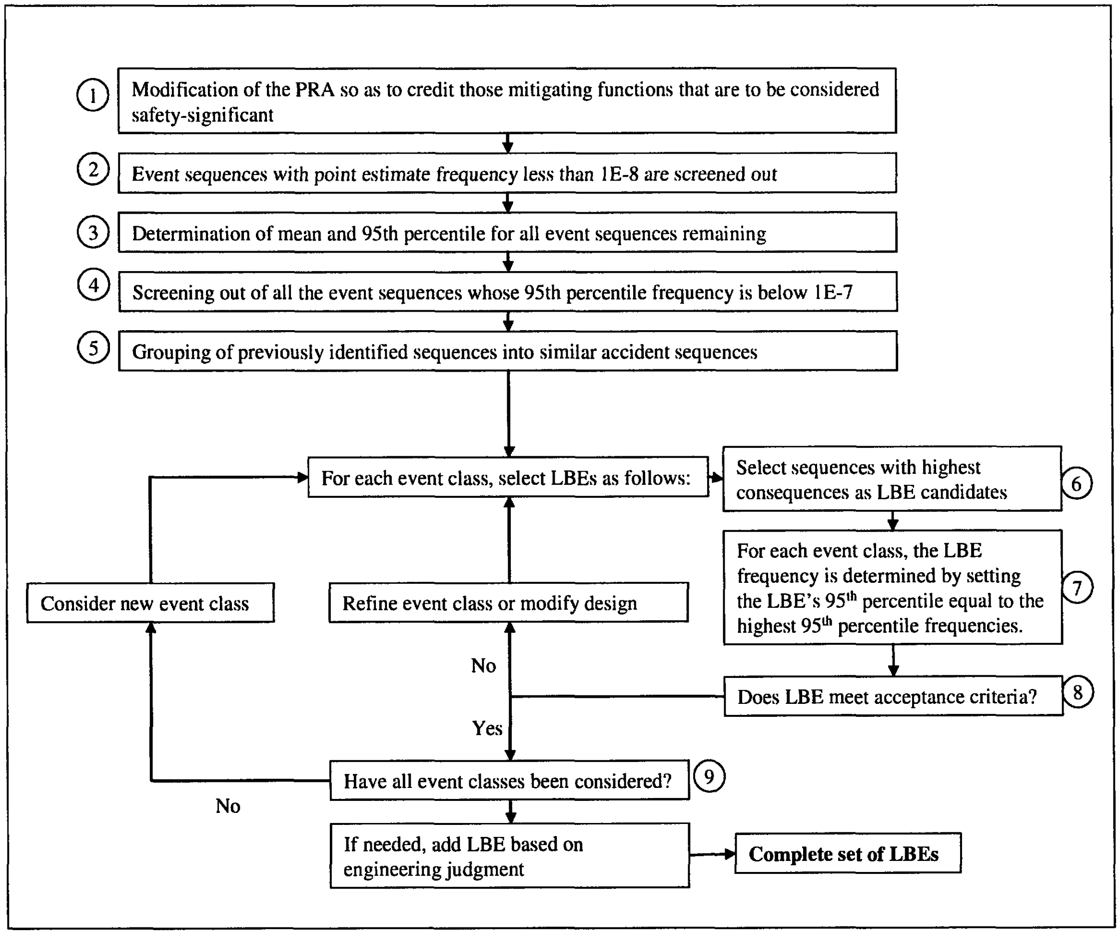

Figure 10: Selection process of Licensing Basis Events

IV.D.2.b. Criteria for selected Licensing Basis Events

Each selected LBE has to lie below the F-C curve.

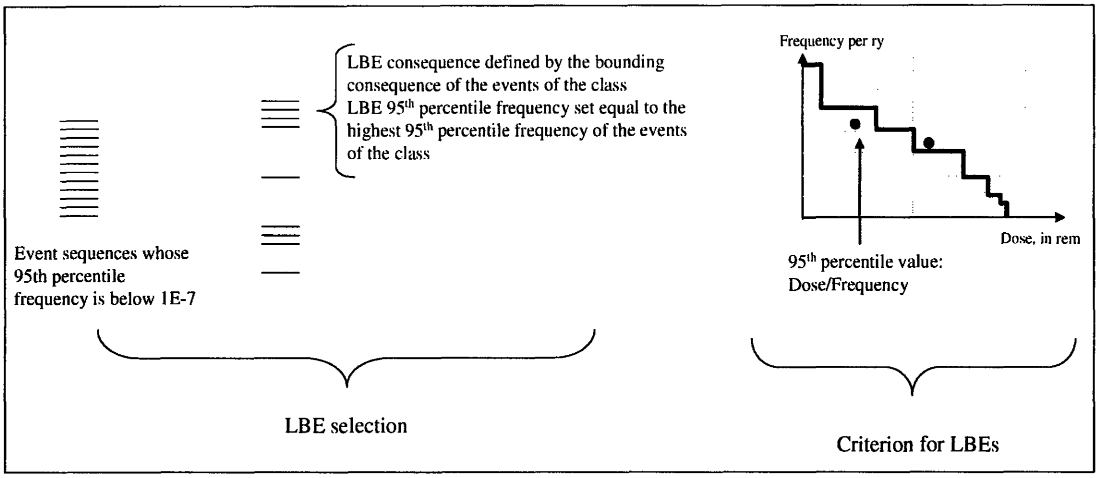

Figure 11: Criterion for probabilistically-selected LBE

Furthermore, for defense-in-depth purposes, LBEs must meet additional deterministic criteria. For that purpose, the region below the F-C curve is divided into three frequency regions, as shown in Figure 12. The rationale for such division is summarized in Table 2. The principle is that it is desirable to have more stringent deterministic criteria for frequent events, than for less frequent events.

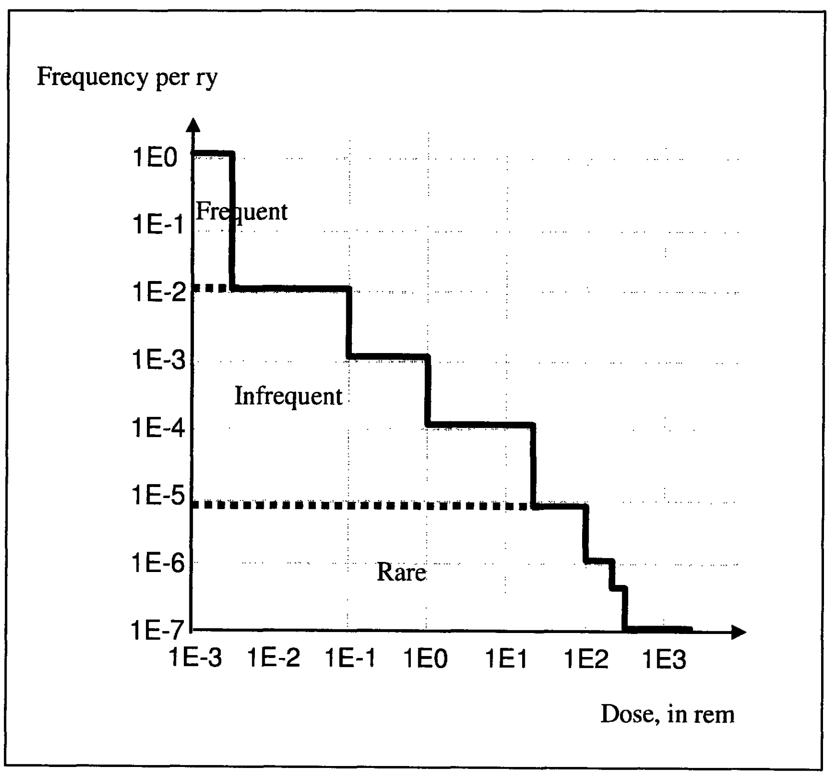

Figure 12: 3-region approach

Category	Frequency	Basis for choice
Frequent	$> 10^{-2}$ /ry (mean value)	Captures all event sequences expected to occur at least once in lifetime of a plant, assumed to be 60 years
Infrequent	$< 10^{-2}$ /ry and $> 10^{-5}$ /ry (mean value)	Captures all event sequences expected to occur at least once in lifetime of population of plants, assumed to be 1000
Rare	$< 10^{-5}$ /ry and $> 10^{-7}$ /ry (mean value)	Captures all event sequences not expected to occur in lifetime of the plant population, but needed to assess the Commission's safety goals

Table 2: Classification of event sequences according to their mean frequency

The previous table applies to event sequences, not only initiating event (IE) frequencies. The framework suggests that each applicant propose cumulative limit on IE frequencies for each of the LBE frequency event categories (for instance, the initiating events with potential to defeat two or more protective strategies should have a frequency below 10^{-7} per plant year). The USNRC and the applicant must agree upon the cumulative IE frequency, taking into account the design characteristics. The limits are monitored on the long term by a living PRA.

The LBEs, based on their frequency category must meet additional deterministic criteria.

Category	Frequency	Deterministic criteria
Frequent	$> 10^{-2}$ /ry (mean value)	- No impact on the safety analysis assumption occurs - No barrier failure occurs - Redundant means of reactor shutdown remain functional - Redundant means of decay heat removal remain functional
Infrequent	$< 10^{-2}$ /ry and	- A coolable geometry is maintained

	> 10^{-5} /ry (mean value)	- At least one barrier remains - At least one means of reactor shutdown remains functional - At least one means of decay heat removal remains functional
Rare	< 10^{-5} /ry and > 10^{-7} /ry (mean value)	No additional deterministic criteria

Table 3: Additional deterministic criteria depending on frequency category

Furthermore, depending on the frequency category, LBEs must satisfy additional dose criteria. For instance, in the higher event frequency category, the cumulative dose has to be below the 5mrem dose specification of 10 CFR 10 Appendix I.

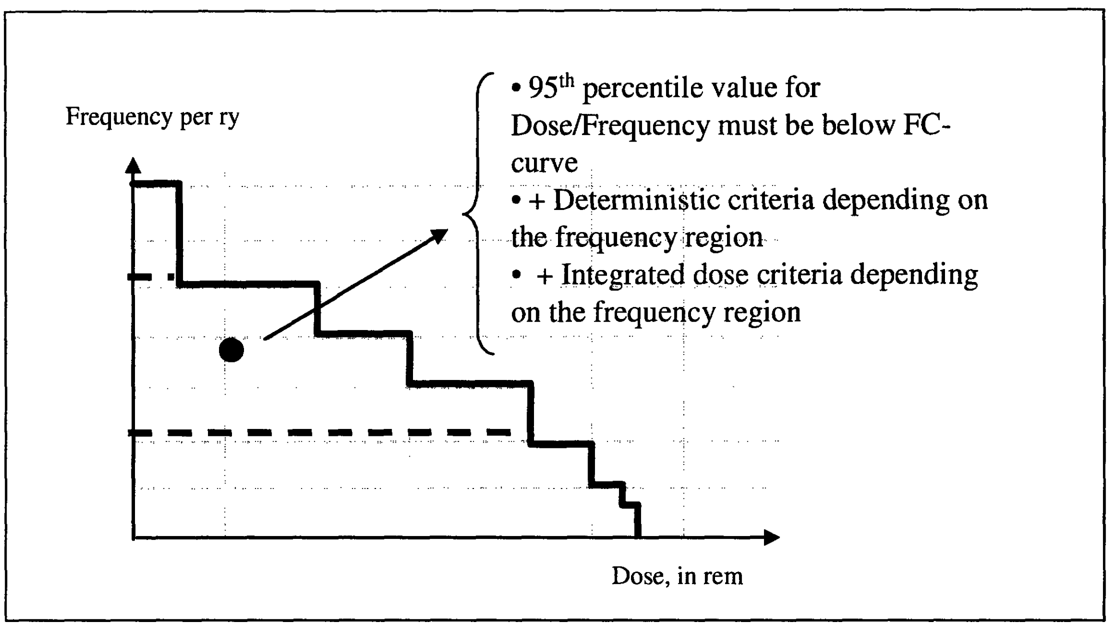

Figure 13: Summary criteria for LBEs

IV.D.3. Deterministic selection of Licensing Basis Events

For siting concerns, one LBE has to be postulated deterministically so as to prove that, regardless of the features incorporated in the plant to prevent an unacceptable release of radioactive material from the fuel and the reactor coolant system, there are additional ways to prevent an unacceptable release to the public. This LBE has to be analyzed mechanistically using conservative assumptions. This event is the event postulated in 10 CFR 100.

IV.E. Analogy between the current framework draft and Farmer paper

In 1967, Farmer proposed to use a F-C curve in order to assess the risk of a power plant from a siting perspective. The F-C curve proposed by the USNRC presents some analogy with the Farmer curve. In both approaches, accident sequences are first analyzed using risk quantification techniques and their acceptability is assessed on a frequency-consequence diagram, based on the similar principle that the higher the consequence of an event sequence is, the lower its frequency must be:

> "A measure of risk can be obtained by estimating the probability of the failure and assessing the consequences. Any initiating event – for example, failure of piping, delays in the operation of control systems, loss of circulator power, or combinations of these – can set up an accident sequence that can follow many paths [...] The full safety evaluation then comprises a spectrum of events with associated probabilities and associated consequences". (Farmer, 1967)

However, if both curves present many similarities, the consequences considered are highly different. Indeed, the Farmer paper addresses siting problems in the sense it limits for each event sequence the total amount of radioactive ^{131}I released. Therefore, Farmer addresses societal risk. The USNRC draft addresses individual risk, i.e. the dose for an individual at the site boundary.

IV.F. Improvements due to Licensing Basis Events

The definition and use of LBEs contributes greatly to the definition of a technology-neutral and risk-informed licensing process. Several improvements should be noted:

- *Calculations to obtain the distribution of frequency and dose are realistic*; except for the source term calculated using the 95th value of the probability range for the amount of radionuclides released. Distributions on the frequency and the dose are assessed.

- *The probabilistically selected LBEs contribute to the existence of quantifiable safety margins.* Regulatory limits on the frequency and consequence of potential events are set by the F-C curve so that adequate regulatory margin is provided. There is indeed a lot of uncertainty regarding the health effects caused by defined radioactive doses, which calls for a conservative regulatory limit. The designer can define additional design margins (distance between a calculated value for the safety variable and the regulatory value, Figure 14).

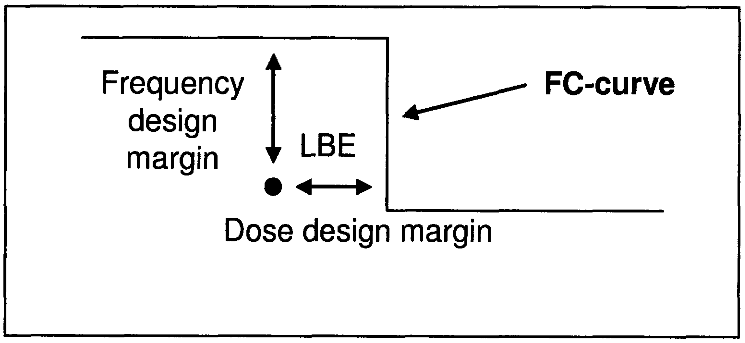

Figure 14: Licensing Basis Event Margins

- *The framework allows a performance-based approach*: indeed, the designer may choose to add deterministic LBEs based on his judgment, but this is not required beforehand by the regulator.

- *Defense-In- Depth (both structuralist and rationalist) remains a fundamental principle of the approach:* LBEs must satisfy certain fundamental criteria depending on their frequency (rationalist and structuralist Defense-In-Depth), and the postulated accident for siting purposes ensures that a balance between prevention and mitigation is maintained (structuralist Defense-In-Depth). Implementation of safety margins ensures that uncertainties are adequately coped with.

IV.G. Conclusion

F-C curves are powerful risk assessment tools, for they provide enhanced safety margins and a rational way to define Licensing Basis Events.

USNRC's use of F-C curves is quite innovative, since these tools are classically used to assess societal risk as opposed to individual risk. The question of including societal risk in the regulations has been regularly raised and it is legitimate in the context of the new framework to ask if societal risk should be included in the new licensing approach, and how could F-C contribute to societal risk assessment.

Part V. What is societal risk?

Before considering the use of F-C curves for societal risk assessment, we will define in this part what societal risk is, and introduce the general concepts attached to it, for instance multiple-fatality aversion. In the more specific context of nuclear power plants, we will identify three main sources of societal risk increase: a degradation of the plant safety, an increase of the core inventory, which can in turn increase the risk to the population as a whole, and an increase in the number of people living around the plant.

V.A. What is societal risk as opposed to individual risk?

V.A.1. Individual risk

A distinction is made in the literature between the risk to an individual, the individual risk, and the risk to groups of people, known as societal risk. In both cases, the definition of risk is reduced to a point value, usually the mean risk.

Many definitions of individual risk exist. The definition used for the purpose of risk management policy in the Netherlands (Versteeg, 1992) is the following:

> "Individual risk is defined as the expected frequency of death due to a hazard of a hypothetical unprotected person, who is permanently located out of the doors, at any given fixed location beyond the perimeter of the installation concerned"

But the definition can be more general as well, such as the one provided by the Institute of Chemical Engineers (Ichem, 1985):

> "The individual risk is the frequency at which an individual may be expected to sustain a given level of harm from the realization of specified hazards."

In the U.S. nuclear risk management field, the individual fatality risk is further refined: the Quantitative Health Objectives make a distinction between individual early fatality risk (mainly an individual's probability of becoming a prompt casualty of a reactor accident in a given year) and the individual latent fatality risk, for which the death occurs many years later.

V.A.2. Societal risk

Parallel definitions exist for societal risk. The most widely used definition for societal risk is the one proposed by the Institute of Chemical Engineers (Ichem, 1985) which defines societal risk as:

> "The relationship between frequency and the number of people suffering from a specified level of harm in a given population from the realization of specified hazards". The definition does not give further precisions on what is meant by "harm".

The term "societal risk" has been traditionally associated with the number of fatalities in the case of an accident. However, others have seen societal risk as a much broader concept, including fatalities as well as other aspects of harm.

Experts have proposed (Ball and Floyd, 1998) to distinguish four categories of societal risks: the "collective risks", the "simple societal risks", the "diverse societal risks", and the "societal concerns". These categories are not mutually exclusive but correspond to a progression in the definition of societal risk and in the complexity of the tools to assess it, from the easily defined collective risks to the highly political "societal concerns".

- The first category (*collective risks*) deals with the diffuse risks associated with normal activities, such as radiation from nuclear materials or waste during normal activity. Generally, this type of risk is dealt with by setting an individual limit and by using cost-benefit analysis methods. The risk to society can be expressed as the product of the individual risk by the total number of people exposed.
- The second category (*'simple' societal risks*) casts risk in term of the number of fatalities that could be caused by an accident. It is based on the principle that often, fatalities are the best surrogate to express the seriousness of an accident and provide a simplified basis for risk evaluation. The most common tools to assess the 'simple' societal risk are FN curves. Those curves will be defined in part VI.A. An example is shown on the following figure:

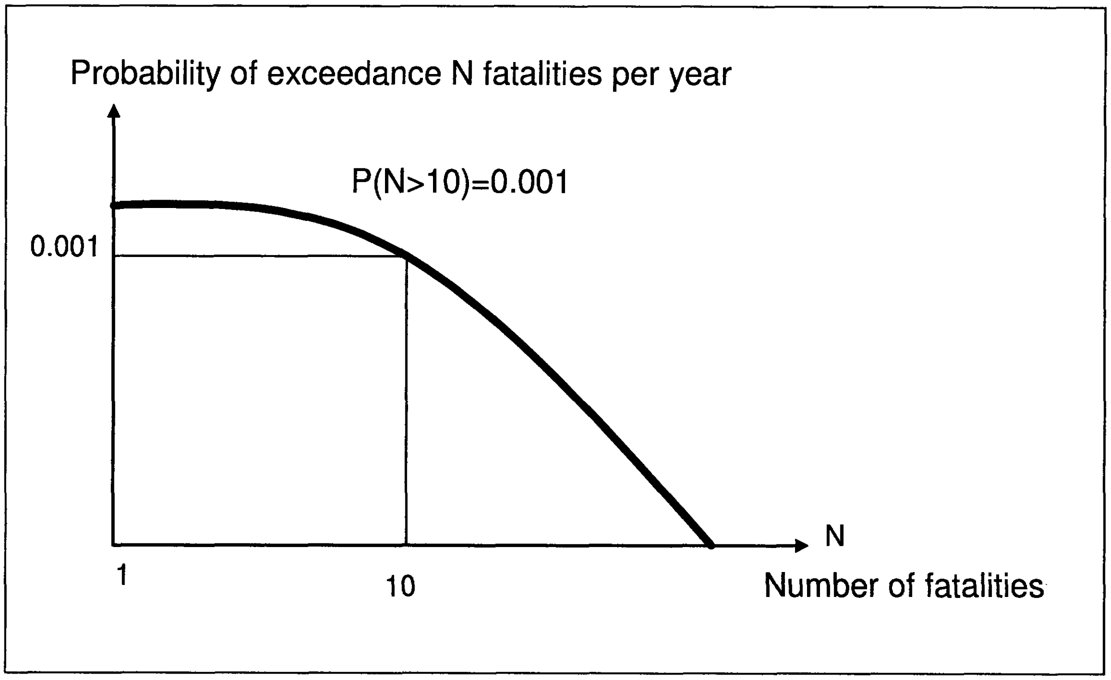

Figure 15: Example of FN curve, which displays the probability of having N or more fatalities per year, as a function of N, on a double logarithmic scale

- The third category[1] (*'diverse' societal risks*) consists in an extension of the second category and considers FN criteria based on fatalities but also on other types of harm such as environmental damage or injuries. However, few attempts have been made to translate such risk measures into criteria.
- Finally the fourth category (*societal concerns*) deals with risks from both normal activity and accidents and is the most complex one. The authors insist that:

  > "At the policy or decision-making level, the crude use of FN curves based on fatalities is meaningless [...]. Nuclear FN curves tend to have a long tail at low probabilities, but it is seldom made clear that it is predicted on fundamental assumptions about the shape of the dose-response curve for ionizing radiation at very low doses, itself an increasingly hotly-debated topic [...]. Clearly, at this strategic level, decision-makers have to consider the full range of potential impacts (associated with both 'normal' activities and accidents) including fatalities, non-fatal injuries, property damage, environmental impacts, psycho-social harm, economic loss, business interruption costs, and even the political consequences of major accidents. Open-ended definitions of this kind tend to be anathema to those whose focus is numerical analysis since many of the components are difficult to handle if not beyond quantification and, even if quantifiable, could not be easily assimilated into a

[1] Ball and Floyd regroup the second and the third categories into a wider one called "societal risks".

> decision model. In practice, however, optimum decisions can ultimately only be made by considering all of the goals and all of the consequences of various decision options, and in the final stages of policy formulation it is imperative that this be done".

On that level, attempts to quantify societal risk are currently being made. The ExternE project (Hirschberg, 1999) for instance aims at quantifying the external costs (production and transportation costs) of different sources of electricity: wind, solar, nuclear, biomass, coal, oil, natural gas, and hydroelectric. This interdisciplinary project uses Life Cycle Analysis (LCA), a method used to identify in details the inventory of material and energy flows associated with all stages of the life of an activity. The idea is that external costs of electricity have to be understood and known in order to be able to internalize the cost in the price of electricity, and make more rational energy choices. For instance, the occupational risk of coal miners or the environmental cost of pollution should be included in the price of coal. As for nuclear, the study aims at quantifying the external costs of the entire fuel cycle, including societal risk due to routine operation and accidents of nuclear power plants.

Table 4 summarizes the different categories determined by Ball and Floyd:

	Risk associated with:			
	'Normal activity'	Accidents	Suggested term	Type of criteria
Diffuse risk associated with exposure to hazardous material	Yes	No	Collective risks	Individual risk + Cost-Benefit Analysis
'Simple' risk associated with hazardous installations/activities which can be easily compared	No	Yes	Societal risks	FN criteria based on fatalities
'Diverse' risks associated with hazardous	No	Yes	Societal risks	FN criteria based on

installations/activities which required a broader basis for meaningful comparison				fatalities and other types of harm
Comparison of overall impacts/risks of technologies/strategies	Yes	Yes	Societal concerns	Political judgment - possibly aided by multi-criteria 'techniques'

Table 4: Categories of risks
(Ball and Floyd, 1998)

V.A.3. Why isn't putting a limit on individual risk enough?

Individual and societal risks deal with different issues. Putting a limit on individual risk is an equity measure, meaning that each individual is entitled the same level of safety. Most countries that have chosen to put a quantitative limit on risk have included a limit on individual risk, be it the United States, the Netherlands or the United Kingdom.

Individual risk does not take into account the total number of people exposed to the hazard. On the contrary, societal risk is a function of the total population exposed. Two nuclear power plants, each complying with the QHOs, can entail different societal risks.

Let's develop a very simple example in order to illustrate this fact:

- Consider two identical nuclear power plants, one for which there are 1000 people located in the vicinity of the plant, the other one for which there are 100,000 persons. Assume furthermore that two independent scenarios only can lead to fatalities: 'Scenario A' has a likelihood of 10^{-4} per year and 'Scenario B' a likelihood of 10^{-5} per year. Assume also that, if 'Scenario A' occurs, one person out of five located in the vicinity of the plant will die, and one out of two for the same region but considering 'Scenario B'.
- The *individual fatality risk* is equal to $\frac{10^{-4}}{5}+\frac{10^{-5}}{2}=2.5*10^{-5}$ per year for both plants.

- There are several ways to calculate the *societal risk*, depending on its definition. If we assume the societal risk is captured by the expected number of fatalities per year, the societal risk in the first case is $2.5*10^{-5}*1000 = 2.5*10^{-2}$ expected fatalities per year, whereas it is equal to 2.5 in the second case.

This example uses simplistic assumptions. In general, there is no direct relation between individual and societal risk. However, it illustrates the fact that two systems complying with individual risk limits might have different societal risk profiles.

Figure 16 illustrates the different parameters considered:

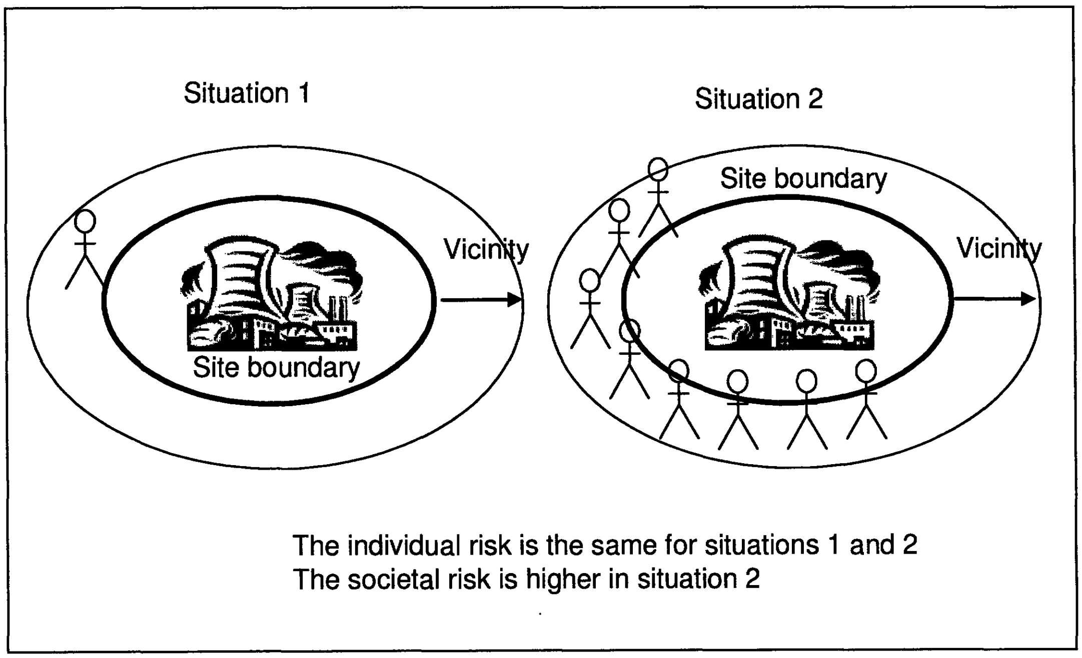

Figure 16: Illustration of the difference between individual and societal risk

V.B. General questions on societal risk

V.B.1. At what level societal risk should be considered?

The Ichem definition of societal risk does not specify the level (e.g. site, regional, national) at which societal risk should be considered.

The approach chosen by the Dutch Ministry of Housing, Land Use Planning and Environment (VROM) assumes that societal risk is measured at the level of an installation (Versteeg, 1992).

However, other "levels" of societal risk are possible. Vrijling argues that certain risks that seem acceptable at an individual/site level may not be acceptable at the national level (Vrijling et al, 1995). He concludes that acceptance of societal risk takes place at a national level. A convincing example that he chooses to present is the commercialization of a toy that would cause a child's death at a frequency of 10^{-4} per year per toy. Compared to risk from other accidents, one can say that from an individual point of view, the toy is relatively safe. If 1000 children use the toy, the expected number of death is 0 or 1 per year. However, if the toy becomes very popular and 10^{7} toys are sold, the expected number of deaths will be 1000, which is clearly unacceptable at a national level.

It is interesting to ask if the previous example applies to nuclear power plants. The idea in the toy example is that the toys are identical, and therefore the risks perfectly correlated. This is not true for nuclear power plants. On a high-level, two plants can differ by their design and the way they are operated (for instance the safety culture might be different). In the United States, there is a variety of vendors and utilities, which favors a site-level approach. This might not be valid in other countries: for instance in France, all reactors have been built by the same vendor, and there is currently only one utility, Electricité de France, operating them.

In the United Kingdom, the Health and Safety Executive (HSE, agency responsible for health and safety regulations in Great Britain) has argued that since any plant in the country could be the source of an accident, it is not the risk per plant that matters but the risk attached to the whole family of plants (HSE, 1992). On the other side, imposing a national limit on societal risk would limit the total number of reactors that could be built.

Defining the level at which societal risk should be considered is a matter of policy. The 1986 individual risk limits were not intended to be used at a site level. However, in practice, they were used as benchmarks for individual plants. Therefore, a site-level is more appropriate for nuclear power plants in the U.S.

V.B.2. Should risk aversion be included in the societal risk measures?

V.B.2.a. Definition

Risk aversion is a concept explaining the behavior of consumers and investors under uncertainty. It is generally defined as the reluctance of a person to accept a lottery with an uncertain payoff rather than another lottery with more certain but possibly lower expected payoffs. In the context of societal risk, a key question is whether more weight should be given to a large accident with many fatalities than to several smaller accidents producing the same total number of fatalities. We will therefore refer to this concept as the multiple-fatality aversion concept. Three attitudes towards multiple fatalities are possible: risk neutrality, risk aversion, and risk proneness, as illustrated on Figure 17.

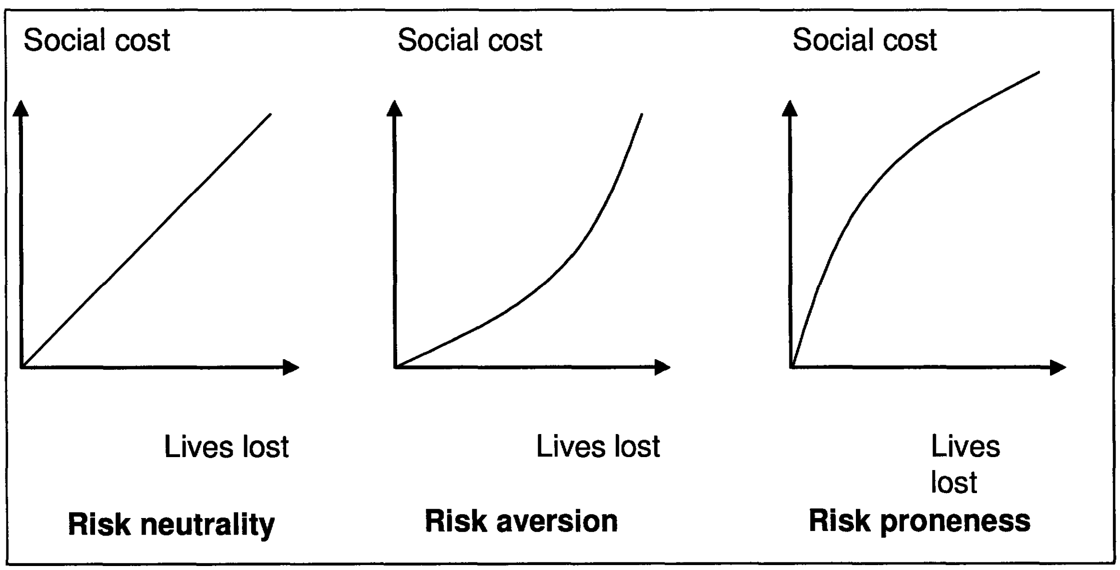

Figure 17: Categories of multiple-fatality risk aversion

(Slovic, 1984)

Policy makers have generally relied on the idea that society was multiple-fatality averse, an assumption revisited by Slovic (Slovic, 1984). According to Slovic, modeling the impact of an accident by a risk-averse function of the number of fatalities is inadequate. Accidents with very few fatalities or even none may have higher societal costs then accidents involving more fatalities. For him, accidents serve as "signals" of the nature and controllability of risk they imply. For instance, an accident whose consequences are well understood, familiar and with little potential for a catastrophe will have a much lower social cost as an accident with the same number of fatalities but that does not meet the previously mentioned criteria.

Keeney (Keeney, 1980) has presented several assumptions that he has proved to lead to risk-proneness: the first assumption states that a sure loss of N persons is less desirable than the 50-50% chance of losing either 2N or 0 person(s), which was supported by some empirical evidence. Second, Keeney argues that as N gets larger, each incremental life lost has less marginal societal impact.

Ball and Floyd of the British Health and Safety Executive support a risk-neutral position:

> "Though documented evidence is sparse, nowhere have we found any compelling support of arguments for an ex-ante stance of other than risk-neutrality in societal decision making" (Ball and Floyd, 1998).

V.B.2.b. Inclusion of risk-aversion into criterion and measure

There are several ways to model risk-aversion:

- The most commonly used method is to include a risk aversion factor: for instance the societal cost C(N) of N fatalities can be taken to be equal to N^{α}, with $\alpha > 1$:

  $C(N) = N^{\alpha}$ (Equation 1)

  The societal cost of having 2N fatalities is more than twice costlier as the societal cost of having N fatalities since C(2N) $=(2N)^{\alpha} = 2^{\alpha} N^{\alpha} > 2(N^{\alpha})$. This has been referred to as the α-model by Slovic (Slovic, 1984) and has been applied in the Netherlands with a factor equal to 2.
- Another possibility consists in integrating the standard deviation into the equation. A measure of total risk (TR) defined by the sum of the expected value of the number of fatalities and the standard deviation multiplied by a risk aversion factor k has been proposed (Jonkman et al, 2003): $TR = E(N) + k\sigma(N)$ (Equation 2)

It is of course possible to derive risk-neutral societal risk criteria by setting the risk aversion factors respectively equal to 1 for α in Equation 1 (this approach has been chosen in the United Kingdom and is known as the Canvey line, but it is not used to assess the tolerability of nuclear risk) and 0 for k in Equation 2.

V.C. Quantitative risk limits in the United States

V.C.1. The 1986 Safety Goals

The process of defining quantitative risk limits in the United States was a long and complex one. In 1986, the U.S. Nuclear Regulatory Commission adopted a Policy Statement on Safety Goals for nuclear power reactors (USNRC, 1986) in order to define an acceptable level of radiological risk, and stated that there were two qualitative safety goals:

> "Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health
> Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks."

The Commission translated these qualitative safety goals into quantitative ones; known as the Quantitative Health Objectives (QHOs) and previously cited in Part III. We remind here their statement:

> "The risk to an average individual in the vicinity of a nuclear power plant (region between the site boundary of the power plant and one mile beyond this boundary) of prompt fatalities that might result from reactor accidents should not exceed one tenth of one percent of the sum of prompt fatality risks that result from other accidents to which the U.S. population is generally exposed.
> The risk to the population in the area near a nuclear power plant (region between the site boundary of the power plant and ten miles beyond this boundary) of cancer fatalities that might result from nuclear power plant operation should not exceed one tenth of one percent of the sum of cancer fatality risks from all other causes."

Many have argued that the quantitative safety goals did not take into account the total societal risk by imposing a limit on the total number of fatalities that could result from a nuclear accident.

This issue was addressed as soon as 1986, in the Safety Goals Policy Statement itself, by Commissioner Bernthal in his separate view on Safety Goals Policy:

> "As they stand, these 0.1 percent goals do not explicitly include population density considerations; a power plant could be located in Central Park and still meet the Commission's quantitative offsite release standard" (USNRC, 1986).

The issue was raised periodically afterwards as a modification of the Safety Goals was prepared. However, this modification was never achieved and it seems today that the very same Quantitative Health Objectives will be used for the next generation of reactors (USNRC, 2006).

V.C.2. Surrogate Risk Metrics

Showing compliance with the QHOs requires a level-3 PRA that calculates the risks to an individual. Those PRAs require an intense modeling of the event sequences, and the uncertainties are very high. Those uncertainties exist independently of the PRA (for instance the health effects due to radiation exposure are uncertain), but the PRA displays these uncertainties, and deciding on the acceptability of risk might be difficult.

To deal with this issue, surrogate risk metrics were developed. A level-1 PRA is necessary to calculate the CDF of a plant. A level-2 PRA calculates both the CDF and the LERF. For current reactors, the limits were set at 10^{-4} /reactor year for the CDF and 10^{-5} /reactor year for the LERF. Interestingly enough, the limits are put on the frequency, no matter of the possible consequences (for instance, the consequence of a large early release depends on the core inventory).

V.D. Sources of societal risk

If we consider a nuclear power plant, there are mainly three sources of societal risk increase: degradation of the plant safety, increase of the core inventory, or an increase in the number of people around the plant. These two issues are very different. The first deals with plant characteristics, the second with siting decisions.

V.D.1. Issue of siting

Societal risk criteria are closely related to siting decisions. Indeed, one of the arguments for not defining a societal risk limit in the United States is that it is already included in 10 CFR Part 100.

Several points have to be made regarding 10 CFR Part 100:

- *No allowable population density around a reactor is quantitatively specified.* Section 3 provides a definition for the Low Population Zone (LPZ), which is:

  "The area immediately surrounding the exclusion area which contains residents, the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of a serious accident. These guides do not specify a permissible population density or total population within this zone because the situation may vary from case to case." Section 10 only mentions the population density as one of the factors that should be considered for evaluating a site: "Population density and use characteristics of the site environs, including the exclusion area, low population zone, and population center distance"

- *An accident is postulated to assess the acceptability of a site but the quantitative dose limits only apply to individuals.* Indeed, section 11 states that:

  "As an aid in evaluating a proposed site, an applicant should assume a fission product release from the core, the expected demonstrable leak rate from the containment and the meteorological conditions pertinent to his site to derive an exclusion area, a low population zone and population center distance. For the purpose of this analysis, which shall set forth the basis for the numerical values used, the applicant should determine the following:

  - *An exclusion area* of such size that an individual located at any point on its boundary for two hours immediately following onset of the postulated fission product release would not receive a total radiation dose to the whole body in excess of 25 rem or a total radiation dose in excess of 300 rem to the thyroid from iodine exposure.
  - *A low population zone* of such size that an individual located at any point on its outer boundary who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a total radiation dose to the whole body in excess of 25 rem or a total radiation dose in excess of 300 rem to the thyroid from iodine exposure.
  - A *population center distance* of at least one and one-third times the distance from the reactor to the outer boundary of the low population zone. In applying this guide, the boundary of the population center shall be determined upon consideration of population distribution. Political boundaries are not controlling in the application of this guide. Where very large cities are involved, a greater distance may be necessary because of total integrated population dose consideration."

Note that the definition of the *population center distance* refers to the population density around the reactor but gives no quantitative indications.

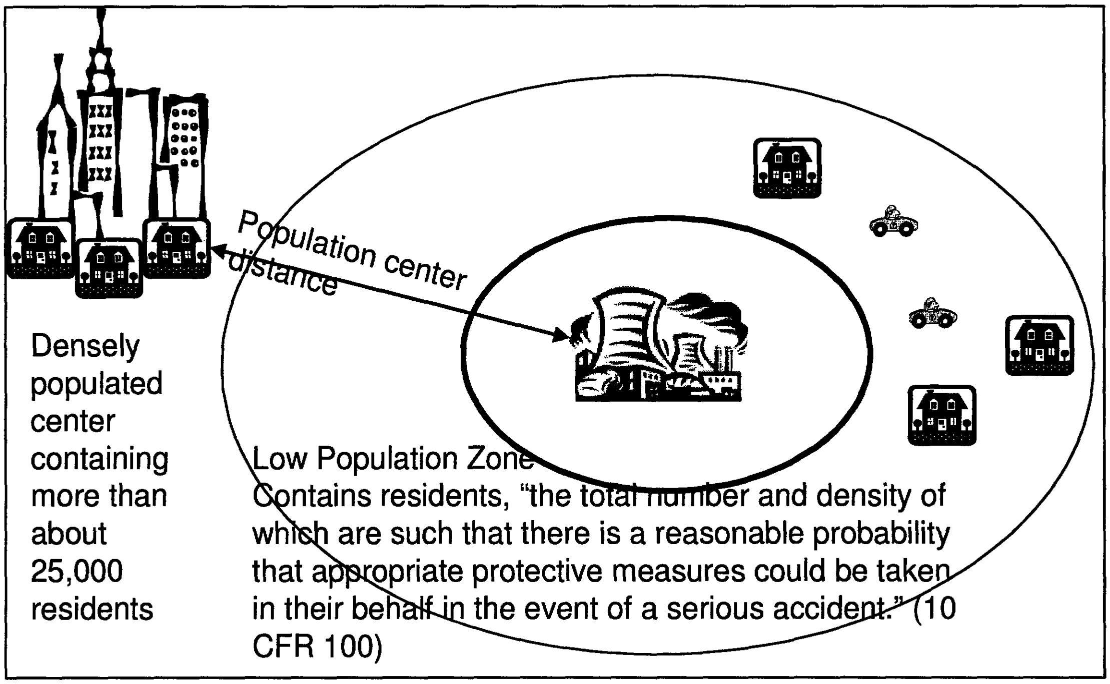

Figure 18: Siting distances in 10 CFR 100

There is a trade-off between safety and siting convenience. The closer a plant is from a metropolitan area, the lower are the costs but the higher are the societal risks. One can also remind briefly the Ravenswood siting controversy, when a nuclear power plant was proposed for construction in the highly populated Queens borough of New York City.

To conclude, one can say that 10 CFR Part 100 deals with societal risk in a qualitative manner but fails to define an acceptable quantitative level of societal risk.

V.D.2. Plant characteristics

Even if there is no change in the population around the plant, societal risk may increase due to plant characteristics themselves:

- If the probabilities of event sequences leading to an accident increase: for instance, for a given number of people living around the plant, if the probability of an accident sequence goes up because of the aging of certain components, societal risk is higher.
- If the potential consequences of event sequences increase: for instance if more radioactive material can be released during an accident. This is the case when utilities are granted power uprates. Indeed, highly enriched uranium is generally added, which increases the total core inventory. In turn, societal risk goes up.

Utilities submit power uprates as license amendment requests. It must be proved that the plant will remain safe, and that there are still adequate measures taken to protect the health and safety of the public. However, the increase in societal risk is not taken into account quantitatively. Power uprates are widely used by the industry: in July 2004, the USNRC had completed 101 power uprate reviews, resulting in a gain of approximately 4,000MWe.

V.E. Conclusion

At a national level, measuring societal risk and assessing its tolerability is highly complex. Indeed, using nuclear technology entails both direct benefits (e.g. available energy) as well as unquantifiable positive externalities (e.g. energy independence). There is no easy way to weight these benefits against the existence of very low probability and high consequence events, able to kill many. Risks at that level have been referred to as "societal concerns", and no quantitative tools can easily help to decision-making. However, if we restrict the analysis to the risk for people around a power plant, such tools exist and are already in use in countries such as the Netherlands. However, one must keep in mind that part of the difficulty in implementing societal risk requirements comes from the tremendous role played by public perception and its reluctance to accept the possibility, even with very low probability, of high consequence events.

Part VI. Overview of Quantitative tools to measure societal risk

Limiting societal risk is a complex issue. The USNRC has recently considered the use of F-C curves, but on an individual event basis only. No goal limiting the societal consequences of nuclear accidents and operation is included in the framework so far. Including such goal, as it is done in the Netherlands by putting a limit on the total number of fatalities resulting from a potential accident, is a possibility.

The risk curves that have been used for societal risk assessment have mostly referred to one type of consequence, usually the total number of fatalities. These curves are called FN curves. Extended measures have been proposed, but have never entered regulations. An overview of different quantitative tools to assess societal risk is presented in the following paragraphs.

VI.A. FN curves

VI.A.1. Definition

An overview of quantitative risk measures of societal risk is provided in (Jonkman et al, 2003), in which societal risk is assumed to be related to the number of fatalities. Among them are FN curves, which display the probability of having N or more fatalities per year, as a function of N, on a double logarithmic scale.

We have $1-F_N(x)=P(N\geq x)=\int_x^\infty f_N(n)dn$, where f_N is the probability density function of the number of fatalities per year, $F_N(x)$ is the cumulative distribution function of the number of fatalities per year, and $1-F_N(x)$ is the complementary cumulative distribution function (probability of having x or more fatalities per year).

Figure 19 presents FN curves for different groups of activities in the Netherlands:

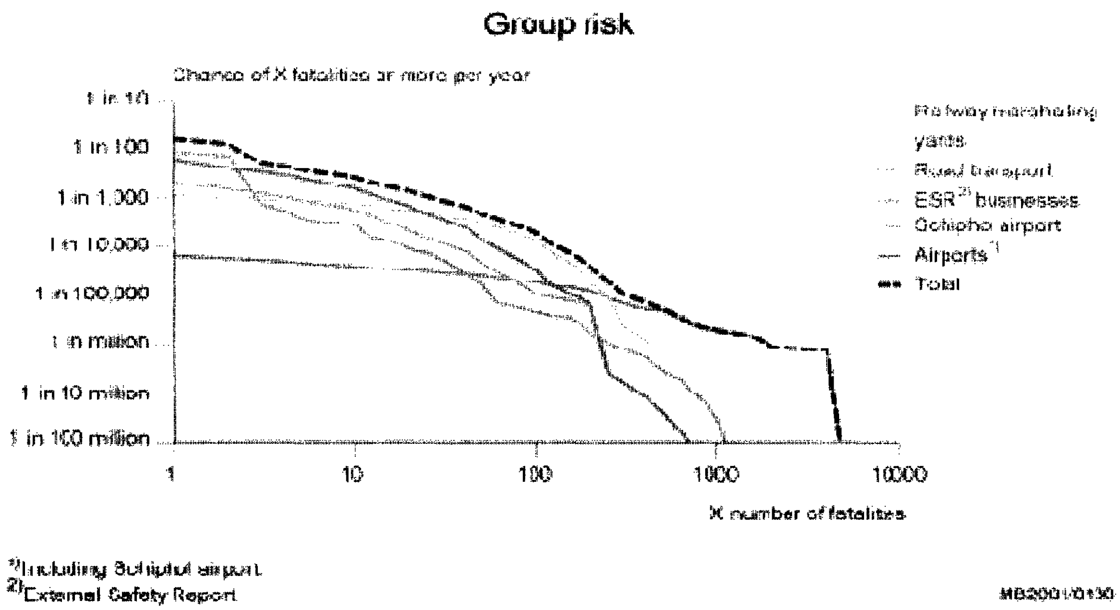

Figure 19: Example of FN curves for different groups of activities in the Netherlands

(Source RIVM, 2001)

VI.A.2. Different types of FN curves

A distinction must be made between:

- The FN curves that display historical records of accidents. They are built using historical data;
- The FN curves that result from quantitative risk assessment. Those are the result of modeling. For instance, a level 3 PRA would be needed in order to build such curve for a nuclear power plant. In practice, FN curves are often a mix of historical / empirical data and modeling (Evans, 2003).
- Finally, the FN criteria are the curves that are used to assess the tolerability of FN curves.

VI.A.3. Use of FN curves in the Netherlands

FN curves are in use in some European countries such as the Netherlands and the United Kingdom, for the purpose of societal risk management.

The Netherlands is a small country, with an area slightly less than twice the size of New Jersey, and a total population of around 16.5 million as of 2006 (CIA data, 2006). Compared to the United States, the number of inhabitants per square kilometer is 15 times higher in the Netherlands. Lack of space is a significant issue in this country, which could account partly for their decision to use societal risk criteria. Major accidents in the 70's involving Liquefied Petroleum Gas (LPG) stations focused the attention on risk assessment and reduction, and on the need for national standards (Ale, 2005). The first document to introduce limit values for individual and societal risk was issued in 1986 and focused on LPG accidents. The policy framework was then integrated in the document "Dealing with risk" that accompanied the First National Environmental Policy Plan in 1989. The individual and societal limits set were also to be used for nuclear power plant policy.

In the Netherlands, probabilistic safety criteria and goals have been developed. The risk management policy (Versteeg, 1992) adopted for potential hazardous industries explicitly refers to the safety of each single individual in the vicinity of the plant and to the population as a whole and consists of different steps. The first step consists of the identification of the hazards and risks and the scenarios that lead to then. These scenarios are then quantified with probabilistic risk assessments methods. A third step, called the "assessment step" consists of showing compliance with criteria and objectives. Risk is reduced until an optimum level is reached, following the As Low as Reasonably Practical (ALARP) principle. Finally, control is implemented to ensure that risk is maintained at this optimum level.

The policy uses a three-region approach and distinguishes three risk-related regions: one where acceptable activities lie, one where reduction of risk is necessary according to the ALARP principle and a last region where risk is considered unacceptable. The first separation is a de minimis value, the second the criterion itself, which is usually referred to as the VROM criterion.

For instance, for each source of activity, the upper bound of acceptable individual level of risk is 10^{-6} /year, while the de minimis value is 10^{-8}. Between those two values, the ALARP principle is applicable. For all hazardous sources or activities, the maximum acceptable level of risk is 10^{-5}.

Regarding societal risk, a curve relating the exceedance frequency of N or more fatalities to the number of fatalities is used at the plant level. No national societal goal has been proposed. Two complementary cumulative density functions are used to determine the three regions. The lines chosen are two straight lines with a slope -2 reflecting risk aversion.

The following figure gives a visualization of the FN criterion adopted in the Netherlands:

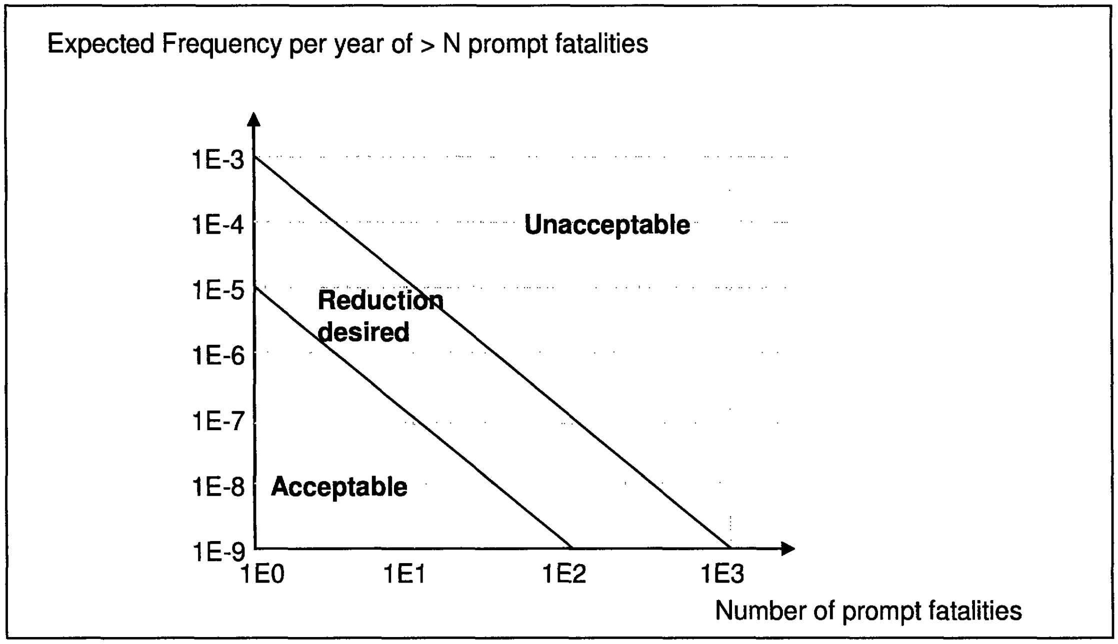

Figure 20: FN criteria in the Netherlands (note that only the upper curve is a criterion)

(Versteeg, 1992)

These criteria are on the number of fatalities outside the side boundary, therefore apply to nuclear major accidents and do not apply to workers.

It is possible to compare the Dutch criterion with the Canvey Line criterion, defined by the British Health and Safety Executive when it assessed in a milestone study in 1978-1981 the potential of the industrial installations at Canvey Island on the Thames for causing a major accident affecting the surrounding population (Ball and Floyd, 1998). The comparison of the two criteria is presented on Figure 21:

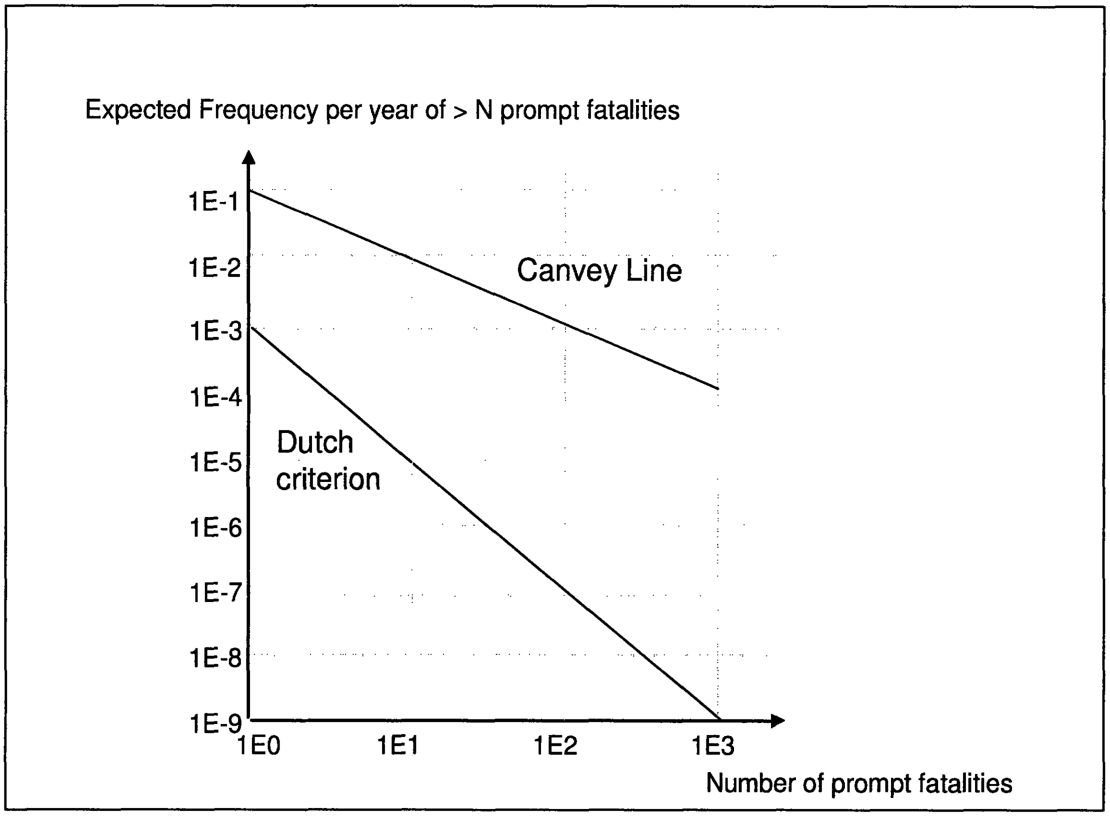

Figure 21: Comparison between Dutch and British risk tolerability criteria (the Canvey Line criterion is risk-neutral, as opposed to the highly risk-averse Dutch criterion.)

VI.A.4. Dutch regulations and U.S. PRA results

Dutch FN curves are highly risk averse. Indeed, if we assess the tolerability of risk of certain U.S. plants using the Dutch criterion, the results might be surprising: Figure 22 shows a risk curve (which is similar to a FN curve) for the total number of early fatalities at a nuclear power plant from NUREG-1150 results (USNRC, 1990). The Dutch criterion is superimposed on the figure.

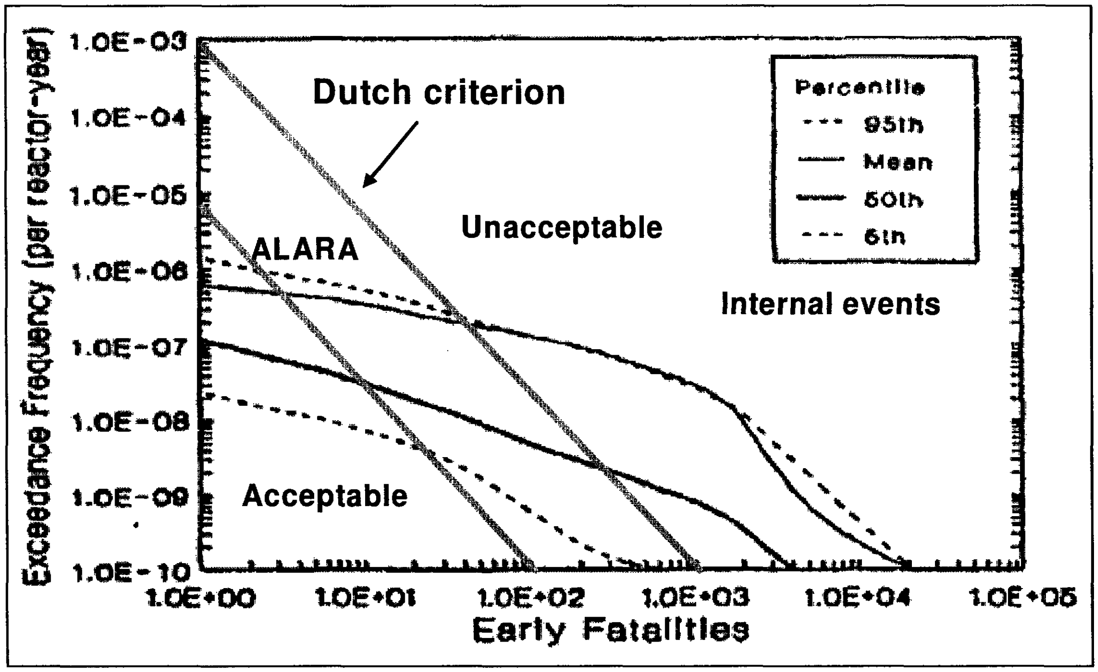

Figure 22: Example of level-3 PRA results (NUREG-1150) and Dutch criterion

There are regions where the mean value risk curve is above the criterion, which is unacceptable in the Dutch view. Furthermore, the assumptions between the Dutch and U.S. approaches are very different. Indeed, such risk curve for NUREG-1150 was obtained making the assumption that 99.5% of the population was evacuated; this assumption is not made in the Netherlands:

> "In demonstrating compliance with the risk criteria, it is necessary to assume that only the usual forms of mitigating measures are taken (i.e. action by fire services, hospitals, etc.). Although special measures like evacuation, iodine prophylaxis and sheltering may be taken by the Emergency Preparedness Organization, these are disregarded in the analysis. In the Dutch view, it is unreasonable to assume that any countermeasure will be 100% effective. On the contrary, it is more realistic to expect that a substantial part of the population will be unable or unwilling to adopt the prescribed countermeasure. The PSA results used to demonstrate compliance with the risk criteria need, therefore, to reflect this more conservative assumption. However, for the sake of interest, the PSA results of the Dutch nuclear power plants show both situations: with and without credit being given for countermeasures." (VROM, 2005)

However, there is today only one nuclear reactor in the Netherlands (PWR, 452 MWe).

If we don't consider the different assumptions, we can see that the result would have been very different with a less conservative criterion:

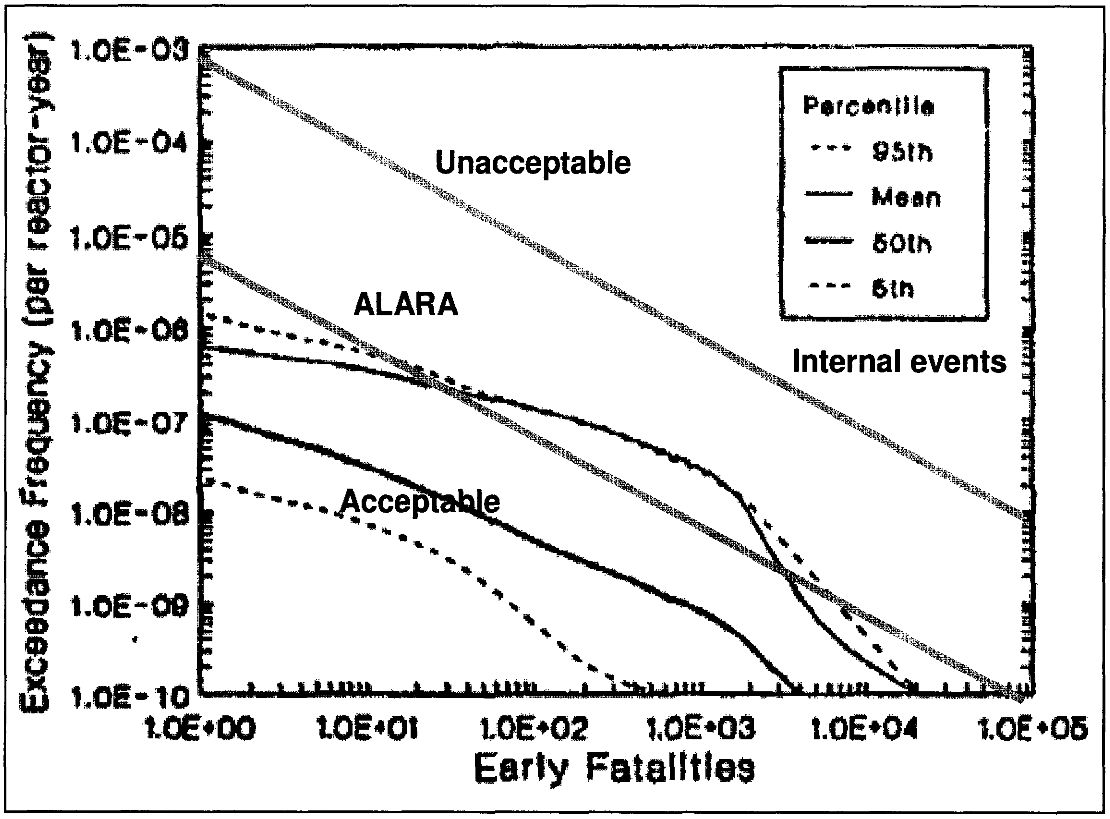

Figure 23: Example of level-3 PRA results (NUREG-1150) and risk-neutral criterion

With a slope equal to -1 and assuming that 99.5% of the population evacuates, the mean FN curve lies below the criterion. This is also the case when the slope of the criterion line is set at 1.2, as illustrated on Figure 24:

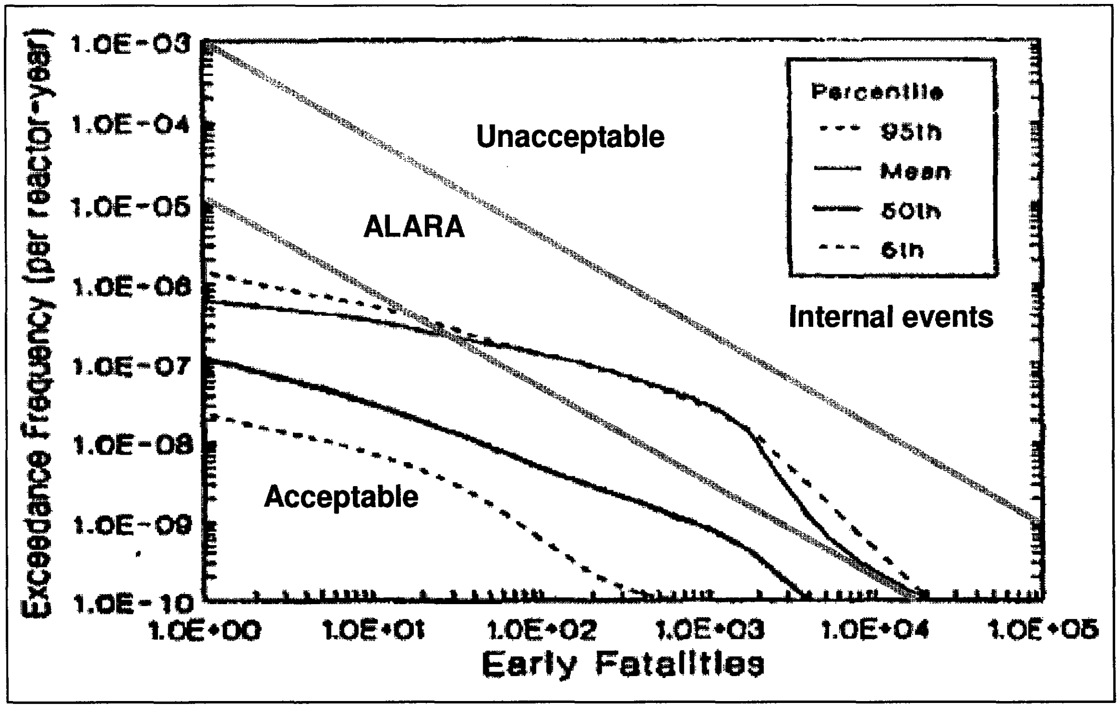

Figure 24: Example of level-3 PRA results (NUREG-1150) and risk-averse criterion (slope equal to 1.2)

VI.A.5. Limits of FN curves

The use of FN curves as a decision-making tool has been criticized for the following reasons:

- FN curves correspond to a minimax decision rule. Therefore, they concentrate on extreme features of statistical distribution, which can lead to decisions that appear unreasonable (Evans and Verlander, 1997)
- As opposed to expected disutility functions, FN curves lead to "incoherent" judgment, in the language of decision theory, when there is uncertainty associated with the accidents (Evans and Verlander, 1997)
- FN curves are based solely on the number of fatalities. Decisions that use FN curves as a risk-assessment tool overlook important consequences of accidents.

VI.B. Other risk assessment measures

Other societal risk measures have been proposed for use, in an attempt to solve the issues associated with FN curves previously identified.

For instance, FN curves do not allow the comparison of different systems, which could be possible if a system could be represented by a single value, and not a curve. A simple measure of societal risk can be expressed by the expected number of fatalities per year (Ale et al, 1996), which is equal to the integral of the FN curve (Vrijling et al, 1997).

$$E(N) = \int_0^\infty x f_N(x)dx = \int_0^\infty (1 - F_N(u))du$$

Other measures also exist, that take into account risk-aversion. The aversion is taken into account through a coefficient that gives more weight to accidents with a large number of fatalities. For instance, the British Health and Safety Executive (HSE) defined a weighted risk integral parameter called the Risk Integral as (Jonkman et al, 2003):

$$RI_{COMAH} = \int_0^\infty x^\alpha f_N(x)dx$$

Evans and Verlander propose another measure of societal risk: the expected disutility (Evans and Verlander, 1997). According to the theory of decision-making under uncertainty, the tolerability decisions must be made on the basis of expected utility to be consistent. The first step is to associate a number u(n) as a measure of harm (u increases with n and has the same properties as a utility function). It is assumed that the disutility function satisfies the axioms of the Expected Utility Theory.

The disutility of an accident of uncertain size in the engineering system is given by:

$$u_\alpha = \sum_n u(n)p(n)$$

The choice of the disutility function can reflect risk-aversion (for instance, $u(n) = n^\beta$ with $\beta > 1$).

Very few societal risk measures allow the consideration of consequences other than fatalities. This possibility should thus be explored.

VI.C. Extended measures of societal risk

VI.C.1. Would an extended definition of societal risk be more appropriate?

An extended definition of societal risk might be more appropriate depending on the technology whose risk is studied. For instance, the risk metric used to assess the societal consequences of car accidents in the U.S. measures the total number of prompt fatalities per year. It could include injuries as well. Societal consequences of dam failure include among others: prompt fatalities, evacuation costs, and off-site property damage. Each category of activity entails specific risks and hence, specific risk assessment tools. It is therefore necessary to investigate the societal consequences of nuclear accidents. A brief overview of Chernobyl and Three Mile Island accidents is provided in the following paragraphs.

VI.C.1.a. Three Mile Island

The Three Mile Island accident in 1979, that involved a partial core meltdown of one reactor, was the most serious nuclear incident in the United States commercial nuclear power plant operating history. Detailed studies were conducted to assess the radiological consequences of the accident by the USNRC, the Environmental Protection Agency, the Department of Health, the Department of Energy and the State of Pennsylvania, as well by independent groups. No adverse effects from radiation on human, animal and plant life could be directly correlated to the accident (USNRC factsheet). However, it is important to note that 12,000 people were asked to evacuate the area (families with pregnant women and preschool children living within 5 miles of the facility), and an estimated 144,000 persons within 15 miles evacuated for a period averaging between 4 and 5 days (Houts et al, 1988). Long term evacuation rates, i.e., people permanently moving out of the area, were not affected by the crisis. Short term costs were much lower than for natural disasters, because it involved no physical damage and consisted mainly of expenses borne by families who evacuated, and loss of sale and production costs for businesses. There was little evidence of the long-term economic impact on people living in the vicinity, for instance regarding real-estate.

During the crisis, there was an estimated 10% increase in the number of patients that reported symptoms characteristic of mental patients, but after 18 months, it was no longer higher than in the rest of the population studies.
The costs of cleaning up the damaged reactor were substantial. Public fear and distrust towards nuclear power greatly increased.

VI.C.1.b. Chernobyl

The Chernobyl accident occurred in Ukraine in 1986 and is the most serious nuclear accident in the history of commercial reactors worldwide. The consequences of the accident are still imperfectly determined. However, Dr. El Baradei, IAEA Director General, has classified them in three categories in a 2005 IAEA conference entitled "Chernobyl: Looking back to go forwards": the physical impacts, in terms of health and environmental impacts, the psycho-social impacts on the populations and the influence of the accident on the nuclear industry worldwide.

The following figures were cited in his speech:

- Among the emergency rescue workers at the scene of the accident, around 50 individuals died either from acute radiation syndrome in 1986 or due to other radiation-related illnesses in the year since.
- About 4000 children and adolescents contracted thyroid cancers from ingestion of contaminated milk and other foods, and 9 of those children have died.
- Overall, based on statistical modeling of the radiation doses received by workers and local residents, a total of 4000 deaths will eventually be attributable to the Chernobyl accident.
- Environmental fallout from the accident affected croplands, forests, rivers, fish and wildlife, and urban centers. In the three countries more affected, nearly 800,000 hectares of agricultural land was removed from service, and timber production was halted for nearly 700,000 hectares of forest.
- The psycho-social impacts were also devastating. Over 100,000 people were evacuated immediately after the accident, and the total number of evacuees from severely contaminated area eventually reached 350,000 people. While these resettlements helped to reduce the collective dose of radiation, it was deeply traumatic for those involved. Studies have found

that exposed population had anxiety levels twice as high as normal, with a greater incidence of depression and stress symptoms.

As it is summarized by G. Saji (Saji, 2003), "As experienced in the Chernobyl accident, the psychological consequences, as a category of health effects may well be the most significant at the present time."

VI.C.1.c. The number of fatalities does not adequately capture societal risk

What we can conclude from the review of these nuclear accidents, especially through the example of Three Mile Island, is that societal consequences, and therefore societal risk, certainly should capture more parameters than only fatalities, for instance psychological damage to the population and land contamination.

The Dutch experience supports this conclusion (VROM, 2006). The country is currently reconsidering its way of addressing societal risk. The fireworks disaster of Enschede in 2000 led to an intensification of external safety policy and ambitious objectives were set out in the Dutch Fourth National Environmental plan. Research is currently undertaken in order to improve the framework used to limit societal risk. A full report will be submitted to the Lower House of the Dutch Parliament in the summer 2006. One of the issues identified so far is the need to identify the potential societal disruption of any prospective disaster, including injuries, damage to people, actions taken by the emergency services and disaster response services.

VI.C.2. Societal risk measures accounting for more than fatalities

VI.C.2.a. Swiss proposal of risk measure

Literature on possible "extended" measures of societal risk is scarce. In order to quantify the integrated impact of a scenario, there are mainly two possibilities: translate all consequences into monetary values or transform all consequences into no-unit values

Such approach was proposed in Switzerland. The federal ordinance on Protection against Major Accidents (BUWAL, 1991) was issued in April 1991 in Switzerland with the objective of protecting the public and the environment from major accidents. A new risk appraisal measure was proposed, which used a F-C curve, with the consequence being the aggregate measure of 9 parameters summarized in the following table:

		Indicator	**Description**
Impact on man, animals and ecosystem	N1 (Persons)	Number of fatalities (persons)	Early and latent fatalities
	N2 (Persons)	Number of injured	Serious and superficial injuries
	N3 (Persons)	Number of evacuees	Persons evacuated for more than a year
	N4 (Persons)	Alarm factor	[Duration of stress × number of affected people]
	N5 (Animals)	Number of dead animals	Big animals. Small animals count for 1/100 Fish belongs to next category
Impact on natural resources	N6 (sq. meters)	Area of damaged ecosystem	
	N7 (sq. meters)	Area of contaminated soil	Area that is no longer usable or inhabitable or that requires very expensive decontamination treatment
	N8 (sq. meters)	Area of polluted groundwater	
Impact on property	N9 (Swiss Francs)	Expenditures	Property damage, evacuation costs...

Table 5: Categories defined in Swiss proposal
(Buwal, 1991)

The proposed regulation assumes that damage can be represented by these 9 parameters. Fewer parameters might be selected, depending on the field of study. It is important to note that the selection of the categories is subjective.

A quantitative risk analysis is done, and each scenario is assessed in terms of its impact on the nine categories, as well as its frequency. Once the overall impact value of a scenario has been determined from the individual impacts on each of the categories, the scenarios can be ordered in terms of their consequences and complementary cumulative density function can be built. The proposed CCDF expresses the probability of exceeding a certain consequence per site and per year as a function of the overall impact.

A crucial question is how the different impacts should be combined in order to retain only one consequence value for each scenario. A suitable impact scale is defined for each category of indicator value, and then these individual impact values are combined to obtain the overall impact value. Hence, the extended damage assessment asks two main questions:

- How can individual indicators be appraised?
- How can the individual indicators be combined into a single consequence value?

A methodology is presented in (Bohnenblust et al, 1994) that uses the Fuzzy Set theory.

If different scales are available in literature to define the significance of an event (Bohnenblust et al, 1994), the Fuzzy Set theory uses a scale that ranges from 0 (normal operation) to 1 (catastrophe). If the impact value is over 1, it is then taken equal to 1. Figure 25 presents such disaster scale:

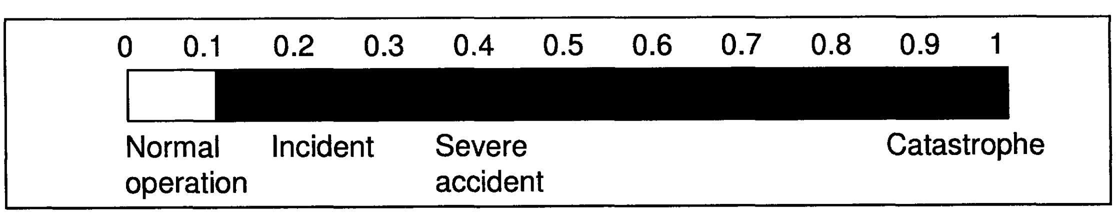

Figure 25: Disaster scale

(Bohenblust et al, 1994)

The Fuzzy Set theory uses membership functions, which are functions that define how each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1. In our case, if the function equals one for an element x, then x necessarily possesses a predefined property. If the function equals zero, then it unequivocally does not possess the property. Finally, an intermediate value indicates the degree of membership or the degree to which x possesses the property.

Bohnenblust postulates a simple linear relationship between the logarithmic indicator value and the impact value. The same approach can be found in the Swiss Ordinance. To determine the function, the magnitude of the impact value 0.2 and 0.6 for each indicator is assessed subjectively by experts. The functions are noted $g_A^i(N_i)$

Figure 26 shows the relationship for fatalities (a total number of 4 fatalities is assigned an impact value of 0.2, 100 fatalities correspond to a value 0.6):

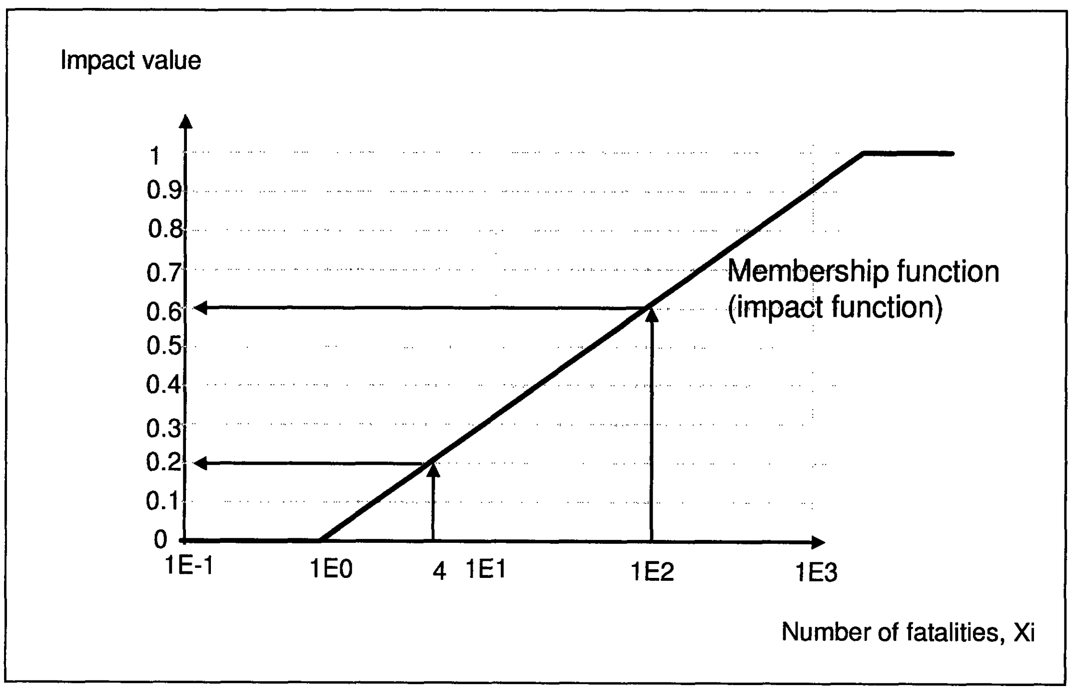

Figure 26: Membership function for total number of fatalities

(Bohnenblust et al, 1994)

The individual impact values must then be combined into a single impact value. The Swiss regulatory proposal does not give a definite answer on this issue, and just states that the maximum of all the indicators could be chosen as the overall impact value:

$$C = \max_i \{N_i\}.$$

Bohnenblust proposes a function value:

$$f_{p,A}(N_1, N_2, \ldots, N_9) = \min(1, \left((g_A^1(N_1))^p + \ldots + (g_A^9(N_9))^p\right)^{\frac{1}{p}},$$

where p is an integer parameter, derived from the Yager operator, and chosen equal to 5 by Bohnenblust in order to lead to a value more significant than the max value and less important than the sum of the individual impact values.

VI.C.2.b. Swiss criterion

Once a risk factor has been calculated, the acceptability of the risk must be addressed. The Swiss proposal includes a three-region approach: a region where risk is unacceptable, a region where it is acceptable and finally a region where risk must be reduced but in consideration of costs and benefits. Figure 27 presents the F-C curve:

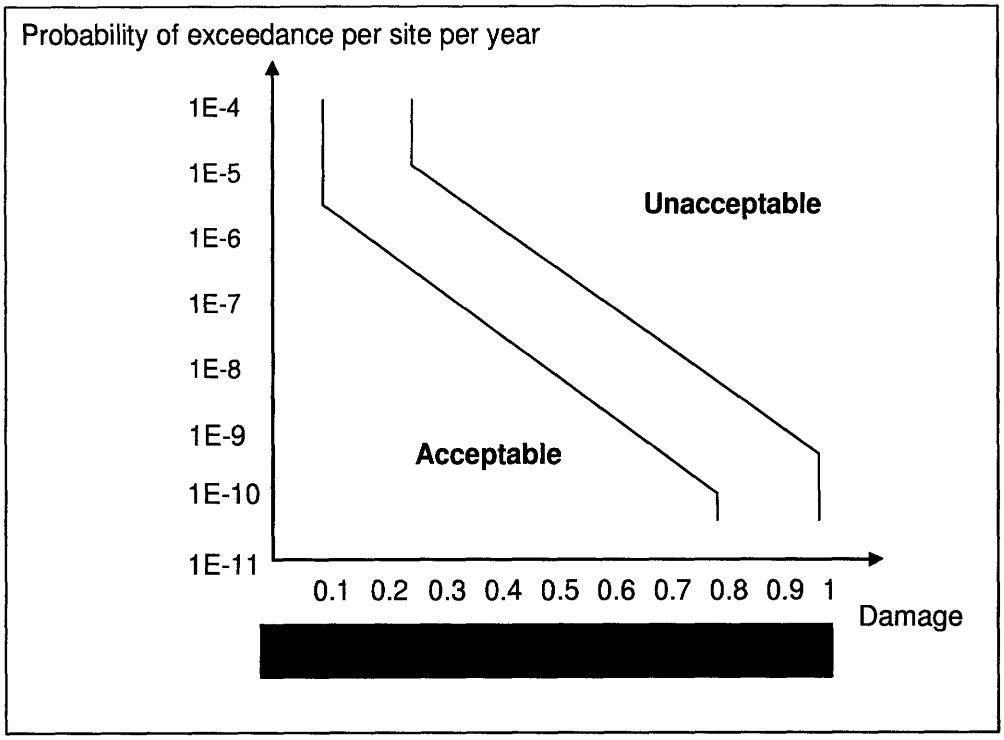

Figure 27: F-C curve proposed by the Swiss Ordinance
(Buwal, 1991)

A single value figure can also be used to compare previous accidents with very different consequences.

However, no consensus exists on the method in Switzerland and it is still discussed. One of the major issues of the method is that it involves subjective judgments almost at every step (definition of categories, translation of the consequences into individual impact values, combination of individual values into an overall value, definition of acceptable level of risk).

VI.D. Conclusion

Use of FN curves in the Netherlands has had a positive impact on safety. It is however hard to extrapolate these results to the United States since the two countries differ in geographical size, population density and in their number of reactors. Furthermore, societal risk from nuclear accidents should capture more than fatalities as a unique category of consequences. For instance, experience from the Chernobyl accident shows that consequences such as land contamination should also be included in any risk assessment tools aimed at limiting the societal risk from nuclear accidents. If "extended" measures of societal risk have been proposed, not one has ever been implemented. The Netherlands have announced their willingness to include such integrated measure in their environmental regulations, but no further details are currently available. The question of integrating such curve into the existing risk criteria in the U.S. has been recently asked.

Part VII. Should societal risk criteria be defined in the United States?

At least one member of the Advisory Committee on Reactor Safeguards (ACRS) in the United States has suggested establishing a F-C curve societal risk criterion for nuclear power plants, and has proposed to use as a consequence the overall societal consequences as determined by the total number of prompt fatalities, latent cancers, injuries, and land contamination (Kress, 2005).

The purpose of this part is to explore the question of societal risk criteria in the United States, to analyze the proposal, as well as to propose variations on the criterion.

VII.A. Description of proposal

VII.A.1. Overview

The F-C curves suggested by Kress are an extension of the "classical" FN curves (Kress, 2005). The ACRS member suggests using as a measure of consequence the overall societal cost as determined by the total number of prompt fatalities, latent cancers, injuries, and land contamination, all expressed in terms of dollars. For each of these four categories of consequences, level-3 PRAs are already able to produce complementary cumulative density functions (CCDF), with uncertainties accounted for, as illustrated in Figure 28.

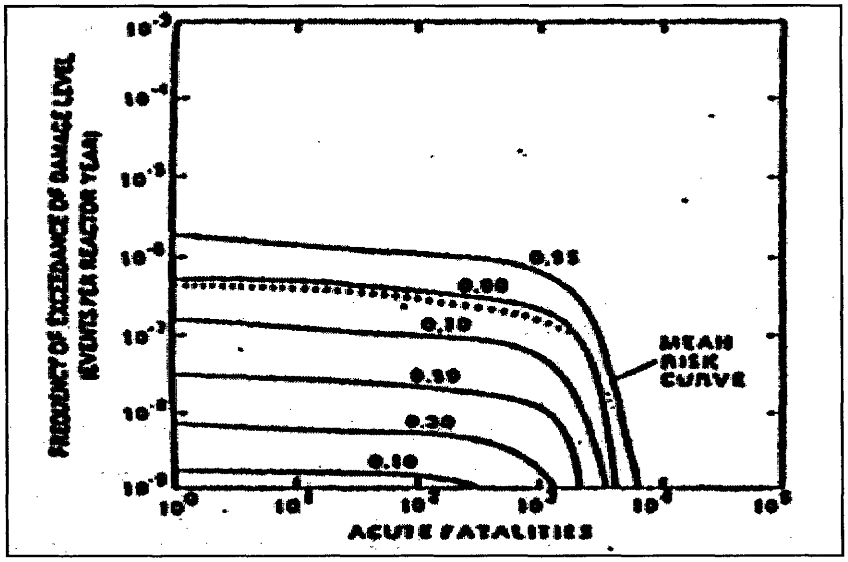

Figure 28: Complementary Cumulative Density Function for acute fatalities from Plant "X" level-3 PRA

CCDF for all four categories of consequences can be translated into a dollar value and then combined so as to obtain one curve capturing all consequences. Difficulties of such an approach are highlighted in Part VII.C.2. The tolerability of risk can then be assessed by comparing the curve to a criterion, such as the illustrative one proposed by Kress and reproduced in Figure 29.

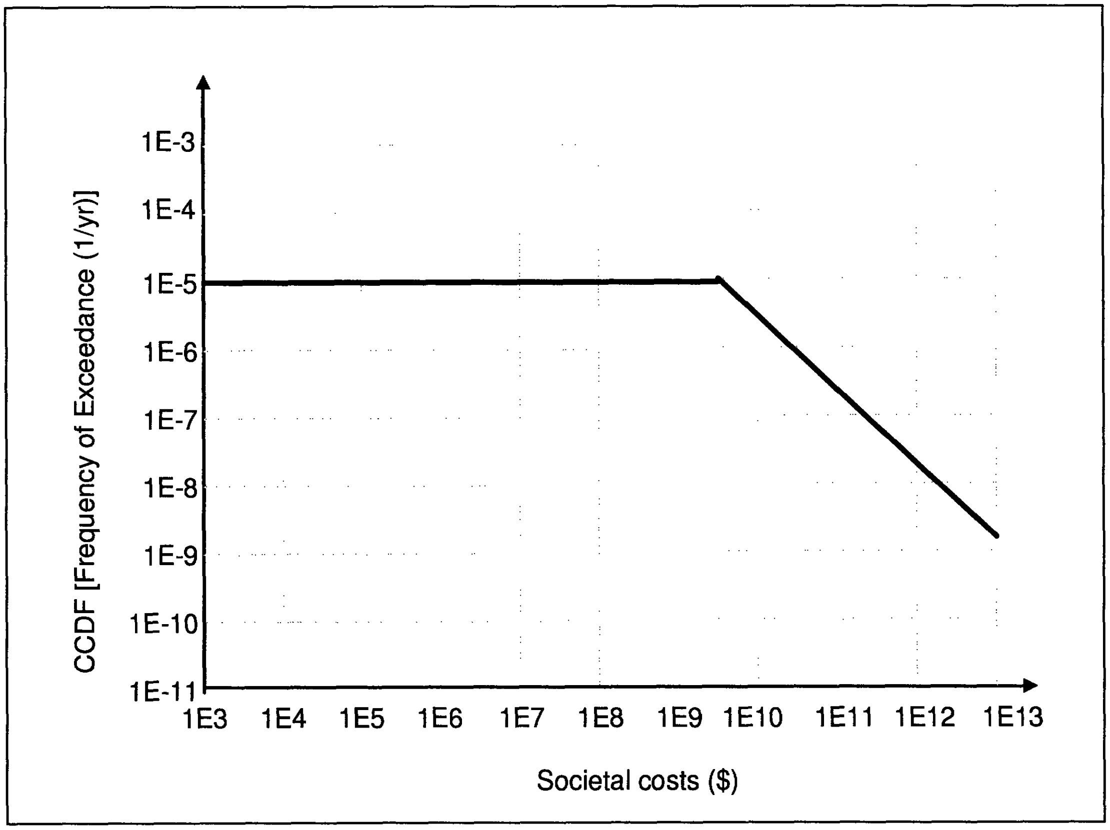

Figure 29: Illustrative Complementary Cumulative Density Function F-C risk acceptance criteria (Kress, 2005)

Kress's choice of the F-C curve shape is justified by the following arguments:

- Exactly like for FN curves, the area under the curve is equal to the expected cost in dollars per site and per year for all the categories of consequences previously defined. The expected cost, called "F-C cost-risk status", can be estimated for each plant, which allows the ranking of different plants based on that figure. If the estimated F-C curve is below the F-C criterion, then the area under the first is smaller than the area under the second. Hence, having a F-C curve criterion limits the F-C cost-risk status. Kress proposes as an example to set the F-C cost-risk status limit, i.e. the area under the curve, in a similar way used to define the QHOs: If there are 100,000 accidents per year in the U.S. and approximately 100 plants, and if the cost per death is taken equal to \$ 2.5 million, then the limit per plant should be set at 0.1% of the total cost of accidents, i.e.: $(0.001)*(2.5*10^6)*(1*10^5)/(100)=$ \$ $2.5*10^6$/site-yr. Since future plants are expected to be safer, the area under the F-C curve is equal to one tenth of this maximum cost-risk status, i.e. $ 2.5*10^5$ /site-yr

- As the consequences tend to 0, the CCDF tends to the value of the Core Damage Frequency (or a preventive risk metric in the technology-neutral context). Therefore, the intersection of the F-C curve and the y-axis is an estimate of the CDF, and must be below the value of the intersection of the F-C criterion and the y-axis. Kress suggests using a value of the CDF limit equal to 10^{-5} /site-yr; a value coherent with the one that has been recently proposed by the USNRC (USNRC, 2006). Therefore, the asymptote of the curve at small consequences is equal to 10^{-5} /site-yr.

- Finally, Kress chooses to define the F-C curve in a risk-neutral manner

The additional criteria implied by the F-C curves are illustrated on Figure 30.

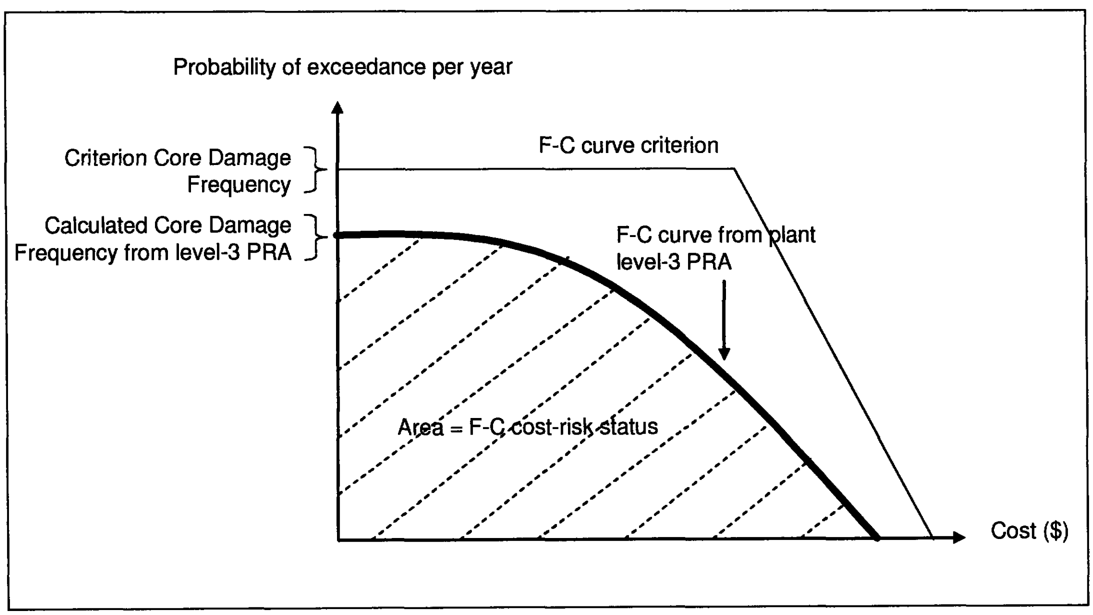

Figure 30: Criteria implied by the F-C curve

Furthermore, in order to account for uncertainties in the PRA calculations, a three-region approach has been proposed. Between the acceptable and the unacceptable regions, a cost-benefit improvement region can be defined. In that region, the costs and benefits of a change, all expressed in dollars, must be weighted in order to decide if the proposed change is acceptable. Each change is evaluated with regards to impact categories defined by the USNRC in the Regulatory Analysis Technical Evaluation Handbook (USNRC, 1997).

VII.A.2. Application of proposal

In order to calculate on a real case the societal risk from different power plants, Kress suggests using the results of the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (USNRC, 1996), detailed in Appendix 1.

VII.A.2.a. Overview of the Generic Environmental Impact Statement for License Renewal of Nuclear Plants

The Generic Environmental Impact Statement (GEIS) examines wherever possible the environmental impacts that could occur as a result of renewing licenses of individual nuclear power plants. For that reason, it estimates the impact of postulated accidents and severe accidents on health effects, captured by early and latent fatalities, and off-site costs for the middle year of relicense (MYR) population for 74 power plants. The calculations are conservative, and no discount rate is considered here.

The GEIS assumes that the license renewal process will ensure that aging effects are controlled, i.e. that the probability of radioactive release from accidents will not increase over the license extension period. Most of the risk is assumed to be captured by the population around the plant, as well as the wind direction. This is a very restrictive assumption, which implies that societal risk due to plant characteristics is not accounted for (see Part V.D.2).
The Exposure Index (EI) methodology is used in NUREG-1437. The EI is a site-specific variable reflecting the population surrounding the plant, weighted by the site-specific wind direction frequency, which determines the fraction of population at risk

The CRAC computer code is used to calculate off-site severe accident costs for the area contaminated by the accident. The code estimates the evacuation costs, the value of crops contaminated and condemned, the value of milk contaminated and condemned, the costs of decontamination of property where practical, and the indirect costs resulting from the loss of use of property and income.

VII.A.2.b. Results

This method does not allow the construction of F-C curves. However, it provides estimates for the total number of early and latent fatalities as well as the off-site costs previously defined. To convert health effects into a monetary value, Kress uses 2.5 million dollars per fatality.

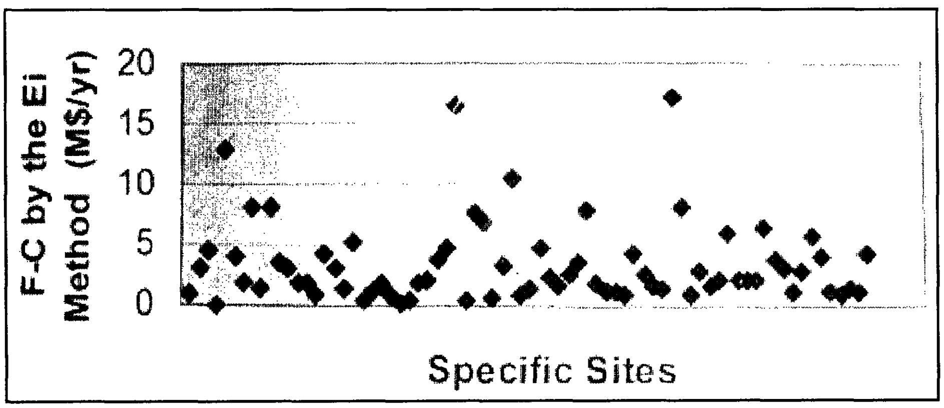

Figure 31: F-C risk-cost status (Kress, 2005)

The results are the following: two plants have a significant higher F-C risk-cost status than the others, with an F-C cost-risk status higher than 15 million dollar per reactor year. Two plants have an F-C cost-risk status between 10 and 15 million dollars per reactor year. The 70 remaining plants are below 10 million dollars.

As seen earlier, Kress suggests requiring that the total societal cost from nuclear accidents be less than 0.1 % of the total societal cost due to accidents in the U.S. , i.e. $ $2.5*10^5$ /site-yr for a value of life of 2.5 million dollars, and considering advanced plants will be ten times safer than current plants.

There are many outliers with this criterion. However, even if no criterion is used, it is still possible to observe a wide range of F-C cost-risk status and that the value is significantly higher than the others for a few of them.

This risk measure relies on the value of statistical life chosen. It is thus necessary to evaluate the dependence of the results on such value.

VII.B. Valuation of life is required in this approach

VII.B.1. USNRC policy regarding valuation of life

Defining the overall societal risk as the sum of the fatalities, injuries and land contamination implies valuing explicitly human life, which is a controversial issue. The position of the USNRC on that matter is stated in NUREG/BR-0184, which is the regulatory analysis technical evaluation handbook (USNRC, 1997). For cost-benefit analyses, the USNRC recommends using the monetary equivalent of \$2000/person-rem for accidental and routine emissions, for both public and occupational exposure, and taking into account all the accident-related health effects.

The mean cancer risk factor reported in the literature is 5×10^{-4}/rem, and the range of uncertainties is estimated to be $3\times10^{-4}-9\times10^{-4}$ (Guenther and Thein, 1997). This cancer risk factor value accounts for the fact that the young have an increased sensitivity to radiations, the non-fatal cancers and the severe genetic effects.

The statistical value of life for latent fatalities entailed by the USNRC guideline is therefore 4,000,000 dollars and the range of uncertainties is \$ 2,000,000 - \$ 7,000,000. Based on this uncertainty, the range of values used to assess the strength of the results is chosen equal to \$ 1,000,000 - \$ 10,000,000.

Literature is scarce on how a latent fatality should be weighted in comparison to an early fatality. A value for early fatality five times higher than the value for latent fatality has been used in a societal risk proposal (Okrent, 1981). However, no rationale for such figure is provided. We will assume in the following calculations that the statistical value of life for an early fatality is at least as high as that of a latent fatality.

One should note that new methods are being developed to replace the traditional concept of a calculation based on the Value of Statistical Life with an evaluation of the Value of Life Year Lost. This concept would be particularly useful to weight an early death against a latent death.

VII.B.2. Sensitivity analysis

Using NUREG-1437 data, it is possible to assess the importance of latent fatalities with regards to early fatalities and to estimate the F-C cost-risk status for the 74 plants using different values of statistical life. Each plant is defined by a number between 1 and 74.

VII.B.2.a. Latent fatalities dominate

The ratio of the predicted number of early fatalities by the predicted number of latent fatalities can be calculated for each plant using NUREG-1437 data, as shown in Figure 32.

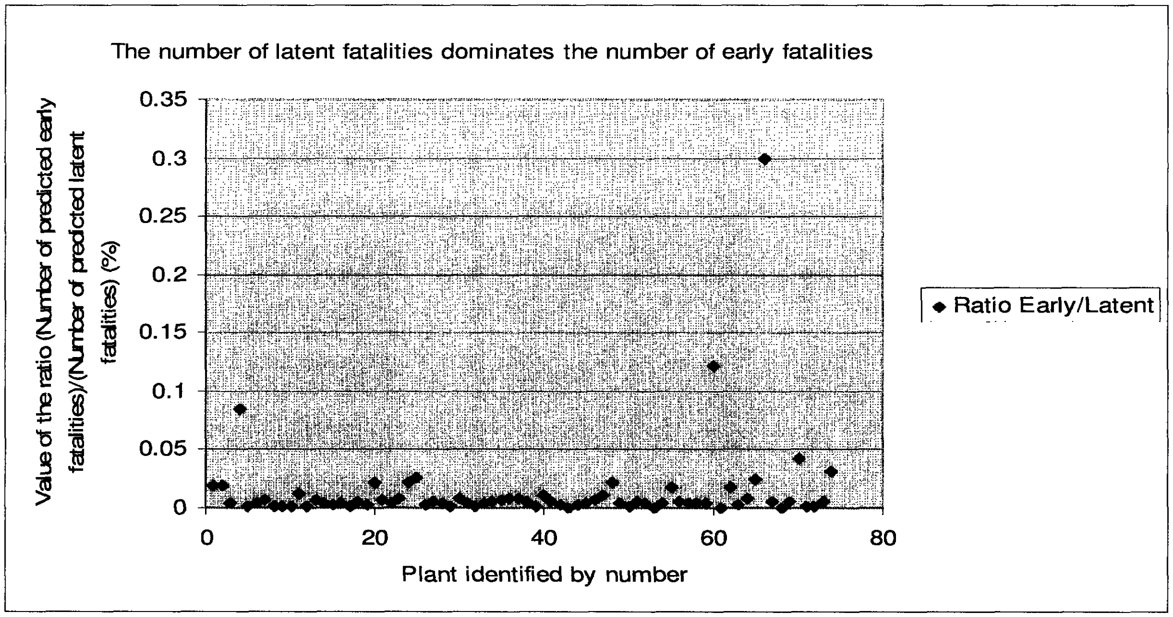

Figure 32: Ratio of the predicted number of early fatalities to the predicted number of latent fatalities

For 71 plants, this ratio is below 5%; for 2 plants, the ratio lies between 5 and 15%. Finally, for only one plant is the ratio as high as 30%. Therefore, latent fatalities dominate early fatalities in terms of absolute predicted numbers.

VII.B.2.b. Frequency-consequence cost-risk status

If we assume that a statistical value of life can be calculated (methods are presented in Appendix 2), the strength of F-C risk measure can be assessed by analyzing the dependence of the results on the value of life chosen. Values ranging from $1,000,000 $ to $10,000,000 are chosen.

- Case 1: Value for early and latent fatality is $ 1,000,000

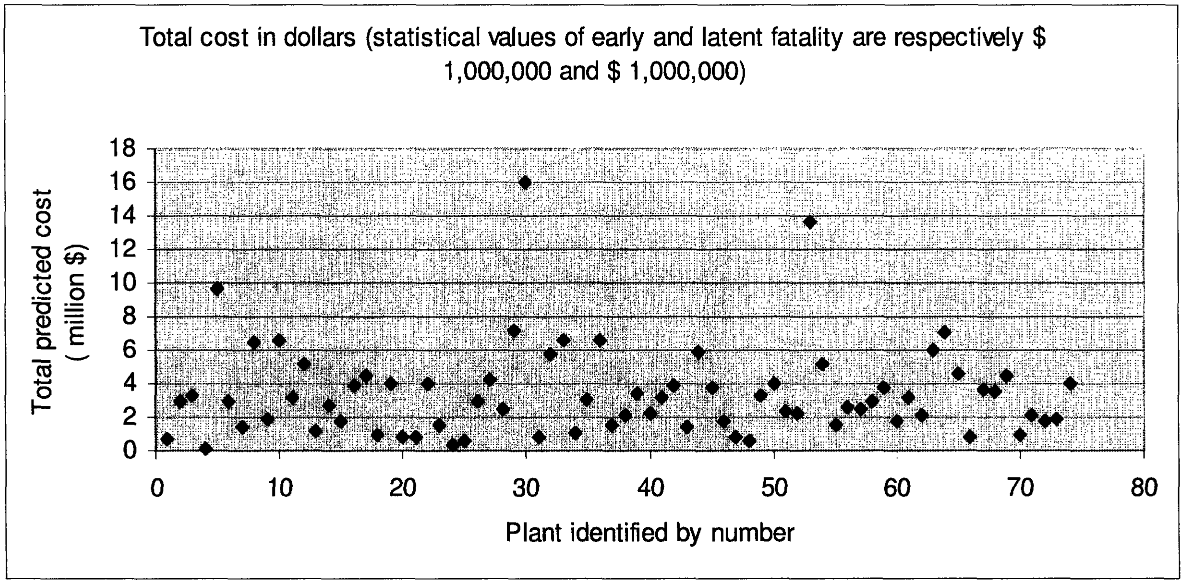

Figure 33: Frequency-consequence cost-risk status - value for early and latent fatality is $ 1,000,000

The three plants with the highest F-C cost-risk status are plants 30, 53 and 5, from the highest to the lowest.

- Case 2: Value for early fatality is $2,500,000 and value for latent fatality is $1,000,000

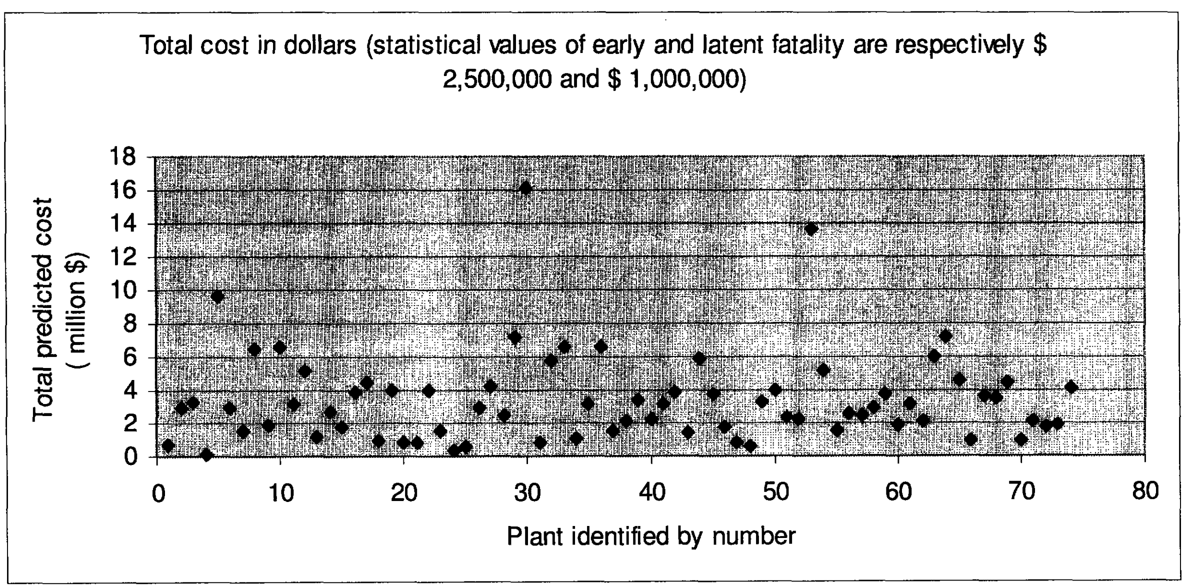

Figure 34: Frequency-consequence cost-risk status – Value for early fatality is $2,500,000 and value for latent fatality is $1,000,000

The three plants with the highest F-C cost-risk status are plants 30, 53 and 5, from the highest to the lowest.

- Case 3: Value for early fatality is $2,500,000 and value for latent fatality is $2,500,000

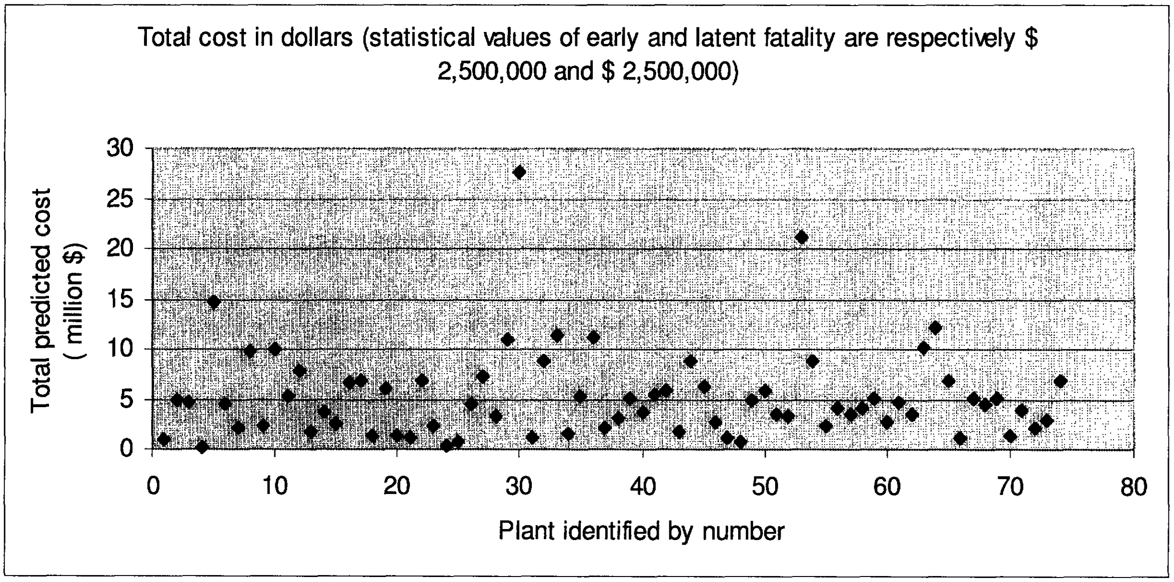

Figure 35: Frequency-consequence cost-risk status - Value for early fatality is $2,500,000 and value for latent fatality is $2,500,000

The three plants with the highest F-C cost-risk status are plants 30, 53 and 5, from the highest to the lowest.

- Case 4: Value for early fatality is $4,000,000 and value for latent fatality is $4,000,000

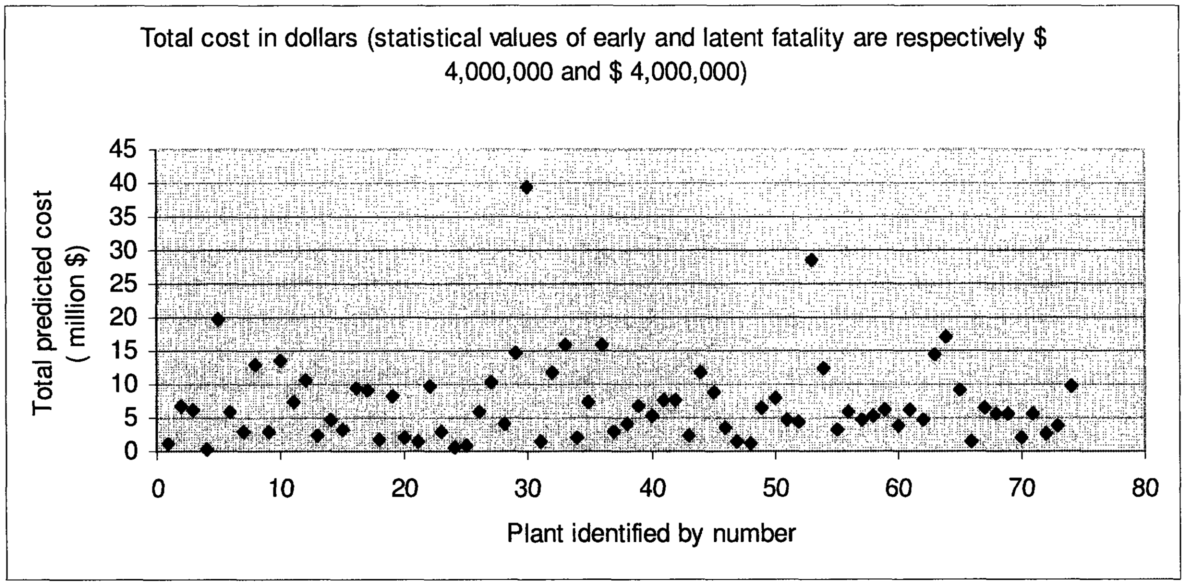

Figure 36: Frequency-consequence cost-risk status – Value for early fatality is $4,000,000 and value for latent fatality is $4,000,000

The three plants with the highest F-C cost-risk status are plants 30, 53 and 5, from the highest to the lowest.

- Case 5: Value for early fatality is $12,500,000 and value for latent fatality is $2.5,000,000

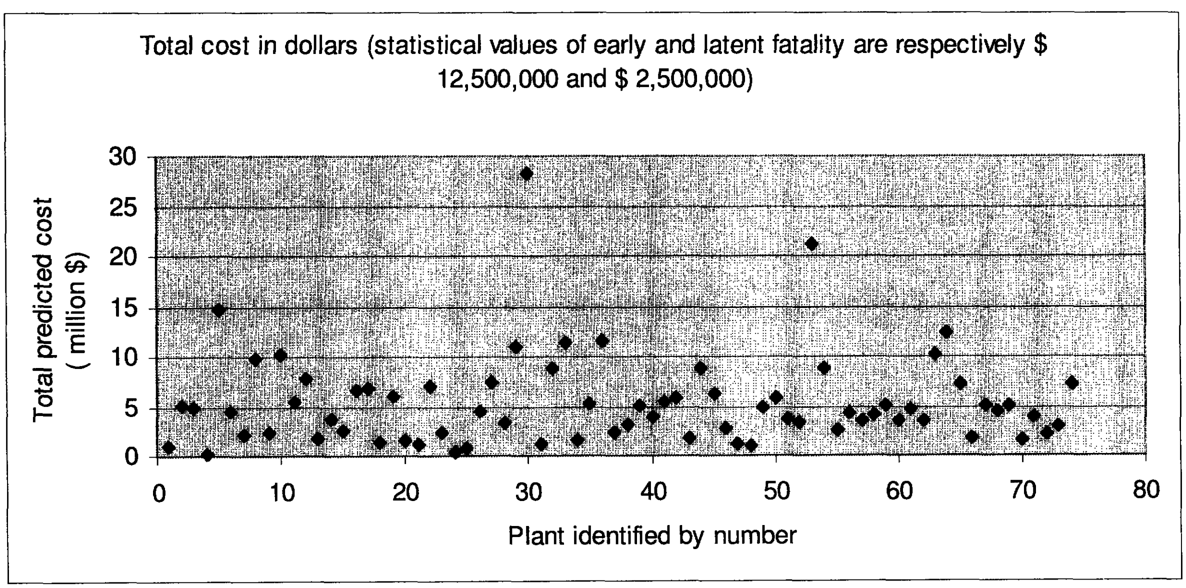

Figure 37: Frequency-consequence cost-risk status - Value for early fatality is $12,500,000 and value for latent fatality is $2,500,000

The three plants with the highest F-C cost-risk status are plants 30, 53 and 5, from the highest to the lowest.

Case 6: Value for early fatality is $20,000,000 and value for latent fatality is $4,000,000

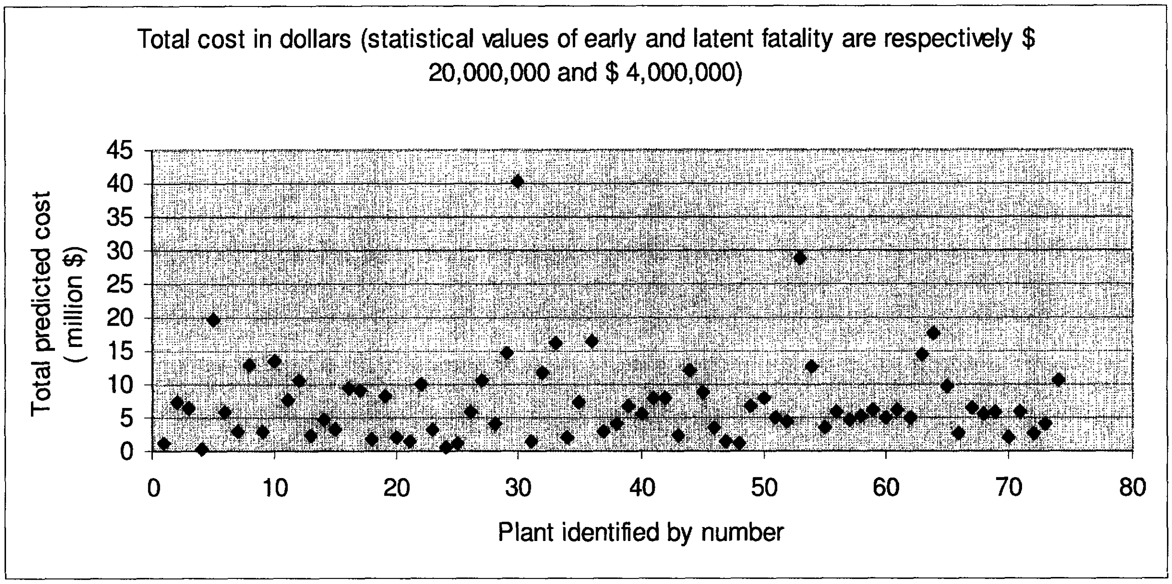

Figure 38: Frequency-consequence cost-risk status - Value for early fatality is $20,000,000 and value for latent fatality is $4,000,000

The three plants with the highest F-C cost-risk status are plants 30, 53 and 5, from the highest to the lowest.

VII.B.3. Summary of results and implications

The previous results are summarized in Table 6:

Case	Value of life (early fatality) In million dollars	Value of life (latent fatality) In million dollars	Plants with highest F-C risk-cost status
1	1	1	30, 53,5 (in order)
2	2.5	1	30, 53,5 (in order)

3	2.5	2.5	30, 53,5 (in order)
4	4	4	30, 53,5 (in order)
5	12.5	2.5	30, 53,5 (in order)
6	20	4	30, 53,5 (in order)

Table 6: Ranking of plants based on their overall societal cost for different values of statistical life

- In light of the results, it appears that no matter the statistical values of life chosen for early and latent fatalities, there are always 3 plants whose F-C cost-risk status is significantly higher than those of the remaining 71 plants. Since the effects of plant aging were not accounted for in the calculations, we can conclude that most of the risk comes from an increased number of people living around the plant, as well as an increase of the off-site costs of accidents (for instance increase in the price of land, crop values, or real estate). The ratio between the costs due to fatalities, both early and latent, and off-site costs, depends of course on the value of life chosen. The following figure presents the calculation of the ratio (Off-site costs in dollars)/(Predicted early and fatality costs for statistical values of early and latent fatalities respectively equal to $12,500,000 and $2,500,000).

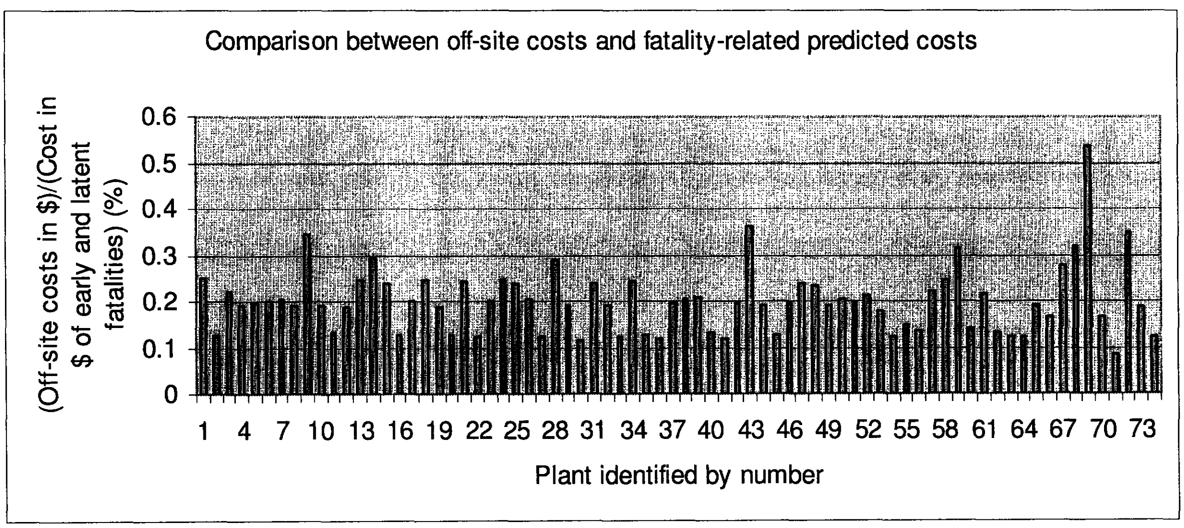

Figure 39: Comparison between off-site costs and fatality-related predicted costs (statistical values of early and latent fatalities respectively equal to $12,500,000 and $2,500,000)

For the majority of cases, the off-site costs represent around 20% of the fatality-related costs. This ratio decreases if higher statistical values of life are chosen. Therefore, costs due to latent fatalities dominate the overall predicted societal cost.

- The criterion proposed by Kress (when not divided by 10 to account for the fact that the plants considered in NUREG-1437 are current plants, and not advanced plants) shows a large number of outliers. Following up on Kress's idea, we can build a criterion similarly to what has been done with the QHOs: There are approximately 100,000 accidental deaths in the U.S. per year, and most of these deaths are early fatalities. The criterion should therefore be calculated using the statistical value of life for early fatality.

In the case where we valued an early life to be equal to 12.5 million dollars and a latent fatality to 2.5 million dollars, the criterion becomes:

$(0.001)*(12.5*10^6)*(1*10^5)/(100)=\$\ 12.5*10^6$/site-yr.

As illustrated on Figure 40, there are only three unambiguous outliers using this criterion:

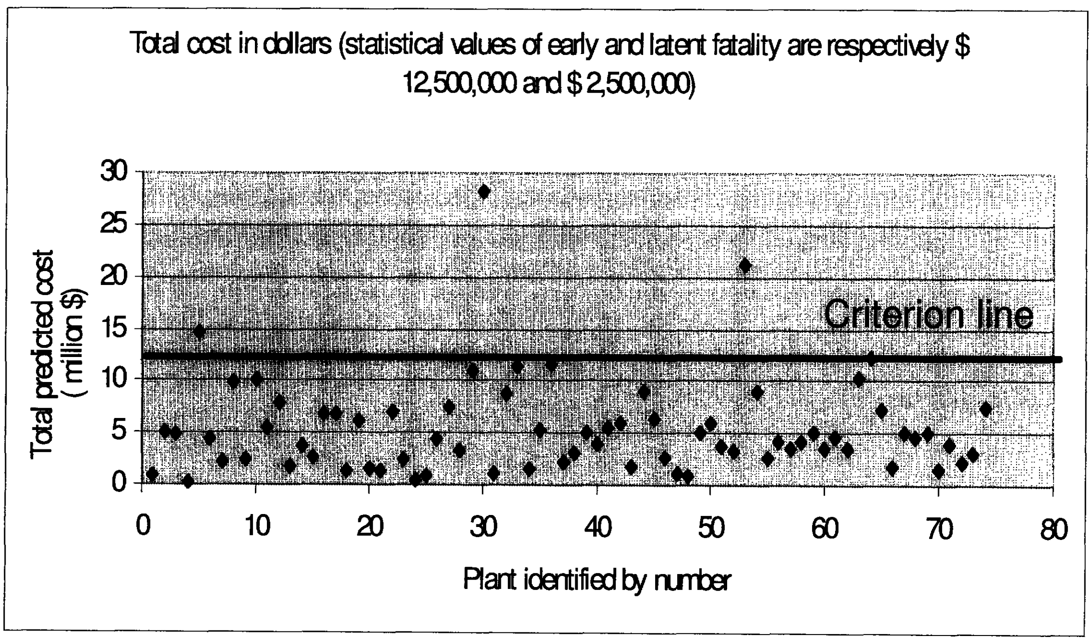

Figure 40: Assessment of the tolerability of F-C cost risk status using statistical values of early and latent fatalities respectively equal to $12,500,000 and $2,500,000

The same can be done for a statistical value of early fatality equal to $20,000,000 and a value of latent fatality equal to 4,000,000.

The criterion becomes: $(0.001)*(20*10^6)*(1*10^5)/(100)=$ \$ $20*10^6$/site-yr, and the tolerability of societal risk in that case is illustrated on Figure 41.

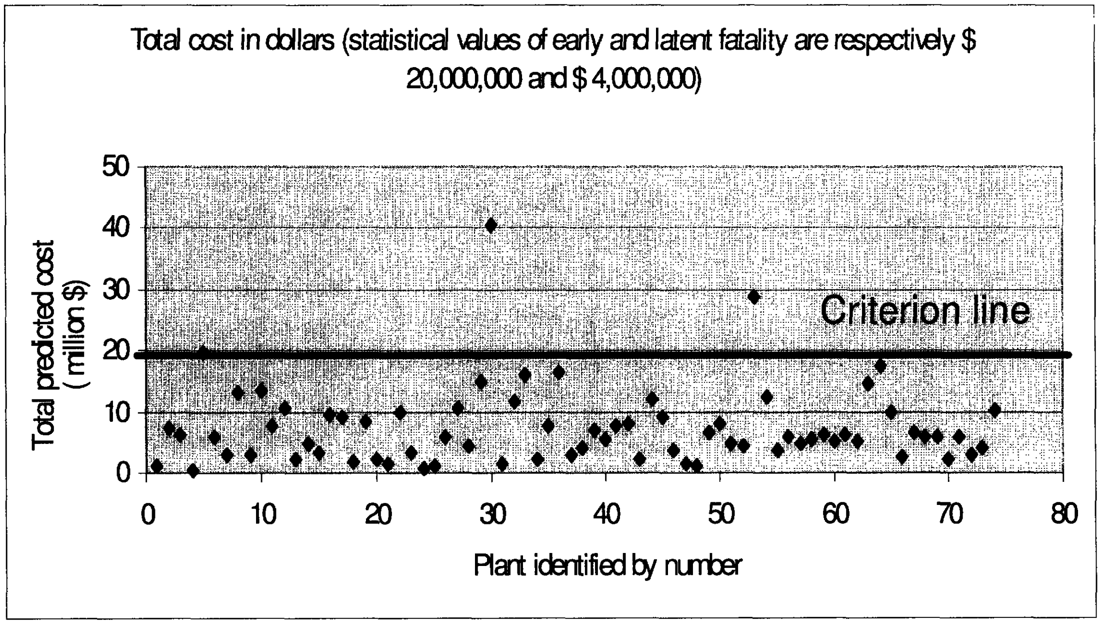

Figure 41: Assessment of the tolerability of F-C cost risk status using statistical values of early and latent fatalities respectively equal to \$20,000,000 and \$4,000,000

- The previous calculations show that societal risk is unequally distributed in the U.S., since some plants involve a much higher societal cost than others. This could be used by regulatory authorities as a screening criterion: outlying plants should be scrutinized in special cases, for instance when licensees require power uprates.

VII.C. Issued related to the approach

VII.C.1. Valuation of injuries

Kress proposes to define the societal cost of nuclear accidents as the sum of the costs of early fatalities, latent fatalities, land contamination and injuries. If there is available literature on the valuation of life, be it to support it or to criticize it (Heinzerling et al, 2002), data on valuation of injuries is very scarce; which makes it difficult to include injuries in the measure.

VII.C.2. Correlation of variables

The consequences "early fatalities", "latent fatalities", "land contamination" and "injuries" can be treated as random variables. For each of them, it is possible to obtain a complementary cumulative density function as an output of a level-3 PRA. To obtain a monetary equivalent for early and latent fatalities, one can easily multiply the consequence axis by the statistical value of life. However, building an aggregated risk curve for all the consequences requires the knowledge of the correlation between the different random variables. For instance, the more people are evacuated (cost taken into account in the off-site cost category or land contamination), the lower are the health effects (the cost of early/latent fatalities decreases). Estimate of these correlations requires additional burdensome and uncertain calculations. This hasn't been done up to date.

VII.C.3. Maturity of computer codes

Computer codes such as Melcor Accident Consequence Code System (MACCS) used for level 3-PRAs produce risk curves for, among other consequences, early fatalities, cancers, injuries, collective dose, and offsite property damage. The epistemic uncertainties are very high, especially for the first three items, as illustrated on figure 42:

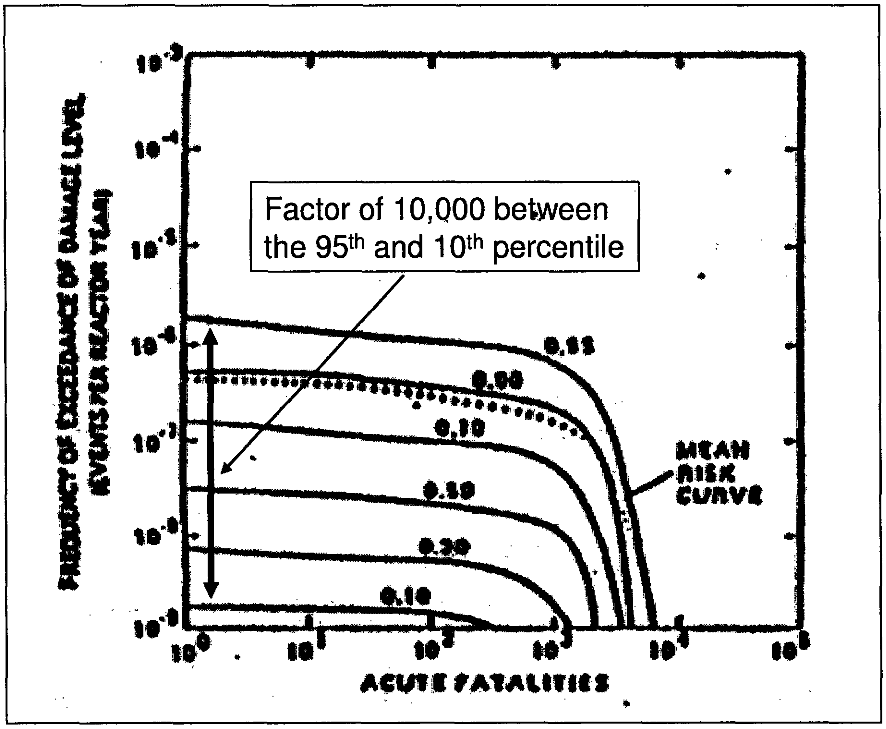

Figure 42: High uncertainties for Plant "X" level-3 PRA output

Decision-making with such uncertainties is highly complex, and tools must be improved. A group of experts of the Nuclear Energy Agency (NEA) recommended in 2000 that accident consequence assessment codes be further developed (NEA, 2000).

VII.C.4. Siting vs Design

Implementing a societal risk criterion is complex because it requires both the knowledge of precise details on the site where the plant is located (e.g. wind direction, density and location of population, evacuation resources) and the plant characteristics. For that reason, it is very unlikely that such criterion could be part of the licensing process, since the designer has little knowledge of the site where the plant will be located.

The following figure details what data is necessary depending on the definition of the F-C curve. The consequence chosen by Farmer in 1967 was the amount of Iodine 131 released. This consequence measure did not require knowledge of the site. The F-C curve developed by the USNRC for the selection of Licensing Basis Events uses the dose to an individual at a specific distance from the site as a consequence measure. Only weather data or models are needed to calculate this consequence. This is not the case for the F-C societal risk criterion which requires both the knowledge of the site and the plant.

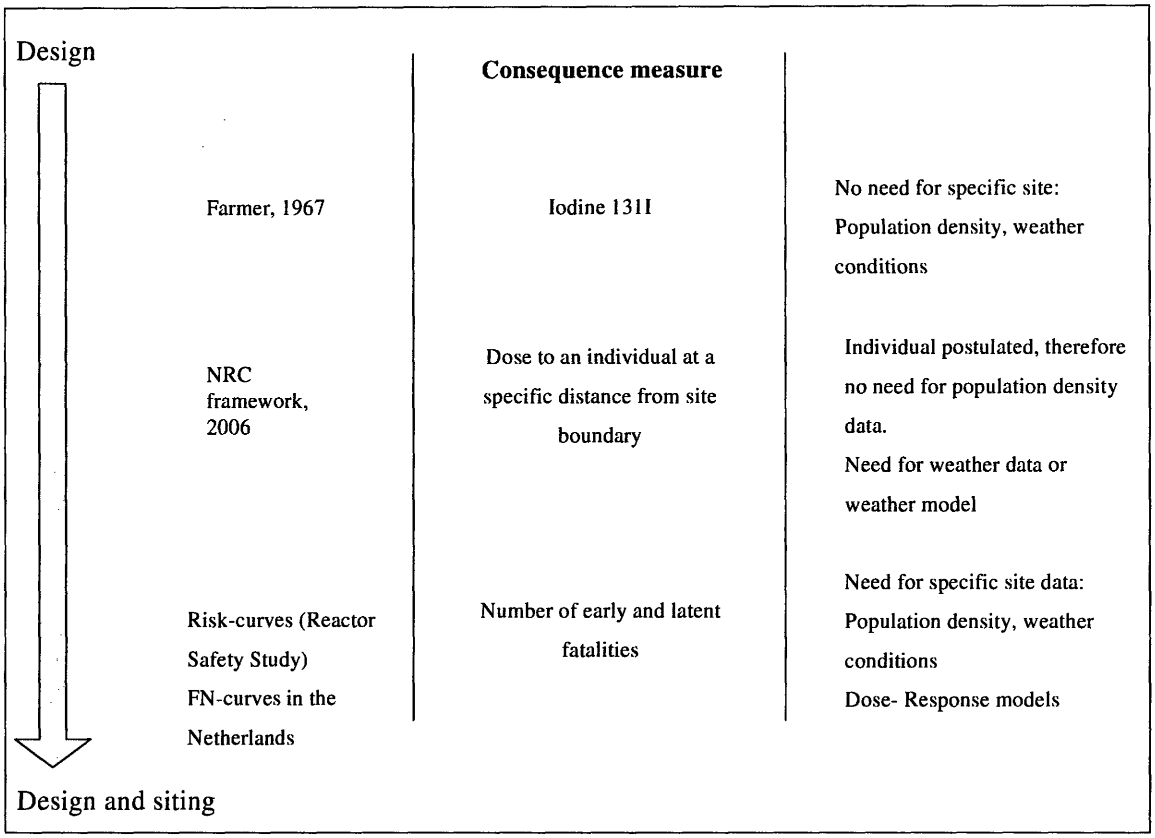

Figure 43: Required data depending on the type of frequency-consequence curve

VII.D. Conclusion

A societal risk criterion defined in the form of a F-C curve would be a useful way to control the risk of current reactors. Indeed, the fleet of reactors displays a wide range of F-C cost-risk statuses and certain plants should be closely scrutinized, for instance when they request power uprates. However, changing the regulations now for current plants would be acknowledging that the point has been missed for decades. Kress suggests using such curves for advanced reactors. Several objections can be made to this suggestion: first, the use of such criterion requires the knowledge of both the site (for instance population and weather) and plant characteristics at the time of licensing; which is often not the case. Second, advanced plants are expected to be so safe that such criterion may not be needed. A new evaluation of the need for such criterion should be done when data on level-3 PRAs of Generation IV reactors becomes available.

Part VIII. Summary of conclusions

The licensing of nuclear power plants has focused until now on Light Water Reactors and has not incorporated systematically insights and benefits from PRA. With the goal of making the licensing process more efficient, predictable and stable for advanced reactors, the U.S. Nuclear Regulatory Commission has recently drafted a risk-informed and technology-neutral framework for new plant licensing. The Commission expects that advanced nuclear power plants will show enhanced margins of safety, and that advanced reactor designs will comply with the Commission's Safety Goal Policy Statement. In order to meet these expectations, PRA tools are currently being considered; among them are frequency-consequence curves, which plot the frequency of having C or more consequences (fatalities, injuries, dollars, dose...) against the consequences C. The objective of this thesis is to study their role and usefulness in the context of the new NRC framework, as well as to explore their potential application as a societal risk acceptance criterion.

In parts II, III and IV, we have presented and analyzed F-C curves, as defined by the USNRC, and concluded that such risk assessment tools contributed effectively to the definition of a risk-informed licensing process, for they allowed, among other changes, the implementation of structuralist and rationalist Defense-in-Depth. Furthermore, the use of F-C curves introduces a major change in the regulations by defining a systematic selection process of Licensing Basis Events, intended to replace the fully deterministic Design-Basis Accidents.

The USNRC's use of F-C curves is based on individual risk and is therefore quite innovative, since these tools are classically used to assess societal risk.

In part IV and V, we introduced the general concept of societal risk and the quantitative tools available to assess and limit such risk. Our conclusions can be summarized as follows:

- Existing tools concentrate on a single type of consequence, in general early fatalities, and are known as FN curves. Those curves have entered the regulations in the Netherlands, and have had a positive impact on safety. It is however hard to extrapolate these results to the United States since the two countries differ in geographical size, population density and in their number of reactors.

- An overview of nuclear accidents shows that societal risk from nuclear accidents should capture more than fatalities as a unique category of consequences. Among other categories, any risk measure specific to the nuclear field should include latent fatalities and land contamination. If "extended" measures of societal risk have been proposed, not one has ever been implemented. The question of integrating such curve into the existing risk criteria in the U.S. has been recently raised.

Finally, after a review in Part VII of the latest proposal to include an extended societal risk criterion in the U.S., we concluded that:

- Societal risk is affected by the siting of the nuclear power plant and the amount of radioactive material present in the core, and not by the design of the reactor. Changing design to suit the site defeats the purpose of standardization and the public would want all sites to have the best available design.
- Current plants involve a wide range of societal costs, and certain costs were deemed unacceptable when compared to the criteria we defined.
- Plants that are considered as outliers in our model should be closely scrutinized when requesting power uprates, likely to increase the amount of radioactive material in the core.
- In light of the available data, societal risk criteria are not needed for future plants. A new evaluation of the need for such criteria should be done when data on level-3 PRAs of Generation IV reactors becomes available.

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Appendix 1: Overview of NUREG-1437

Background

Operating licenses of nuclear power plants may be renewed for up to 20 years beyond the 40-year term of the initial license. Such renewal is authorized by the Atomic Energy Act of 1954 and the renewal process examines if the plant can continue to operate safety during the extension period. Limiting the initial operating license to 40 years was justified for economic and antitrust considerations. The first operating license will expire in 2009, and 40 % of the operating licenses will expire by 2015. In 1991, the USNRC published safety requirements for license renewal as 10 CFR Part 54. This first license renewal rule was amended in 1995. The operator that wishes to renew its license must submit a report that identifies the systems, structures and components that would be affected by the license renewal, shows that the effect of aging are well managed; and finally analyzes the environmental impact of the renewal (the scope of the environmental review is codified in 10 CFR 51). Independent reviews by the USNRC and the ACRS are carried out.

The Generic Environmental Impact Statement

The Generic Environmental Impact Statement (GEIS) examines wherever possible the environmental impacts that could occur as a result of renewing licenses of individual nuclear power plants. The GEIS was undertaken to provide the technical basis for an amendment to the 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," with regard to the renewal of nuclear power plant operating licenses.

Assumptions

On a high-level, the increase in risk during the renewal period can be due to either deterioration of the plant safety itself due to aging phenomena for instance; or in the change in the environment around the plant (e.g. increase in the density around the plant). The GEIS assumes that the license renewal process will ensure that aging effects are controlled, i.e. that the probability of radioactive release from accidents will not increase over the license extension period. Most of the risk is assumed to be captured by the population around the plant, as well as by the wind direction.

Methodology for predicting risk

Both the risks from design-basis accidents and severe accidents are evaluated in the GEIS. Doses and the resulting health effects, captured by early and latent fatalities, are estimated for the middle year of relicense (MYR) population, defined as the "estimated midpoint of the renewal period for a given plant rounded upward to the next year of available population data".
The Exposure Index (EI) methodology was used. The EI is a site-specific variable reflecting the population surrounding the plant, weighted by the site-specific wind direction frequency, which

determines the fraction of population at risk. The total risk value of each plant, available from existing FES analyses, was regressed against the EI for that plant; and average and 95 percent upper confidence bound values of total risk were estimated.

Appendix 2: Valuation of life

Valuing life is a controversial issue, and the estimated values of life vary considerably from one study to another, depending on the way they are calculated. Two approaches have traditionally been used (Viscusi et al, 2000): the first approach estimates the implicit prices for the social risk commodities that may be traded on markets (for instance, workers are willing to accept higher wages for jobs that carry higher risks). The second consists in polling people and ask them how much they value a health outcome. This approach is referred to as the "Willingness to Pay" approach. It is important to remind here that the estimated values are statistical values of life: they do not refer to a specific individual, but rather as the cost to reduce the average number of deaths by one.

Valuing life is needed for certain cost-benefit analyses when health impacts of a regulation have to be monetized. There are many opponents to the use of cost benefit analysis in the environmental regulations, arguing that not only is it impossible to value life but it can also lead to unreasonable results (for instance, smoking should be encouraged based on a cost-benefit analysis since people are expected to die younger and therefore the cost of their retirement on society decreases) (Heinzerling et al, 2000).

In 1997, the USNRC released a document designed to provide guidance for cost-benefit analysis (USNRC, 1997). In that document, the Commission recommended the use of the value $2000/per person-rem averted for both public and occupational exposure, to account for all health effects (and not land contamination). This value was to be used for both routine and accidental exposure. In a paper summarizing a work performed under contract for the U.S. Department of Energy in 1995, Guenther and Thein used a two-fold approach: after estimating the value of statistical life (in dollars), an evaluation of the probability of cancer death due to radiation exposure of some given amount (death per person-Sv) was carried out. The product of both results produced a value per person-Sv. The methods illustrated in the paper are the following:

- *The analysis of jury awards and settlements from wrongful death suits* reflects society's valuation of life thanks to a randomly selected jury. The following table provides a summary of the main assumptions of this method.

Approach: Lawsuit of wrongful deaths			
Method	Advantages	Assumptions	Observations
Examination of jury-awards and settlements in wrongful deaths suits (Otway, 1971; Miller, 1989) from 1989 to 1993 (the time value of money is not taken into account) Distinction between wrongful deaths involving malpractice and wrongful deaths involving product liability	In the case of awards, all aspects (e.g. pain and suffering, loss of service, wrongful deaths and punitive damage) of the award reflect the economic impact of the loss of life	As juries are randomly selected, their decisions "represent a consensus of society's values" The value awarded reflects the value of life remaining.	When the jury specified the remaining years of life, the average annualized awards was 2 to 4 times higher than the calculated average of all the cases There was a small number of large settlements, which skewed the average above the median

Table 7: Valuation of life: Lawsuit of wrongful deaths

- *Another approach is the study of medical expenditures,* which consists in the evaluation of the amount of money "the individual is willing to spend to save or prolong the life of an individual suffering from a debilitating illness". The study carried out chose to analyze cancer.

- *The analysis of insurance coverage* is a third possible method, and assumes that the value individuals place on their own lives is reflected by the amount of coverage they purchase.

- The fourth study carried out consisted in analyzing individual *wages and investments*, which reflect an individual's contribution to society. This approach is very similar to the Human Capital approach.

Finally, the authors performed a literature search for values of life. The results of the various calculation approaches are summarized in Table 8.

Method used to ascertain a value of life	Range in values (1990 U.S. dollars)	Recommended values (1990 U.S. dollars)
Jury award from wrongful death suits	562,000 – 12,760,000	3,454,000
Medical expenditures	141,000 – 4,222,000	4,222,000
Life insurance coverage	130,700 – 3,356,000	3,356,000
Lifetime wages and investments	960,000 – 2,670,000	2,670,000
Review of literature		
500 life-saving interventions	1,297,999 – 191,000,000	2,865,000
Willingness To Pay approach	83,000 – 18,400,000	2,844,000
Human-Capital Approach	210,000 – 1,124,000	558,000
Values used by federal government	2,000,000 – 300,000,000	2,500,000
Law Enforcement		3,017,000
AVERAGE	672,000 – 7,089,000	3,116,000

Table 8: Methods for valuating life

The paper concludes that since the average value of life has been calculated to be $3,116,000; a "conservative" value is $4,000,000 (1990 dollars). The methodologies do not make a difference between early and latent fatalities: for instance, wrongful deaths can be both early and latent. Literature is scarce on how a latent fatality should be weighted in comparison to an early fatality. A value for early fatality five times higher than the value for latent fatality has been used in a societal risk proposal (Okrent, 1981). However, no rationale for such figure is provided. It is reasonable to assume that the statistical value of life for an early fatality is at least as high as that of a latent fatality.

The use of cancer risk factor estimates allow the calculation of the value of a latent fatality: Guenther and Thein estimate the cancer risk factor to be 0.052 Sv^-1; with a range of uncertainty being 0.03 to 0.09 SV^-1. This cancer risk factor value accounts for the fact that the young have an increased sensitivity to radiations, the non-fatal cancers and the severe genetic effects
The value of life has been previously chosen to be equal to 4,000,000 dollars. If the cancer risk factor is estimated to be equal to approximately 0.05 Sv-1; the cost per person-rem is $2000.

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"Looking to the Future"

The Honorable Gregory B. Jaczko
Chairman
U.S. Nuclear Regulatory Commission
at
Platts 8th Annual Nuclear Energy Conference
Rockville, MD
February 9, 2012

Good morning, everyone, and thank you for that very kind introduction.

I was looking over the program, and it's a tremendously distinguished panel here this morning as well as throughout the conference. I think you will have some very interesting discussions in what is really, I think, a very interesting time.

I thought I would talk a little bit today about some of the questions that I see that are out there in the nuclear industry. And I won't claim to have answers for most of those questions. I will give you some thoughts on what I think about some of those questions, but I hope that as this two-day conference goes on, perhaps some of those questions will have answers more fully fleshed out.

Today is a very unique day and a very unique time for the nuclear industry. It was only within the last several weeks that the Blue Ribbon Commission on America's Nuclear Future – which was looking at spent nuclear fuel and geological repositories -- issued their report, which perhaps provides an answer to a long-standing quest in this country to come up with a feasible way to develop a geological repository.

I think as was mentioned, today the Commission will be meeting to make a final decision on the mandatory hearing for the Vogtle COL application. Had I been speaking to you about 1:00 p.m., I would probably give you a very different talk than I am going to give you this morning. So I can't really say much more about that than what I said already.

Our staff at the NRC are continuing to meet to tackle what we refer to as the Tier 1 Fukushima recommendations. Those are a series of eight recommendations that have been established by the Commission as really the top category of activities that need to be moved forward in the near term. And the Commission is expecting to get a proposal from the staff on specific ways to address a subset of those recommendations in about two weeks.

So that is some of the landscape of the work and the activity that we have in front of us, running the gamut from spent fuel storage to new reactor licensing to Fukushima response. But at the same time, of course, we have a fleet of 104 operating reactors that continue to be the primary day-to-day focus of the agency.

And of course at this time we find ourselves in a somewhat unique situation from recent experience. We have one plant in column 4 of our action matrix, so that is a plant that is getting more significant oversight from the NRC. And we also have another plant which is a Manual Chapter 0350 plant, which is getting a little bit more exposure and oversight and there are some additional conditions for potentially restarting that facility.

So, again, we have some new situations, but things that are not historically too far out of the norm, but certainly present some challenges and issues for us I think as we go forward.

So as I said, perhaps we will have more in the way of questions that I will leave you with today than answers for some of these.

As I was thinking about preparing these remarks, one of the things that I believe we often don't do a good enough job on, is trying to look out into the future to see where we will be and where we want to be in nuclear safety, and where you want to be as a nuclear power And I will share with you an experience. I went to visit another country as part of my responsibilities as Chairman, and I had a long discussion with the regulators, with people in the industry in that country, about their future and what they intended to do for nuclear power.

They had a very ambitious program for nuclear power development that would take them out 30, 40, 50 years. And they were making decisions today to prepare themselves for decisions that they were going to need to make in 20 or 30 years.

So one of the things that I was thinking about is: what are the decisions that we need to be making today to ensure that we are at the right place 20 years from now? And the question I would ask is, what is the future of nuclear safety?

Twenty years from now, what kind of a future do we see for nuclear regulation? Well, of course, hovering over all of this are the past occurrences. There have probably been three really seminal accidents or incidents at nuclear power plants, commercial nuclear facilities.

Of course there was Three Mile Island here in the United States. It was an accident. There were no significant releases of radiation, but it created a tremendous amount of activity and work for the U.S. Nuclear Regulatory Commission and very much changed how we did our job. It changed the very nature and structure of the NRC itself.

Following that, several years later, was the Chernobyl accident. And of course that had profound impacts on the way nuclear safety was conducted. Chernobyl was the impetus for a number of enhanced international agreements and international efforts to better share information about nuclear safety, to ensure that there were better ways to communicate and share information and ensure consistency and increase the regulatory competence in as many countries as possible.

Then, of course, the most recent incident was the Fukushima Daiichi accident. And if you look at these three incidents together, one of the things that struck me as I was looking at this, is there is definitely a progression. And it's an interesting progression, because generally what we want to see as we learn more and we have a better understanding of nuclear safety, is that the accidents decrease in their magnitude and severity.

But to some extent, we haven't really seen that. The first accident -- Three Mile Island -- did not have a significant release. It did not lead to significant offsite consequences. But that of course was not what happened at Chernobyl. It was not what happened at Fukushima.

I think there are a lot of reasons for that. One is that I think we have done a very good in the safety world of addressing and tackling the more likely, smaller types of accidents. In many ways, we have done a lot to really prevent the Three Mile Island type of accidents.

But I think what this tells us, and what it may show us, is that we have not done enough to prevent the more significant severe accidents. Now, that may not be something that is possible. And that is a question that I want to explore a little bit more -- what that would mean, and can we really get to a place in which we can prevent severe accidents?

Now, I think if you look at the countries that are involved in these accidents, in looking at the United States, the former Soviet Union, and Japan, we are looking at countries that are considered to have very mature nuclear programs.

So as we look at the future of nuclear safety, clearly in those countries that have mature nuclear programs there are still things that we need to focus on and need to consider. One of the most important, and will always be the most important, is ensuring a trusted and credible and reliable regulator.

I think in many ways the U.S. NRC is a world leader as a regulator today, because of what happened at Three Mile Island. It caused us to change how we do our work, change our practices, and change the way we go about nuclear safety. But we have had the benefit of 30-some years since that accident to refine and develop what is now I believe a very mature and very stable regulatory program.

But it is certainly one in which we can learn and we can do better. If we look to the future in 20 years, there will certainly be continuing challenges with those mature nuclear regulators. But in 20 years, we may also be introducing new entrants.

The IAEA has forecast that there are 60-some entrants or countries that are interested in getting into the commercial nuclear business. So as we look 20 years from now, one of the most important things I think for us as a regulatory community, and for those of you in the industry, is to ensure that those new entrants don't go through the same kind of learning curve that the mature regulators have gone through.

That means we don't want to see an accident in one of these countries that forces a rethinking and a reevaluation of the regulatory infrastructure, changes to the regulator that are made because of the response to a significant incident.

As we look at these new entrant countries, we really have to understand what it is that led these mature countries down the path in which their regulatory systems or their industry did not properly do something which then led to a severe accident or some type of accident.

And I think one of the things that in this country has made us very unique is the role that INPO plays. It's a very unique model. It provides a tremendous opportunity for licensees and utilities in this country to improve and refine their performance and to fill a gap that the regulator never can fill.

As we look 20 years out, I think one of the most important areas in which we need to ensure improvement is on some type of INPO organization for other countries. Ensuring that this type of structure exists to complement the work that the regulator does is, I think, crucial. I believe it is one of the key reasons for the tremendous improvement in the capacity factors in this country and the performance of utilities in this country. Of course, I think a large measure of credit goes to the work of the NRC as well, but I believe INPO plays a very, very important role.

So what type of organization can fill that void in other countries? Clearly, right now the most reasonable candidate is WANO. And as we look 20 years from now, one of the things that we need to think about today is, what do we want WANO to look like in the future? And how can WANO develop and grow today, so that 20 years from now it can play the kind of strong role that INPO plays in the United States today?

It is one of those areas where I think investment today will pay tremendous dividends into the future, and, in particular, to help those new entrant countries as they begin to embark on nuclear programs. And hopefully we will be able to prevent them from having to go through the learning curve that so many of us in the mature countries have gone through.

Now, I want to touch on another subject, again thinking about where we will be 20 years from now. As the nuclear industry in this country has developed, and as nuclear safety in this country has developed, one of the areas we have begun to explore more and utilize more is the area of risk analysis and what we call risk-informed regulation.

This is still very much a young activity in this country, but I would say that in the United States, and in the U.S. Nuclear Regulatory Commission, we are probably one of the more dominant users of risk information, and the U.S. nuclear industry is one of the more dominant users of risk information relative to other countries. But we are still at a very early stage in development of this kind of activity.

So as we look at the future, 20 years from now, one of the things that I believe is very important to think about is what role risk information will play in regulatory decisions, in economic decisions, in business decisions, in safety and operational decisions at nuclear power plants.

And I believe it is very important to put a lot of this in the context of Fukushima. I think it raises some very interesting questions for us today that we need to analyze and address if we want risk information to play a much more dominant role in the future.

The first and most important question may be: how do we properly model risk for nuclear power plants? And by that I don't mean how do we develop the computer codes, how do we do the analysis, but what kinds of things are we really interested in when it comes to accident consequences?

If you look back to the work that we have done, the metrics that we use are metrics based on exposures to radiation and the effects that those have on people. There are basically two types of these -- the prompt radiation health effects, and the latent radiation health effects.

So risk tells us things like that. We can develop models; we can develop the probabilities and likelihoods of certain individuals, in certain accident scenarios, being exposed to a certain amount of radiation that may have a potential either for a prompt health effect or latent health effect.

Now here is where things get a little bit difficult, as we look out to the future. While Fukushima was certainly a very significant event, it was not a very significant event from the risk metrics that we currently use in terms of those health effects.

So the question is: what does that tell us about the use of risk? Is it an effective metric? To some extent one could argue that based on the risk models, accidents like Fukushima will happen -- hopefully with a very unlikely or low frequency, but they will happen -- and they are acceptable. They are well within our risk metrics, primarily because we ultimately had a robust system that allowed people to be evacuated and allowed ultimately for people to be relocated from any exposure to radiation.

Now, I think if I were to talk to an average person on the street and say that, people would say no, that was a pretty significant event. And I personally think that's right. I think that this was a significant event, and it was an unacceptable event. But if we look at the risk models that we use today, it is not -- in our risk models -- an unacceptable event.

There were no prompt fatalities, the latent cancers are dramatically reduced, and eventually we will get better projections and better understandings of what those will be. But they will likely not be significantly different from whatever background cancer incidents would likely have occurred in those areas without Fukushima happening.

So if we look today at our risk models, the most fundamentally missing piece, I believe, is the right way to characterize what we believe as societies are the unacceptable things about nuclear power accidents. But it is a very different way to think about these things than we have done in the past.

And by that, I mean it is the real human consequences that we are dealing with -- evacuations of large populations, perhaps extended relocation of populations; significant effort to clean up, decommission and decontaminate perhaps significant areas of land; the redevelopment and the loss of significant energy infrastructure; and the societal consequences that entails.

These are much more complicated consequences to model and characterize in our models. Land contamination we can probably do. We can do pretty good estimates of what it takes -- what the material deposition would be, what generally it would take to remediate soil. We can put a cost on that right now and have a pretty good way to model what that land contamination will be.

But I don’t think we have a good way right now to determine what is the effect of a relocation of a population for two months, three months, four months, five months, perhaps a population that can never return to a specific area. These are very, very difficult things to model.

And if we look to a risk-based approach or risk-informed approach, these are things we need to begin to understand today, so that we can better prepare for the kinds of actions that are likely to happen in the future. While I don't think we have the ability to prevent accidents, I do think we have dramatically reduced the likelihood that there will be accidents in which we see any type of prompt fatality and any type of significant impact from a latent health exposure from direct or indirect radiation exposure.

It is the intangible health effects of displacing a population from their homes, from their friends, their families, from the schools their children attend -- those are the kinds of intangibles that we don't account for right now in our understanding of consequences.

So as we look to the future, for a risk analysis framework, if we are going to be honest about talking about the consequences, we have to figure out a way to encapsulate these ideas into our risk models. That will be very, very difficult to do. I don't think it's impossible, but it will be a significant and difficult task as we go forward.

Now, I will just close with just a few points here. I think as we look at these issues it is very important to think about ultimately, what do we want accidents to be? Do we as an industry, do we as regulators, believe that severe accidents are acceptable or not? I would say today we believe that severe accidents -- while we work to reduce them -- are unavoidable, that it may be that severe accidents will happen.

I think pre-Fukushima more people would have said, "No, I don't think severe accidents are possible." I think today, certainly in my opinion, I think that they are.

That is an interesting policy question and a policy choice that we have to tackle as a society. Do we find that as an acceptable metric? And if not, what are the things we need to do today, to work towards achieving that? And, again, this is not to say that there will likely be accidents or severe accidents. They are still very, very unlikely events.

But I think all of us today would acknowledge that we can't with certainty say that they won't happen. That there is a very, very small probability or likelihood, but there is still a severe accident possibility.

So, again, as we look to the future, I think it's important that we begin to think about these things and understand what the nuclear safety paradigm will look like in the future. Is it one in which we will do risk modeling that accounts for the consequences of severe accidents in a very different way than we do today? Will we account for the more likely consequences that we will be experiencing and consequences which to society are probably unacceptable just as prompt fatalities, significantly enhanced latent health effects would be?

If I were to look to the future, instead of looking at things like large early release frequencies and core damage frequencies, to me the metric that we are really looking at, that I think would really describe a societally acceptable consequence, is that accidents can't lead to the need for evacuation.

That is a very different risk metric than anything we have used before, but it addresses all of the uncertainties in trying to figure out how you quantify the health effects on an individual from extended relocation. How you quantify the costs for cleanup of significant areas that may have been contaminated by a severe accident.

It's just a very different approach to our risk metrics and our risk calculations. And quite frankly, it would lead to a very significant rewrite of the Commission's safety objectives and safety goals.

So, again, I'm not saying I have the answers for any of these questions right now. But I pose these for you to think about, in where we want to be 20 years into the future. If I look 20 years into the future I think I can see two different scenarios for the nuclear industry, one perhaps more active than the other.

I think there is certainly one that for the industry is probably the most ideal, and that would be 20 years from now we see -- either in operation or under construction -- a large number of small module reactors; a smaller but increasing number of generation three reactors; perhaps a number of reactors operating in 60-plus years of operation, beyond their original 40-year life in their next 20 years of operation; a geologic repository under construction, fuel in interim storage facilities throughout the country, or in a few select locations throughout the country; and a continuous process of construction of new reactors, generally of Gen Three type, and small modular reactors.

That is one vision, and that is one that is certainly possible. But what you should think about is, what is it that needs to be done today for that vision to be realized? Because there are things that would need to be done for that to be realized. And none of those things that I laid out, while I'm sure there are many of you who would dream of that as the ideal future, I'm not sure that there is any of you that would say with certainty that is where we will be in 20 years.

I will give you another scenario, which perhaps is just as plausible. In 20 years, we can see ourselves with a few unsustainable Gen Three reactors in this country. And by "unsustainable," I mean plants that have been built today, or in the next few years, that are suffering from a dwindling workforce, a lack of expertise in nuclear technology, a lack of interest in young people in going into the nuclear industry, no geologic repository, no geologic repository option in sight, and fuel sitting at decommissioned reactor sites.

And instead of a process of continuous construction of nuclear reactors, we are seeing the industry dominated by a process of continuous decommissioning, and embarking on a process and a long-term trend of continuous decommissioning.

Now, I don't think today either one of those scenarios is more or less likely than the other. But I think today there are a number of decisions about nuclear safety and actions related to nuclear safety that may move you on one of those paths versus the other path.

As I said, I perhaps am offering you more questions than there are answers. I wish I could spend more time to stay here and listen to the panels and hear the discussions that you are going to have, because I think in many ways a lot of these things are topics that you will be touching on. It looks like you have a tremendous schedule in front of you. I thank you for your attention.

IAEA SAFETY STANDARDS SERIES

Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants

SAFETY GUIDE

No. NS-G-3.2

INTERNATIONAL
ATOMIC ENERGY AGENCY
VIENNA

IAEA SAFETY RELATED PUBLICATIONS

IAEA SAFETY STANDARDS

Under the terms of Article III of its Statute, the IAEA is authorized to establish standards of safety for protection against ionizing radiation and to provide for the application of these standards to peaceful nuclear activities.

The regulatory related publications by means of which the IAEA establishes safety standards and measures are issued in the **IAEA Safety Standards Series**. This series covers nuclear safety, radiation safety, transport safety and waste safety, and also general safety (that is, of relevance in two or more of the four areas), and the categories within it are **Safety Fundamentals**, **Safety Requirements** and **Safety Guides.**

Safety Fundamentals (blue lettering) present basic objectives, concepts and principles of safety and protection in the development and application of nuclear energy for peaceful purposes.

Safety Requirements (red lettering) establish the requirements that must be met to ensure safety. These requirements, which are expressed as 'shall' statements, are governed by the objectives and principles presented in the Safety Fundamentals.

Safety Guides (green lettering) recommend actions, conditions or procedures for meeting safety requirements. Recommendations in Safety Guides are expressed as 'should' statements, with the implication that it is necessary to take the measures recommended or equivalent alternative measures to comply with the requirements.

The IAEA's safety standards are not legally binding on Member States but may be adopted by them, at their own discretion, for use in national regulations in respect of their own activities. The standards are binding on the IAEA in relation to its own operations and on States in relation to operations assisted by the IAEA.

Information on the IAEA's safety standards programme (including editions in languages other than English) is available at the IAEA Internet site

www.iaea.org/ns/coordinet

or on request to the Safety Co-ordination Section, IAEA, P.O. Box 100, A-1400 Vienna, Austria.

OTHER SAFETY RELATED PUBLICATIONS

Under the terms of Articles III and VIII.C of its Statute, the IAEA makes available and fosters the exchange of information relating to peaceful nuclear activities and serves as an intermediary among its Member States for this purpose.

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DISPERSION OF RADIOACTIVE MATERIAL IN AIR AND WATER AND CONSIDERATION OF POPULATION DISTRIBUTION IN SITE EVALUATION FOR NUCLEAR POWER PLANTS

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world''.

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FOREWORD

by Mohamed ElBaradei
Director General

One of the statutory functions of the IAEA is to establish or adopt standards of safety for the protection of health, life and property in the development and application of nuclear energy for peaceful purposes, and to provide for the application of these standards to its own operations as well as to assisted operations and, at the request of the parties, to operations under any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of nuclear energy.

The following bodies oversee the development of safety standards: the Commission for Safety Standards (CSS); the Nuclear Safety Standards Committee (NUSSC); the Radiation Safety Standards Committee (RASSC); the Transport Safety Standards Committee (TRANSSC); and the Waste Safety Standards Committee (WASSC). Member States are widely represented on these committees.

In order to ensure the broadest international consensus, safety standards are also submitted to all Member States for comment before approval by the IAEA Board of Governors (for Safety Fundamentals and Safety Requirements) or, on behalf of the Director General, by the Publications Committee (for Safety Guides).

The IAEA's safety standards are not legally binding on Member States but may be adopted by them, at their own discretion, for use in national regulations in respect of their own activities. The standards are binding on the IAEA in relation to its own operations and on States in relation to operations assisted by the IAEA. Any State wishing to enter into an agreement with the IAEA for its assistance in connection with the siting, design, construction, commissioning, operation or decommissioning of a nuclear facility or any other activities will be required to follow those parts of the safety standards that pertain to the activities to be covered by the agreement. However, it should be recalled that the final decisions and legal responsibilities in any licensing procedures rest with the States.

Although the safety standards establish an essential basis for safety, the incorporation of more detailed requirements, in accordance with national practice, may also be necessary. Moreover, there will generally be special aspects that need to be assessed on a case by case basis.

The physical protection of fissile and radioactive materials and of nuclear power plants as a whole is mentioned where appropriate but is not treated in detail; obligations of States in this respect should be addressed on the basis of the relevant instruments and publications developed under the auspices of the IAEA. Non-radiological aspects of industrial safety and environmental protection are also not explicitly considered; it is recognized that States should fulfil their international undertakings and obligations in relation to these.

The requirements and recommendations set forth in the IAEA safety standards might not be fully satisfied by some facilities built to earlier standards. Decisions on the way in which the safety standards are applied to such facilities will be taken by individual States.

The attention of States is drawn to the fact that the safety standards of the IAEA, while not legally binding, are developed with the aim of ensuring that the peaceful uses of nuclear energy and of radioactive materials are undertaken in a manner that enables States to meet their obligations under generally accepted principles of international law and rules such as those relating to environmental protection. According to one such general principle, the territory of a State must not be used in such a way as to cause damage in another State. States thus have an obligation of diligence and standard of care.

Civil nuclear activities conducted within the jurisdiction of States are, as any other activities, subject to obligations to which States may subscribe under international conventions, in addition to generally accepted principles of international law. States are expected to adopt within their national legal systems such legislation (including regulations) and other standards and measures as may be necessary to fulfil all of their international obligations effectively.

EDITORIAL NOTE

An appendix, when included, is considered to form an integral part of the standard and to have the same status as the main text. Annexes, footnotes and bibliographies, if included, are used to provide additional information or practical examples that might be helpful to the user.

The safety standards use the form 'shall' in making statements about requirements, responsibilities and obligations. Use of the form 'should' denotes recommendations of a desired option.

The English version of the text is the authoritative version.

CONTENTS

1. INTRODUCTION

BACKGROUND

1.1. The IAEA issues Safety Requirements and Safety Guides pertaining to nuclear power plants and activities in the field of nuclear energy, on the basis of its Safety Fundamentals publication on The Safety of Nuclear Installations [1]. The present Safety Guide, which supplements the Code on the Safety of Nuclear Power Plants: Siting [2][1], concerns the effects of a nuclear power plant on the surrounding region and the consideration of population distribution in the siting of a plant.

1.2. This Safety Guide makes recommendations on how to meet the requirements of the Code on the Safety of Nuclear Power Plants: Siting, on the basis of knowledge of the mechanisms for the dispersion of effluents discharged into the atmosphere and into surface water and groundwater. Relevant site characteristics and safety considerations are discussed. Population distribution, the projected population growth rate, particular geographical features, the capabilities of local transport networks and communications networks, industry and agriculture in the region, and recreational and institutional activities in the region should be considered in assessing the feasibility of developing an emergency response plan.

1.3. In the selection of a site for a facility using radioactive material, such as a nuclear power plant, account should be taken of any local features that might be affected by the facility and of the feasibility of off-site intervention, including emergency response and protective actions (see the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources [3], Appendices IV and V). This is in addition to the evaluation of any features of the site itself that might affect the safety of the facility. This Safety Guide recommends methods for the assessment of regional and local characteristics.

1.4. This Safety Guide supersedes four earlier IAEA Safety Guides, namely: Atmospheric Dispersion in Nuclear Power Plant Siting (Safety Series No. 50-SG-S3 (1980)); Site Selection and Evaluation for Nuclear Power Plants with Respect to Population Distribution (Safety Series No. 50-SG-S4 (1980)); Hydrological Dispersion of Radioactive Material in Relation to Nuclear Power Plant Siting (Safety Series No. 50-SG-S6 (1985)); and Nuclear Power Plant Siting: Hydrogeological Aspects (Safety Series No. 50-SG-S7 (1984)).

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[1] To be superseded by a Safety Requirements publication on Safety of Nuclear Power Plants: Site Evaluation, in the Safety Standards Series.

OBJECTIVE

1.5. Radioactive materials discharged from a nuclear power plant might reach the public and might contaminate the environment in the region by way of both direct and indirect pathways. The objective of this Safety Guide is to provide guidance on the studies and investigations necessary for assessing the impact of a nuclear power plant on humans and the environment. It also provides guidance on the feasibility of an effective emergency response plan, in consideration of all the relevant site features.

1.6. This Safety Guide provides guidance on investigations relating to population distribution, and on the dispersion of effluents in air, surface water and groundwater. The guidance is intended to help determine whether the site selected for a nuclear power plant satisfies national requirements and whether possible radiological exposure and hazards to the population and to the environment are controlled within the limits set by the regulatory body, with account taken of international recommendations.

SCOPE

1.7. This Safety Guide provides guidance for the site evaluation stage of a facility, specifically on:

- — the development of meteorological, hydrological and hydrogeological descriptions of a plant site;
- — programmes to collect meteorological and hydrological data (for surface water and groundwater);
- — programmes to collect data on the distribution of the surrounding population in order to demonstrate the feasibility of an effective emergency plan.

1.8. The effects of the proposed plant on the uses of land and water in the region of the site have to be investigated and are covered by this Safety Guide. This is also an aspect that should be considered in the preparation of an emergency plan and in the environmental impact assessment.

1.9. This Safety Guide does not give guidance on dose assessment in relation to the siting of a nuclear power plant. Specific guidance on the calculation of doses and for the identification of characteristics of the site that are relevant to the local and regional radiological impact of a nuclear power plant is given in Refs [4, 5].

1.10. This Safety Guide does not give detailed information on specific methods or mathematical models. Methods for calculating the concentrations and rates of deposition of radioactive material due to the dispersion of effluents in air or water are presented in Ref. [4]. Attention should be paid to the use of environmental data in conjunction with calculational models to ensure that the type of data is appropriate for the regulatory objective.

STRUCTURE

1.11. Sections 2 and 3 provide guidance on the collection of data on the dispersion of radioactive material in air and water. Sections 4 and 5 provide guidance relating to uses of land and water and to the distribution of the population in the region. Guidance on the site related information necessary for the establishment of an emergency plan is given in Section 6. Guidance on quality assurance considerations is provided in Section 7.

2. TRANSPORT AND DIFFUSION OF EFFLUENTS DISCHARGED INTO THE ATMOSPHERE

GENERAL CONSIDERATIONS

2.1. The atmosphere is a major exposure pathway by which radioactive materials that are either routinely discharged under authorization or accidentally released from a nuclear power plant could be dispersed in the environment and transported to locations where they may reach the public.

2.2. The evaluation of the transport in the atmosphere of radioactive materials discharged from a nuclear power plant under normal operational or accidental conditions is a requirement of design and licensing (Ref. [2], para. 503). A meteorological investigation should be carried out to evaluate regional and site specific meteorological parameters. These data should be collected from appropriate elevations above ground in order to obtain realistic dispersion parameters.

2.3. Contamination in the air, on the ground and in water over short and long time periods should be described in the atmospheric dispersion models, with account taken of diffusion conditions in the region. Orographic elevations having significant slopes should be considered in the models.

2.4. The type and extent of acquired and stored meteorological data should allow for reliable statistical analyses to determine the distribution of radiation exposures.

2.5. The effects and consequences for the public and the environment of short term or long term radioactive discharges should be assessed on the basis of meteorological information and site specific conditions relating to land and water uses, population distribution, infrastructure in the vicinity of the site and relevant radiological parameters.

2.6. A detailed meteorological investigation should be carried out in the region. The calculations of the dispersion and concentrations of radioactive materials should show whether the radiological consequences of routine discharges and potential accidental releases of radioactive materials into the atmosphere are acceptable. The results of these calculations may be used to establish authorized limits for radioactive discharges from the plant into the atmosphere (see Ref. [5]).

2.7. The results of the meteorological investigation should be used to confirm the suitability of a site; to provide a baseline for site evaluation; to determine whether local meteorological characteristics have altered since the site evaluation was made and before operation of the plant commences; to select appropriate dispersion models for the site; to establish limits for radioactive discharges into the atmosphere; to establish limits for design performance (for example, containment leak rates and control room habitability); and to assist in demonstrating the feasibility of an emergency plan.

RADIOACTIVE SOURCE PARAMETERS FOR NORMAL AND ACCIDENTAL DISCHARGES IN AIR

2.8. The following properties and parameters should be estimated for radioactive sources:

(a) Radioactivity:
- — the rate of discharge of each important nuclide and the total activity of each important nuclide released in a specified period;
- — variation of the rate of discharge of each important nuclide;

(b) Chemical characteristics of the material released;
(c) Physical properties of the material released;
(d) Geometry and mechanics of the discharge.

2.9. Information should be collected on the background levels of activity in air due to natural and artificial sources.

PROGRAMME FOR METEOROLOGICAL INVESTIGATION

2.10. A programme for meteorological investigation should be designed to collect and evaluate data continuously also on the following parameters during normal operation of a nuclear power plant:

— Site specific meteorological parameters relating to calculations of atmospheric dispersion and statistical analyses;
— Site specific meteorological parameters as specified in the emergency plan; and
— Site specific meteorological parameters relating to safe operation and confirmation of the design bases for the plant (see Refs [6, 7]).

2.11. The programme of meteorological measurements should provide data for an adequate time period (at least one full year) that are representative of the site before the start of plant construction, and should continue for the lifetime of the plant. In addition, the data should be compared with data collected after the plant is constructed, but before operation, to determine whether changes are necessary to the design bases or to assumptions made in the calculational model.

METEOROLOGICAL DATA NECESSARY FOR THE PROGRAMME

2.12. The meteorological data collected should be compatible in terms of their nature, scope and precision with the methods and models in which they will be used in evaluating the radiation exposure of the public and the radiological impact on the environment for assessment against each regulatory objective.

2.13. Meteorological measurements are often affected by terrain, and local features such as vegetation and ground cover, orographic features and plant structures (such as cooling towers and masts supporting meteorological sensors) as well as building wake effects may influence the representativeness of the data obtained. In collecting meteorological data, care should be taken to prevent local effects from unduly altering the values of the parameters to be measured.

2.14. In order to provide a description of the meteorological conditions, data on the following should be obtained concurrently:

— wind vectors (i.e. wind directions and speeds),
— specific indicators of atmospheric turbulence,
— precipitation,
— air temperatures,

— humidity,
— air pressure.

COLLECTION OF DATA

2.15. It should be ensured that the data collected adequately represent local meteorological conditions. Activities should be undertaken in accordance with accepted international standards. Data for at least one representative year should be presented. Information should be given to indicate the extent to which these data represent the long term meteorological characteristics of the site. This information may be obtained by comparing the local data with concurrent and long term data from synoptic meteorological stations in the surrounding area.

Siting of the meteorological measurement system

2.16. Meteorological equipment should be installed in such a way as to obtain data representing the dispersion conditions at release points. Examination of the terrain in the range of several kilometres around a nuclear power plant site is necessary. Topographical features of interest include valleys, principal ridges and coastlines. Isolated hills, wooded and forested areas and large artificial structures should be noted. Shallow valleys (less than 100 m deep and 5–10 km wide) should be considered because they can affect lower level winds. Equipment should be properly exposed and should be positioned far enough from any obstacles to minimize their effects on measurements. Ground cover and vegetation should be managed for the duration of the investigation programme, to avoid local influences.

2.17. When the site is near an international border and it is necessary to locate meteorological equipment on the territory of the neighbouring country, an agreement should be concluded for the installation and maintenance of the equipment and for the collection of data.

Wind characteristics

2.18. To gain a better understanding of atmospheric conditions at the site, the positions and settings of equipment should be selected for maximum exposure. In addition, instruments should be capable of obtaining data representing the entire profile of the wind at least up to the height of potential releases.

2.19. If the wind speed or direction does not vary significantly across the region, then the wind speed and direction at a single location representative of the site may be measured in order to obtain wind data continuously at the following levels:

— At an elevation of 10 m, for purposes of comparing and correlating wind data from the site with wind data from the synoptic network of meteorological stations; and
— At the point representing the effective height of discharge[2] (to be evaluated on the basis of preliminary information).

2.20. In other cases, measurements should be made at more than one location. For example, where the effect of sea breezes is important, data from an additional meteorological station further inland should be used in order to evaluate characteristics of the diffusion regime for the sea breeze over land.

2.21. Meteorological data should be obtained at least hourly. The averaging time and the sampling time for the data should be in accordance with the regulatory objective. Instruments should be provided for continuous recording in order to ensure that the data collected can be made readily available at the appropriate locations where they are used.

2.22. Measurements of wind parameters at additional stations should be made concurrently with measurements of other parameters.

Turbulence in the atmosphere

2.23. Fluctuations in meteorological conditions are direct indicators of atmospheric turbulence. Depending upon the model, turbulence should be indicated by the use of data relating to one or more of the following:

— Fluctuations in wind direction (sigma–theta method);
— Air temperature and temperature lapse rate (delta T method);
— Wind speed and solar radiation levels or sky cover during the daytime, and sky cover or net radiation levels at night-time (insulation method); and
— Wind speed at different heights.

2.24. For the purpose of meeting certain regulatory objectives (notably those relating to site evaluation and design), dispersion characteristics of an atmospheric layer may need to be determined by the temperature variation with height between at least two

[2] The effective height of discharge will depend on the buoyancy of the plume and on building wake effects.

measurement levels. These levels should include the level at which the wind is measured.

2.25. The frequency, duration and time of the measurements of temperature variation with height should be concomitant with the wind data. For complex meteorological situations, for example in relation to orography, measurements of turbulence indicators made at the site alone may not be sufficient. Depending on the particular characteristics of the region, it may be necessary to make additional measurements of wind and turbulence indicators a few kilometres from the site. In certain cases, normal discharges of effluents or experimental discharges of tracers are used for the development of a local diffusion model, which is often a general model with adjustments derived from air concentration values measured at the site and in the region.

2.26. In developing site specific diffusion models, sufficient information should be acquired on the space and time distributions of wind and temperature to be able to understand and determine the trajectory of effluents. Such information should be obtained by way of a programme of field measurements. This programme should be planned to be conducted in various seasons and at various times of the day in order to be representative of meteorological conditions over at least one year.

2.27. If atmospheric turbulence is determined by visual observations of sky cover at various times of the day (the insulation method), then the observations of the amount of sky cover and of the height of clouds should be combined with wind data measured concurrently at the site.

Precipitation and humidity

2.28. Precipitation should be reported at least hourly. Measurements of the intensity of precipitation and total precipitation as well as details of the type of precipitation should be used to evaluate the impact of precipitation on airborne concentrations of contaminants and on ground contamination. Data on humidity may also help to determine any effects of cooling towers (for example, icing or fogging on roadways and bridges, and effects of salt drift on vegetation). Air humidity can modify the dispersion of aerosols, as it can increase the coalescence of particulates.

INSTRUMENTATION

2.29. Meteorological instrumentation and systems should be shielded, maintained, serviced and calibrated on a regular basis in order to mitigate harmful environmental effects such as those of sun, lightning, ice, sandstorms and corrosive agents.

2.30. In assessing the accuracy of instrumentation, allowance should be made for errors due to cabling, signal conditioning, recording, solar radiation and the effects of fluctuations in environmental temperature. The accuracy and reliability of equipment should be ensured by means of a quality assurance programme including regular maintenance and inspection.

2.31. When Doppler–SODAR instrumentation is used in lieu of a tall mast to characterize wind vector measurements, a measurement system should still be maintained to record the conditions at the 10 m elevation as well as at other elevations of interest (see para. 2.15).

ANALYSIS AND PRESENTATION OF DATA

2.32. There are two basic steps in the analysis of the data:

(1) Determination of average values of the variables at regular intervals; and
(2) Statistical analysis of these average values.

2.33. The wind vector at different elevations and temperatures should be averaged at least once per hour, while for other variables such as solar radiation levels and precipitation levels the period of integration should be one hour. Wind direction should be averaged as a vector and wind speed as a scalar over the prescribed time period.

2.34. For purposes of site evaluation and design, statistical analyses should be performed to evaluate the effects of both routine discharges and accidental releases.

2.35. Depending on the requirements of the calculational model, analysis for routine discharges may necessitate a joint frequency distribution of wind direction and wind speed for each stability class (three dimensional weather statistics). For effluents subject to washout, account should also be taken of the precipitation class (four dimensional weather statistics).

2.36. Analysis of postulated accidental radioactive releases may involve the probability of occurrence of different sets of meteorological conditions during different periods of time over the duration of the accident, for example, in the first hours of the postulated accident, on the first day, over the first week and over the balance of the duration of the accident.

2.37. The information necessary to perform dose assessments for exposure to radioactive materials includes:

(a) the source term for the discharge of radioactive material to the environment and its variation in time;
(b) atmospheric, physical and physicochemical characteristics governing the transport, diffusion and suspension of radioactive materials;
(c) relevant food-chains leading to humans;
(d) characteristics of resident and transient populations, including their agricultural, industrial, recreational and institutional activities.

MODELLING OF ATMOSPHERIC DISPERSION[3]

2.38. Atmospheric dispersion models should typically be applied in site evaluation and design for nuclear power plants to meet the following objectives:

(1) To derive short term (a few hours) normalized concentrations[4] and deposition values in order to assess the probability of occurrence of high normalized concentrations and contamination levels due to postulated accidents;
(2) To derive longer term (up to one month) time integrated normalized concentrations and deposition values for postulated accidents;
(3) To derive long term (about one year) time integrated normalized concentrations and deposition values for routine operations.

These atmospheric dispersion models serve to calculate concentrations which may be applicable for normal or accidental discharges.

2.39. Once a radioactive gas or aerosol becomes airborne, it travels and disperses in a manner governed by its own physical properties and those of the ambient atmosphere into which it is discharged. The effluent enters the atmosphere with a certain velocity and temperature which are generally different from those of the ambient atmosphere. The effluent motion has a vertical component owing to the effects of vertical velocity and differences in temperature, as long as these continue. This upward rise of the effluent, termed ‘plume rise’, changes the effective height of the discharge point. The path of the effluent is affected by flow modifications near

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[3] If the publications referenced in this Safety Guide are used in the modelling of dispersion, the applicability of the model to a particular site and plant state (normal operation or accident conditions) should be verified, because these references do not directly address issues which may arise in site evaluation for nuclear power plants.

[4] The term ‘normalized concentration’ as used here means the ratio of the actual concentration to the release rate.

obstacles such as buildings and structures. The model(s) employed should account for these effects.

2.40. The effluent, while undergoing plume rise, transport and diffusion, may also be subject to processes such as the following:

(a) radioactive decay and buildup of daughter products;
(b) wet deposition:
  — rainout and/or snowout (in which vapour or aerosol is scavenged by water droplets or snowflakes in cloud and falls out as precipitation);
  — washout (in which vapour or aerosol is scavenged below the rain cloud by falling precipitation);
  — fogging (in which vapour or aerosol is scavenged by water droplets in fog);
(c) dry deposition:
  — sedimentation of aerosols or gravitational settling (for particulate diameters larger than about 10 μm);
  — impaction of aerosols and adsorption of vapours and gases onto obstacles in the path of the wind;
(d) formation and coalescence of aerosols; and
(e) resuspension of materials deposited on surfaces.

These effects can be expressed mathematically, and they should be considered in the calculational models when this is appropriate for the regulatory objective.

2.41. Calculational models for atmospheric dispersion should be chosen in accordance with the regulatory objective and, to the extent possible, site and/or plant specific characteristics should be taken into account.

2.42. Methods and mathematical equations used in the models for turbulence indicators and for the calculation of atmospheric dispersion, plume rise and effective stack height, and time integrated concentrations, as well as general procedures for evaluating dispersion and techniques for estimating resuspension of deposited materials, are discussed in Refs [4, 5]. They are not discussed in this Safety Guide.

DATA STORAGE AND DOCUMENTATION

2.43. The raw data should be stored until data qualification and statistical analysis have been performed. Hourly mean values derived from the programme for meteorological investigation should be stored for the lifetime of the facility. Data averaged over shorter periods of time (less than one hour) should be stored continuously for purposes of emergency response and recovery, as they can be used to assess the plume dispersion in the event of an accidental release.

2.44. The programme for regional meteorological investigation and all information relating to it should be documented for the purposes of site evaluation and design, and for use in emergency response plans.

3. TRANSPORT AND DIFFUSION OF EFFLUENTS DISCHARGED INTO THE HYDROSPHERE

GENERAL CONSIDERATIONS

3.1. The hydrosphere is a major exposure pathway by which radioactive materials that are routinely discharged under authorization or are accidentally released from a nuclear power plant could be dispersed to the environment and transported to locations where water is used by or for the population in the region of the site. Radionuclides are transported rapidly in some surface waters such as rivers, and very slowly in groundwater. The dispersion of discharged effluents in surface water and groundwater is discussed separately in this Section.

3.2. A detailed investigation of the hydrosphere in the region should be carried out. Calculations of dispersion and concentrations of radionuclides should be made to show whether the radiological consequences of routine discharges and potential accidental releases of radioactive materials into the hydrosphere are acceptable. The results of these calculations may be used to demonstrate compliance with the national authorized limits for discharges of radioactive effluents [5].

3.3. The information necessary to perform dose assessment relating to exposure pathways in the hydrosphere includes:

- — the source term for the discharge of radioactive material to the environment;
- — hydrological, physical, physicochemical and biological characteristics governing the transport, diffusion and retention of radioactive materials;
- — relevant food-chains leading to humans;
- — locations and amounts of water used for drinking and for industrial, agricultural and recreational purposes;

— dietary and other relevant habits of the population, including special occupational activities such as the handling of fishing gear and recreational pursuits such as water sports and fishing.

3.4. The results of the hydrospheric investigation should be used for the following purposes: to confirm the suitability of the site; to select and calibrate an appropriate dispersion model for the site; to establish limits for radioactive discharges into water; to assess the radiological consequences of releases; and to assist in demonstrating the feasibility of an emergency plan. They should also be used to develop a monitoring programme and a sampling strategy for use in the event of an accidental radioactive release.

RADIOACTIVE SOURCE PARAMETERS FOR NORMAL OR ACCIDENTAL DISCHARGES TO SURFACE WATER AND GROUNDWATER

3.5. The following properties and parameters should be estimated for radioactive discharges:

(a) Radioactivity:
   - — the rate of discharge of each important nuclide, and an estimate of the total activity discharged in a specific period and its fixation capacity on soils;

(b) Chemical properties, including:
   - — important anion and cation concentrations, and their oxidation states and complexing states (e.g. Ca^{2+}, K^+, Mg^{2+}, Na^+, NH_4^+, HCO_3^-, Cl^-, SO_4^-, NO_2^-, NO_3^-, PO_4^-);
   - — organic content;
   - — pH;
   - — the concentration of dissolved oxygen, and conductivity and concentrations of associated pollutants;

(c) Physical properties of the liquid effluents discharged, including:
   - — temperature;
   - — density;
   - — loads and granulometry of suspended solids;

(d) Flow rates for continuous discharges, or volume and frequency for batch discharges;

(e) The variation of the source term over the duration of the discharge, which is necessary to evaluate the concentrations due to long term releases;

(f) The geometry and mechanics of discharges.

3.6. Any airborne radioactive material deposited on the ground surface or on surface water may be transmitted by infiltration processes into groundwater. The potential for indirect contamination in surface water and possible contamination of groundwater from the surface should be assessed.

MONITORING PROGRAMME FOR SURFACE WATER AND GROUNDWATER

3.7. A monitoring programme should be established for both surface water and groundwater. The purpose of such a programme is to provide a baseline for site evaluation and to determine whether the hydrological characteristics of the region have altered since the site evaluation and before the commencement of plant operation.

3.8. The monitoring programme for groundwater should be initiated about two years before the start of plant construction. The site area should be monitored before the foundation work is begun in order to verify possible changes in the groundwater regime, and monitoring should be continued after construction has finished.

3.9. Groundwater is monitored by means of samples taken from boreholes and wells. The samples can also be taken from groundwater reaching the surface in springs or in natural depressions. The monitoring programme should be continued throughout the lifetime of the plant. Boreholes and wells should be kept in an operable state for the same period of time.

3.10. The monitoring programme for surface water should also commence well before the start of construction of the plant, and should continue for its lifetime.

3.11. All surface water and groundwater in the site region should be sampled regularly, at intervals that will depend on the half-lives of the radionuclides that could potentially be discharged.

SURFACE WATER

Necessary data

3.12. The data necessary for the surface hydrological analysis for a nuclear power plant site come from different sources. The existing hydrometeorological network usually provides sufficient data. These, however, should be verified before being used.

3.13. The data needs presented herein relate to standard calculational methods. For advanced models, the data needs depend on the model being used to satisfy the relevant regulatory objectives. Specific parameters necessary in the models for assessing the aquatic environmental transfer of radionuclides are discussed in Refs [4, 5].

3.14. Typical water bodies in the vicinity of a nuclear power plant range from rivers, estuaries, open shores of large lakes, seas and oceans to human made impoundments. The collection of hydrological data for sites on different types of water bodies is discussed in the following.

Sites on rivers

3.15. For sites on rivers, the hydrological and other information should cover the following:

(a) The channel geometry, defined by the mean width, the mean cross-sectional area and the mean slope over the river reaches of interest (the water level can be computed from the channel geometry and the river flow rate). If there are important irregularities such as dead zones or hydraulic equipment in the stream which could influence the dispersion of the plume, they should be described. Additional downstream measurements of channel geometry should be made as necessary to assess the dispersion process over the river reaches of interest.
(b) The river flow rate, presented as monthly averages of the inverse of daily flows. The inverse rate of flow is used since the fully mixed concentration is proportional to the reciprocal of the flow rate if sediment sorption effects are not considered. The flow rates of other relevant and important water bodies (such as downstream tributaries of the river) should be measured if they affect dispersion.
(c) Extremes in the flow rate evaluated from available historical data.
(d) Temporal variation of the water level over the reaches of interest.
(e) Tidal variations in water level and flow rate in the case of a tidal river.
(f) Data to describe possible interactions between river water and groundwater, and the identification of those reaches of the channel where the river may gain water from or lose water to groundwater.
(g) River temperature, measured at a representative location over at least an entire year and expressed as monthly averages of daily temperatures.
(h) The thickness of the top layer if thermal stratification of water in the river occurs.
(i) Extreme temperatures evaluated from available historical data.
(j) The concentrations of suspended matter measured:
   — at locations downstream of sections where the river is slowed, depleted or fed by tributaries;

— on discrete samples at appropriate intervals (such as every two months for at least an entire year);
— over a sufficient range of flows to establish curves of flow versus sedimentation and/or erosion rate;

(k) The characteristics of deposited sediments, including mineral and/or organic compositions and size classification;
(l) The distribution coefficients for sediments and for suspended matter for the various radionuclides that may be discharged;
(m) The background levels of activity in water, sediment and aquatic food due to natural and artificial sources;
(n) Seasonal cycles of phytoplankton and zooplankton, with at least the periods of their presence and cyclical evolutions of their biomass;
(o) Spawning periods and feeding cycles of major fish species.

Sites on estuaries

3.16. For sites on estuaries, the following information should be collected:

(a) The salinity distribution determined along several verticals covering different cross-sections of the salinity intrusion zone. The data should be sufficient to delineate the flow pattern, which is directed towards the estuary mouth in the upper layer and towards the inner reaches in the lower layer of a fully or partially mixed estuary.
(b) Evaluations of sediment displacements, the load of suspended matter, the rate of buildup of deposited sediment layers and the movement of these sediments with the tide.
(c) Channel characteristics sufficiently upstream of the site to model the maximum upstream travel of radioactive effluents if applicable.
(d) The distribution coefficients for sediments and for suspended matter for the various radionuclides that may be discharged.
(e) The background levels of activity in water, sediment and aquatic food due to natural and artificial sources.
(f) Seasonal cycles of phytoplankton and zooplankton, with at least the periods of their presence and cyclical evolutions of their biomass.
(g) Spawning periods and feeding cycles of major fish species.

3.17. Measurements of water temperature, salinity and other relevant water quality parameters in estuaries should be made at appropriate depths, distances and times, depending on the river flow, tidal levels and the configuration of the water body in different seasons.

Sites on the open shores of large lakes, seas and oceans

3.18. For sites located on the shores of large lakes, seas and oceans, the hydrological information should include the following:

(a) The general shore and bottom configuration in the region, and unique features of the shoreline in the vicinity of the discharge. Data on bathymetry out to a distance of several kilometres, and data on the amount and character of sediments in the shallow shelf waters.
(b) Speeds, temperatures and directions of any near shore currents that could affect the dispersion of discharged radioactive material. Measurements should be made at appropriate depths and distances, depending on the bottom profile and the location of the point of discharge.
(c) The duration of stagnation and characteristics of current reversals. After a stagnation, a reversal in current usually leads to a large scale mass exchange between inshore and offshore waters that effectively removes pollutants from the shore zone.
(d) The thermal stratification of water layers and its variation with time, including the position of the thermocline and its seasonal changes.
(e) The load of suspended matter, sedimentation rates and sediment distribution coefficients, including data on sediment movements characterized by defining at least the areas of high rates of sediment accumulation.
(f) The background levels of activity in water, sediment and aquatic food due to natural and artificial sources.
(g) Seasonal cycles of phytoplankton and zooplankton, with at least the periods of their presence and cyclical evolutions of their biomass.
(h) Spawning periods and feeding cycles of major fish species.

Sites on human made impoundments

3.19. For sites on impoundments, the hydrological information should include the following:

(a) Parameters of the impoundment geometry, including length, width and depth at different locations;
(b) Rates of inflow and outflow;
(c) Expected fluctuations in water level on a monthly basis;
(d) The water quality at inflows, including temperature and suspended solids;
(e) Data on thermal stratification and its seasonal variation for relevant water bodies;
(f) Interaction with groundwater;

(g) Characteristics of bottom sediments (type and quantity);
(h) The distribution coefficients for sediments and for suspended matter for the various radionuclides that may be discharged;
(i) The rate of sediment deposition;
(j) The background levels of activity in water, sediment and aquatic food due to natural and artificial sources;
(k) Seasonal cycles of phytoplankton and zooplankton, with at least the periods of their presence and cyclical evolutions of their biomass;
(l) Spawning periods and feeding cycles of major fish species.

Modelling of radionuclide dispersion in surface water

3.20. Many models are available to calculate the dispersion in surface waters of material originating from routine discharges and accidental releases [4, 5]. Advanced models should be used for particularly complex conditions (see footnote 3).

3.21. The three basic groups of models are the following:

(1) Advanced calculational models transform the basic equations of radionuclide dispersion into finite difference or finite element form. Such models permit most of the relevant physical phenomena to be taken into account in the analysis.
(2) Box type models treat the entire body of water, or sections thereof, as composed of homogeneous compartments. In this type of model, average concentrations are computed for each compartment and transfer constants are set up to relate the variables for one compartment to those in adjacent compartments. Most models dealing with the interactions between radionuclides and sediment are of this type.
(3) Calculational models solve the basic equations describing radionuclide transport with major simplifications made for the geometry of the water body and the dispersion coefficients. This group of models is the one most frequently used in surface hydrological analysis.

In addition, Monte Carlo methods may be used to model water body geometry and to simulate particles.

3.22. Standard calculational models drawn from groups 2 and 3 above are commonly used in the site evaluation for a nuclear power plant. The selection of a model should be based on the type of discharge (surface or submerged), the type of water body (river, estuary, impoundment, large lake or ocean) and the use being made of the water. The magnitude of the source term under normal operation and potential accident conditions, the required accuracy and the type of water affected should be considered in the selection of the model.

3.23. The results from a calculational model should be compared with laboratory data or field data for a specific site. Such validation usually has a limited range of applicability, which should be determined with a full understanding of the model.

GROUNDWATER

General considerations

3.24. A discharge of radioactive material from a nuclear power plant may contaminate the groundwater system in the region either directly or indirectly, via earth, atmosphere or surface water, in the following three ways:

(1) Indirect discharge to the groundwater through seepage and infiltration of surface water that has been contaminated by radioactive material discharged from the nuclear power plant;
(2) Infiltration into the groundwater of radioactive liquids from a storage tank or reservoir;
(3) Direct release from a nuclear power plant; an accident at the plant might induce such an event, and radioactive material could penetrate into the groundwater system. The protection of aquifers from such events should be considered in the safety analysis for postulated accident conditions, and a geological barrier to provide protection should be considered.

3.25. The evaluation of hydrogeological characteristics should determine the following:

— the estimated concentration of radioactive material in groundwater at the nearest point in the region where groundwater is drawn for human consumption;
— the transport paths and travel times for radioactive material to reach the source of consumption from the point of release;
— the transport capacity of the surface flow, interflow and groundwater recharge;
— the susceptibility to contamination of the aquifers at different levels; and
— time and space distributions of the concentrations in the groundwater of radioactive material resulting from accidental releases from the plant.

DATA NECESSARY FOR INVESTIGATIONS OF GROUNDWATER

3.26. Hydrogeological investigation in the framework of site evaluation for a nuclear power plant involves regional and local investigations using comparatively standard surface geophysical surveys and programmes for drilling boreholes for geophysical and tracer studies.

Regional and local hydrogeological information

3.27. Both local and regional information should be collected to identify the hydrogeological system and the preferential flow paths. The information to be collected should include:

- — climatological data;
- — initial concentrations of radionuclides;
- — major hydrogeological units, their hydrodynamic parameters and the ages or mean turnover times of groundwater;
- — recharge and discharge relationships;
- — data on surface hydrology.

Climatological data

3.28. In regions where rainfall makes a substantial contribution to groundwater, hydrometeorological data on seasonal and annual rainfall and on evapotranspiration that have been systematically collected should be analysed for as long a period as they are available. From meteorological (precipitation) data, groundwater recharge should be calculated. Alternatively, tracers (chemical or isotopic) of the water cycle could be introduced to calculate groundwater recharge.

Major hydrogeological units

3.29. Data should be obtained on the types of the various geological formations in the region and their stratigraphic distribution in order to characterize the regional system and its relationship with the local hydrogeological units.

3.30. The geology and surface hydrology of the site area should be studied in sufficient detail to indicate potential pathways of contamination to surface water or groundwater. Any surface drainage system or standing water body accessible from a potential release point in an accident should be identified. Areas from which contaminated surface water can directly enter an aquifer should be determined. The relevant hydrogeological information for surface or near surface discharges includes information on soil moisture properties, infiltration rates, configuration of unsaturated zones and chemical retention properties under unsaturated conditions.

3.31. For consideration of the transport potential of seepage and groundwater in the region of the site (a few tens of kilometres in radius), data on types of aquifers, aquitards and aquicludes, their interconnections and the flow velocities and mean turnover times should be investigated. Such data will permit the regional flow pattern and its relation to the local flow pattern of seepage and groundwater to be characterized. This investigation should include the following data:

— Geological data: lithology, thickness, extent, degree of homogeneity and degree of surface weathering of the geological units;
— Hydrogeological data: hydraulic functions of the unsaturated zone, and hydraulic conductivities and transmissivities, specific yield and storage coefficients, dispersion parameters, and hydraulic gradients of the saturated zone for each geological unit;
— Depth related water ages and mean turnover times;
— Interconnections between aquifers and aquitards without and with groundwater usage;
— The chemical composition of groundwater from the respective aquifers and aquitards in comparison with their lithology;
— Physical properties of the groundwater, especially temperatures, gas contents and density;
— Variations of water levels in wells and mining shafts and in the discharges of springs and rivers;
— Locations of active and potential sink holes in the region.

Water bearing characteristics of the hydrogeological units

3.32. Information on the water bearing characteristics of the main hydrogeological units should be collected, including information on the following properties:

— moisture content;
— porosity and bulk density;
— specific yield for unconfined aquifers and storage coefficients for confined aquifers;
— hydraulic conductivity or permeability;
— transmissivity for fully saturated confined aquifers.

3.33. For the relevant hydrogeological units, information should be collected on the following chemical and physical properties of the groundwater:

— concentrations and oxidation and complexing states of important anions and cations, and their presence in organic compounds;
— contents of organic and biological material;
— pH;
— Eh;
— temperature;
— sorption characteristics.

Interrelationship between groundwater and surface water

3.34. The extent and degree of hydraulic connections between bodies of surface water and groundwater should be identified. Topographic and geological maps should be studied in order to identify lines or areas where such hydraulic connections between surface water and groundwater are present. The amounts of the exchanges should be estimated and their corresponding exchange regimes should be determined.

Modelling of dispersion and retention of radionuclides in groundwater

3.35. Models have been developed to calculate the dispersion and retention of radionuclides released into groundwater. Standard calculational models are generally satisfactory and should be used in most cases. The complexity of the model chosen should reflect the complexity of the hydrogeological system at a particular site.

3.36. Simplified evaluations should be performed with conservative assumptions and data to evaluate the effects of postulated accidental releases of radioactive material to the groundwater. Further, more refined analysis with more realistic assumptions and models should be performed if necessary.

3.37. The direction of groundwater movement and of radionuclide transport is in general orthogonal to the contours at groundwater level. Where this is the case, the standard calculational models should be applied. If aquifers are strongly anisotropic, and water and transported effluents can move over a limited domain through fractures, most calculational models are not valid. Field studies including tracer studies may be necessary and should be considered.

3.38. The analytical models for radionuclide transport in groundwater have several sources of uncertainty. The model used should be validated for each specific application. Validated hydrogeological models that would apply for characteristics similar to those of the site should be considered as a reference for purposes of comparison.

3.39. The documentation generated in a monitoring programme for surface water and groundwater should follow the recommendations made in Section 7.

4. USES OF LAND AND WATER IN THE REGION OF THE SITE

4.1. The operation of a nuclear power plant may affect the population in the surrounding area and the local and regional environment. As part of the environmental impact assessment for the site, the uses of land and water should be investigated. The characteristics of the land and water utilized in the region should also be considered in demonstrating the feasibility of the emergency response plan.

4.2. The investigations should cover:

(a) land devoted to agricultural uses, its extent, and the main crops and their yields;
(b) land devoted to dairy farming, its extent and yields;
(c) land devoted to industrial, institutional and recreational purposes, its extent and the characteristics of its use;
(d) bodies of water used for commercial, individual and recreational fishing, including details of the aquatic species fished, their abundance and yield;
(e) bodies of water used for commercial purposes, including navigation, community water supply, irrigation, and recreational purposes such as bathing and sailing;
(f) land and bodies of water supporting wildlife and livestock;
(g) direct and indirect pathways for potential radioactive contamination of the food-chain;
(h) products imported to or exported from the region which may form part of the food-chain;
(i) free foods such as mushrooms, berries and seaweed.

4.3. Present uses of water which could be affected by changes in the water temperature and by radioactive material discharged from a nuclear power plant, together with the location, nature and extent of usage, should be identified. Changes in uses of water in the region, such as for irrigation, fishing and recreational activities, should also be considered.

4.4. Special consideration should be given to any population centres for which drinking water is obtained from water bodies that may be affected by a nuclear power plant. To the extent possible, future water flow and water uses should be projected over the lifetime of the plant. This may lead to a change in the critical group of the population[5].

4.5. For areas where drinking water is obtained from springs, wells or any other source of groundwater, the movement and quality of the groundwater should be studied.

4.6. The data on different water uses should include data on the following:

(a) For water used for drinking by humans and animals, and for municipal and industrial purposes:
- average and maximum rates of water intake by users;
- distance of the intake from the potential source of radioactive discharges;
- mode of water consumption;
- number of water users.

(b) For water used for irrigation:
- rate of water use;
- area of irrigated land;
- types and yields of agricultural products, and their usual consumers.

(c) For water used for fishing:
- the aquatic species fished, and their abundance and yields in water used for commercial, individual and recreational fishing.

(d) For water used for recreational purposes:
- the number of persons engaging in swimming, boating and other recreational uses, and the time spent on these activities.

4.7. These investigations should cover a reasonably large area in the site region. If a nuclear power plant is located on a river bank, users downstream from the site should be identified. If the site is near a lake, all users of the lake should be identified. If a site is on an ocean coast, users of the sea out to a few tens of kilometres in all directions should be identified.

4.8. Information should be collected on levels of background activity for environmentally relevant substances such as soils, and for vegetables and other foodstuffs.

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[5] The critical group is a group of members of the public which is reasonably homogeneous with respect to its exposure for a given radiation source and given exposure pathway and is typical of individuals receiving the highest effective dose or equivalent dose (as applicable) by the given exposure pathway from the given source.

5. POPULATION DISTRIBUTION

5.1. The distribution and characteristics of the regional population should be studied in the site evaluation for a nuclear power plant. The purposes of the studies should be:

— to evaluate the potential radiological impacts of normal radioactive discharges and accidental releases; and
— to assist in the demonstration of the feasibility of the emergency response plan.

5.2. When a site is near a State's national border, there should be appropriate co-operation with neighbouring countries in the vicinity of the nuclear power plant. Efforts should be made to exchange relevant information. Information relating to the plant should be provided on request to neighbouring countries to permit any potential impacts of the plant on their territory to be evaluated.

5.3. The external zone includes an area immediately surrounding the site of a nuclear power plant in which population distribution, population density, population growth rate, industrial activity, and land and water uses are considered in relation to the feasibility of implementing emergency measures.

5.4. The term 'present population' includes the two categories of permanent population and temporary population. Data on the present population in the external zone should be obtained from local authorities or by means of special field surveys, and these data should be as accurate and as up to date as possible. Similar data should also be collected throughout the region outside the external zone to distances determined in accordance with national practice and regulatory objectives. The data should include the number of people normally present in the area, and the locations of houses, hospitals, prisons and other institutions and recreational facilities such as parks and marinas.

5.5. Information on the permanent population of the region and its distribution should include information on occupation, places of work, means of communication and typical diet of the inhabitants. If a city or town in the region is associated with a major industrial facility, this should be considered.

5.6. The information on the temporary population should cover:

— the short term transient population, such as tourists and nomads; and
— the long term transient population, such as seasonal inhabitants and students.

5.7. The maximum size of the temporary population and its periods of occupancy in the external zone should be estimated. Particular types of institutions such as schools, hospitals, prisons and military bases within the external zone should be identified for the purposes of emergency planning. In the area outside the external zone, estimates of the approximate size of the temporary population together with its periods of occupancy should be made.

5.8. A projection of the present population in the region should be made for:

— the expected year of commissioning of the plant;
— selected years (e.g. every tenth year) over the lifetime of the plant.

5.9. Projections should be made on the basis of population growth rate, migration trends and plans for possible development in the region. The projected figures for the two categories of permanent population and temporary population should be extrapolated separately if data are available.

5.10. Data should be analysed to give both the current and the projected population distribution in terms of direction and distance from the plant.

5.11. The critical group associated with each nuclear power plant should be identified. Critical groups of the population (see footnote 5) with particular dietary habits and specific locations for particular types of activity in the region should be considered. The persons in the critical group may be located beyond national borders.

5.12. The population data collected should be presented in a suitable format and scale to permit their correlation with other relevant data, such as data on atmospheric dispersion and on uses of land and water. The two categories of permanent population and temporary population should be clearly indicated. In general, population data should be presented either in tabular form, or graphically, using concentric circles and radial segments with the site as the origin. More details should be given for areas closer to the site, especially within the external zone.

Considerations relating to radiological exposure

5.13. The results of the study on the characteristics and distribution of the population, together with results obtained in respect of the dispersion of radioactive material discharged into air, surface water and groundwater, should be used in demonstrating that, for a proposed site and design and for normal operations, the radiological exposure of the population in the region remains as low as reasonably achievable and, in any case, will be within the limits set in the national requirements and those established in the Basic Safety Standards (Ref. [3]), even for the critical groups mentioned in para. 5.11.

5.14. Information similar to that mentioned in para. 5.13 should be used to demonstrate also that, on the selected site, the radiological risk to the population that may result from accident states at the plant, including those which may lead to the implementation of emergency measures, is acceptably low and in accordance with national requirements, account being taken of international recommendations.

5.15. If, after thorough evaluation, it is shown that appropriate measures to comply with the national regulatory requirements cannot be devised, and the engineered safety features of the plant cannot be further improved, the site should be deemed unsuitable for a nuclear power plant of the type proposed.

6. CONSIDERATION OF THE FEASIBILITY OF AN EMERGENCY PLAN

6.1. Before final approval of a nuclear power plant site, the feasibility of an emergency plan should be demonstrated. There should be no adverse site conditions which could hinder the sheltering or evacuation of the population in the region or the ingress or egress of external services needed to deal with an emergency.

6.2. The feasibility of an emergency plan should be demonstrated for the nuclear power plant on the basis of site specific natural and infrastructural conditions in the region. In this context, infrastructure means transport and communications networks, industrial activities and, in general, anything that may influence the rapid and free movement of people and vehicles in the region of the site. Other information on the region, such as information on the availability of sheltering, the systems for the collection and distribution of milk and other agricultural products, special population groups such as those resident in institutions (for example, hospitals and prisons), industrial facilities, and environmental conditions such as the range of weather conditions, should be collected for demonstrating the feasibility of an emergency plan.

6.3. Many site related factors should be taken into account in demonstrating the feasibility of an emergency plan. The most important ones are:

— population density and distribution in the region;

— distance of the site from population centres;
— special groups of the population who are difficult to evacuate or shelter, such as people in hospitals or prisons, or nomadic groups;
— particular geographical features such as islands, mountains and rivers;
— characteristics of local transport and communications networks;
— industrial facilities which may entail potentially hazardous activities;
— agricultural activities that are sensitive to possible discharges of radionuclides; and
— possible concurrent external events.

6.4. The presence of large populations in the region or the proximity of a city to the nuclear power plant site may diminish the effectiveness and viability of an emergency plan. In addition, the specific circumstances of any special groups of the population should be recognized and taken into account. The presence of any residents whose evacuation route would necessarily pass near the nuclear power plant may lead to the rejection of a site if no other emergency measure can overcome this difficulty.

6.5. Disastrous external events or foreseeable natural phenomena such as fog or snow may have consequences that can limit the effectiveness of any response to an accident at a nuclear power plant. For example, an event may result in a problem with the infrastructure or in damage to sheltering facilities. In order to ensure that the population in the region can be sheltered and evacuated effectively, consideration should be given to the provision of backup facilities and alternative routes.

6.6. If, upon evaluating the aforementioned factors and their possible consequences, it is determined that no viable emergency plan can be established, then the proposed site should be considered unacceptable.

6.7. It is possible that conditions assessed for the purposes of approval of the site and design will change over time. The site related factors considered in the emergency plan, such as infrastructural developments, should be reviewed periodically during the operational phase of the plant.

6.8. Detailed guidance on emergency planning is available in other IAEA publications [8–11].

7. QUALITY ASSURANCE PROGRAMME

7.1. A quality assurance (QA) programme should be established to cover all the activities recommended in this Safety Guide.

7.2. The process of site evaluation includes the conduct of scientific and engineering analyses and the exercise of judgement. The data used in the analyses and in making judgements should be as complete and as reliable as possible. Data should be collected in a systematic manner and should be evaluated by technically qualified and experienced personnel. The QA programme for site evaluation is part of the overall QA programme for a nuclear power plant (see Ref. [12], Code and Safety Guide QA1).

7.3. All the investigatory programmes and other studies recommended in this Safety Guide, together with the necessary data and information, should be documented for the purposes of site evaluation.

7.4. In order for data to be collected, recorded and retained throughout the lifetime of the plant, the media for recording and storing data should be checked periodically to verify their compatibility with the technology in use (both hardware and software).

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Sendai Framework for Disaster Risk Reduction 2015 - 2030

United Nations

Sendai Framework for Disaster Risk Reduction **2015-2030**

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Foreword

The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted at the Third UN World Conference in Sendai, Japan, on March 18, 2015. It is the outcome of stakeholder consultations initiated in March 2012 and inter-governmental negotiations from July 2014 to March 2015, supported by the United Nations Office for Disaster Risk Reduction at the request of the UN General Assembly.

The Sendai Framework is the successor instrument to the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters. The HFA was conceived to give further impetus to the global work under the International Framework for Action for the International Decade for Natural Disaster Reduction of 1989, and the Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and its Plan of Action, adopted in 1994 and the International Strategy for Disaster Reduction of 1999.

The Sendai Framework is built on elements which ensure continuity with the work done by States and other stakeholders under the HFA and introduces a number of innovations as called for during the consultations and negotiations. Many commentators have identified the most significant shifts as a strong emphasis on disaster risk management as opposed to disaster management, the definition of seven global targets, the reduction of disaster risk as an expected outcome, a goal focused on preventing new risk, reducing existing risk and strengthening resilience, as well as a set of guiding principles, including primary responsibility of states to prevent and reduce disaster risk, all-of-society and all-of-State institutions engagement. In addition, the scope of disaster risk reduction has been broadened significantly to focus on both natural and man-made hazards and related environmental, technological and biological hazards and risks. Health resilience is strongly promoted throughout.

The Sendai Framework also articulates the following: the need for improved understanding of disaster risk in all its dimensions of exposure, vulnerability and hazard characteristics; the strengthening of disaster risk governance, including national platforms; accountability for disaster risk management; preparedness to "Build Back Better"; recognition of stakeholders and their roles; mobilization of risk-sensitive investment to avoid the creation of new risk; resilience of health infrastructure, cultural heritage and work-places; strengthening of international cooperation and global partnership, and risk-informed donor policies and programs, including financial support and loans from international financial institutions. There is also clear recognition of the Global Platform for Disaster Risk Reduction and the regional platforms for disaster risk reduction as mechanisms for coherence across agendas, monitoring and periodic reviews in support of UN Governance bodies.

UNISDR has been tasked to support the implementation, follow-up and review of the Sendai Framework.

Margareta Wahlström,

United Nations Special Representative of
the Secretary-General for Disaster Risk Reduction

Sendai Framework for Disaster Risk Reduction 2015-2030

Contents

I. Preamble

1. The Sendai Framework for Disaster Risk Reduction 2015–2030 was adopted at the Third United Nations World Conference on Disaster Risk Reduction, held from 14 to 18 March 2015 in Sendai, Miyagi, Japan, which represented a unique opportunity for countries:

(a) To adopt a concise, focused, forward-looking and action-oriented post 2015 framework for disaster risk reduction;

(b) To complete the assessment and review of the implementation of the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters;[1]

(c) To consider the experience gained through the regional and national strategies/institutions and plans for disaster risk reduction and their recommendations, as well as relevant regional agreements for the implementation of the Hyogo Framework for Action;

(d) To identify modalities of cooperation based on commitments to implement a post 2015 framework for disaster risk reduction;

(e) To determine modalities for the periodic review of the implementation of a post 2015 framework for disaster risk reduction.

2. During the World Conference, States also reiterated their commitment to address disaster risk reduction and the building of resilience[2] to disasters with a renewed sense of urgency within the context of sustainable development and poverty eradication, and to integrate, as appropriate, both disaster risk reduction and the building of resilience into policies, plans, programmes and budgets at all levels and to consider both within relevant frameworks.

Hyogo Framework for Action: lessons learned, gaps identified and future challenges

3. Since the adoption of the Hyogo Framework for Action in 2005, as documented in national and regional progress reports on its implementation as well as in other global reports, progress has been achieved in reducing disaster risk at local, national, regional and global levels by countries and other relevant stakeholders, leading to a decrease in mortality in the case of some hazards.[3] Reducing disaster risk is a cost-effective investment in preventing future losses. Effective disaster risk management contributes to sustainable development. Countries have enhanced their capacities in disaster risk management. International mechanisms for strategic advice, coordination and partnership development for disaster risk reduction, such as the Global Platform for Disaster Risk Reduction and the regional platforms for disaster risk reduction, as well as other relevant international and regional forums for cooperation, have been instrumental in the development of policies and strategies and the advancement of knowledge and mutual learning. Overall, the Hyogo Framework for Action has been an important instrument for raising public and institutional awareness, generating political commitment and focusing and catalysing actions by a wide range of stakeholders at all levels.

1. A/CONF.206/6 and Corr.1, chap. I, resolution 2.

2. Resilience is defined as: "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions", United Nations Office for Disaster Risk Reduction (UNISDR), "2009 UNISDR Terminology on Disaster Risk Reduction", Geneva, May 2009 (http://www.unisdr.org/we/inform/terminology).

3.Hazard is defined in the Hyogo Framework for Action as: "A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards).

4. Over the same 10 year time frame, however, disasters have continued to exact a heavy toll and, as a result, the well-being and safety of persons, communities and countries as a whole have been affected. Over 700 thousand people have lost their lives, over 1.4 million have been injured and approximately 23 million have been made homeless as a result of disasters. Overall, more than 1.5 billion people have been affected by disasters in various ways, with women, children and people in vulnerable situations disproportionately affected. The total economic loss was more than $1.3 trillion. In addition, between 2008 and 2012, 144 million people were displaced by disasters. Disasters, many of which are exacerbated by climate change and which are increasing in frequency and intensity, significantly impede progress towards sustainable development. Evidence indicates that exposure of persons and assets in all countries has increased faster than vulnerability[4] has decreased, thus generating new risks and a steady rise in disaster-related losses, with a significant economic, social, health, cultural and environmental impact in the short, medium and long term, especially at the local and community levels. Recurring small-scale disasters and slow-onset disasters particularly affect communities, households and small and medium-sized enterprises, constituting a high percentage of all losses. All countries – especially developing countries, where the mortality and economic losses from disasters are disproportionately higher – are faced with increasing levels of possible hidden costs and challenges in order to meet financial and other obligations.

5. It is urgent and critical to anticipate, plan for and reduce disaster risk in order to more effectively protect persons, communities and countries, their livelihoods, health, cultural heritage, socioeconomic assets and ecosystems, and thus strengthen their resilience.

6. Enhanced work to reduce exposure and vulnerability, thus preventing the creation of new disaster risks, and accountability for disaster risk creation are needed at all levels. More dedicated action needs to be focused on tackling underlying disaster risk drivers, such as the consequences of poverty and inequality, climate change and variability, unplanned and rapid urbanization, poor land management and compounding factors such as demographic change, weak institutional arrangements, non-risk-informed policies, lack of regulation and incentives for private disaster risk reduction investment, complex supply chains, limited availability of technology, unsustainable uses of natural resources, declining ecosystems, pandemics and epidemics. Moreover, it is necessary to continue strengthening good governance in disaster risk reduction strategies at the national, regional and global levels and improving preparedness and national coordination for disaster response, rehabilitation and reconstruction, and to use post-disaster recovery and reconstruction to "Build Back Better", supported by strengthened modalities of international cooperation.

7. There has to be a broader and a more people-centred preventive approach to disaster risk. Disaster risk reduction practices need to be multi-hazard and multisectoral, inclusive and accessible in order to be efficient and effective. While recognizing their leading, regulatory and coordination role, Governments should engage with relevant stakeholders, including women, children and youth, persons with disabilities, poor people, migrants, indigenous peoples, volunteers, the community of practitioners and older persons in the design and implementation of policies, plans and standards. There is a need for the public and private sectors and civil society organizations, as well as academia and scientific and research institutions, to work more closely together and to create opportunities for collaboration, and for businesses to integrate disaster risk into their management practices.

8. International, regional, subregional and transboundary cooperation remains pivotal in supporting the efforts of States, their national and local authorities, as well as communities and businesses, to reduce disaster risk. Existing mechanisms may require strengthening in order to provide effective support and achieve better implementation. Developing countries, in particular the least developed countries, small island developing States, landlocked developing countries and African countries, as well as middle-income countries facing specific challenges, need special attention and support to augment domestic resources and capabilities through bilateral and multilateral channels in order to ensure adequate, sustainable, and timely means of implementation in capacity-building, financial and technical assistance and technology transfer, in accordance with international commitments.

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4. Vulnerability is defined in the Hyogo Framework for Action as: "The conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards".

9. Overall, the Hyogo Framework for Action has provided critical guidance in efforts to reduce disaster risk and has contributed to the progress towards the achievement of the Millennium Development Goals. Its implementation has, however, highlighted a number of gaps in addressing the underlying disaster risk factors, in the formulation of goals and priorities for action,[5] in the need to foster disaster resilience at all levels and in ensuring adequate means of implementation. The gaps indicate a need to develop an action-oriented framework that Governments and relevant stakeholders can implement in a supportive and complementary manner, and which helps to identify disaster risks to be managed and guides investment to improve resilience.

10. Ten years after the adoption of the Hyogo Framework for Action, disasters continue to undermine efforts to achieve sustainable development.

11. The intergovernmental negotiations on the post 2015 development agenda, financing for development, climate change and disaster risk reduction provide the international community with a unique opportunity to enhance coherence across policies, institutions, goals, indicators and measurement systems for implementation, while respecting the respective mandates. Ensuring credible links, as appropriate, between these processes will contribute to building resilience and achieving the global goal of eradicating poverty.

12. It is recalled that the outcome document of the United Nations Conference on Sustainable Development, held in 2012, entitled "The future we want",[6] called for disaster risk reduction and the building of resilience to disasters to be addressed with a renewed sense of urgency in the context of sustainable development and poverty eradication and, as appropriate, to be integrated at all levels. The Conference also reaffirmed all the principles of the Rio Declaration on Environment and Development.[7]

13. Addressing climate change as one of the drivers of disaster risk, while respecting the mandate of the United Nations Framework Convention on Climate Change,[8] represents an opportunity to reduce disaster risk in a meaningful and coherent manner throughout the interrelated intergovernmental processes.

14. Against this background, and in order to reduce disaster risk, there is a need to address existing challenges and prepare for future ones by focusing on monitoring, assessing and understanding disaster risk and sharing such information and on how it is created; strengthening disaster risk governance and coordination across relevant institutions and sectors and the full and meaningful participation of relevant stakeholders at appropriate levels; investing in the economic, social, health, cultural and educational resilience of persons, communities and countries and the environment, as well as through technology and research; and enhancing multi-hazard early warning systems, preparedness, response, recovery, rehabilitation and reconstruction. To complement national action and capacity, there is a need to enhance international cooperation between developed and developing countries and between States and international organizations.

15. The present Framework will apply to the risk of small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters caused by natural or man-made hazards, as well as related environmental, technological and biological hazards and risks. It aims to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors.

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5. The Hyogo Framework priorities for action 2005-2015 are: (1) ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation; (2) identify, assess and monitor disaster risks and enhance early warning; (3) use knowledge, innovation and education to build a culture of safety and resilience at all levels; (4) reduce the underlying risk factors; and (5) strengthen disaster preparedness for effective response at all levels

6. A/RES/66/288, annex.

7. Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992, vol. I, Resolutions Adopted by the Conference (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex I.

8. The climate change issues mentioned in this Framework remain within the mandate of the United Nations Framework Convention on Climate Change under the competences of the Parties to the Convention.

II. Expected outcome and goal

16. While some progress in building resilience and reducing losses and damages has been achieved, a substantial reduction of disaster risk requires perseverance and persistence, with a more explicit focus on people and their health and livelihoods, and regular follow-up. Building on the Hyogo Framework for Action, the present Framework aims to achieve the following outcome over the next 15 years:

> The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

The realization of this outcome requires the strong commitment and involvement of political leadership in every country at all levels in the implementation and follow-up of the present Framework and in the creation of the necessary conducive and enabling environment.

17. To attain the expected outcome, the following goal must be pursued:

> Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience.

The pursuance of this goal requires the enhancement of the implementation capacity and capability of developing countries, in particular the least developed countries, small island developing States, landlocked developing countries and African countries, as well as middle-income countries facing specific challenges, including the mobilization of support through international cooperation for the provision of means of implementation in accordance with their national priorities.

18. To support the assessment of global progress in achieving the outcome and goal of the present Framework, seven global targets have been agreed. These targets will be measured at the global level and will be complemented by work to develop appropriate indicators. National targets and indicators will contribute to the achievement of the outcome and goal of the present Framework. The seven global targets are:

(a) Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020–2030 compared to the period 2005–2015;

(b) Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020–2030 compared to the period 2005–2015;[9]

(c) Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030;

(d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;

(e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;

(f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030;

(g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.

9. Categories of affected people will be elaborated in the process for post-Sendai work decided by the Conference.

III. Guiding principles

19. Drawing from the principles contained in the Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and its Plan of Action[10] and the Hyogo Framework for Action, the implementation of the present Framework will be guided by the following principles, while taking into account national circumstances, and consistent with domestic laws as well as international obligations and commitments:

(a) Each State has the primary responsibility to prevent and reduce disaster risk, including through international, regional, subregional, transboundary and bilateral cooperation. The reduction of disaster risk is a common concern for all States and the extent to which developing countries are able to effectively enhance and implement national disaster risk reduction policies and measures in the context of their respective circumstances and capabilities can be further enhanced through the provision of sustainable international cooperation;

(b) Disaster risk reduction requires that responsibilities be shared by central Governments and relevant national authorities, sectors and stakeholders, as appropriate to their national circumstances and systems of governance;

(c) Managing the risk of disasters is aimed at protecting persons and their property, health, livelihoods and productive assets, as well as cultural and environmental assets, while promoting and protecting all human rights, including the right to development;

(d) Disaster risk reduction requires an all-of-society engagement and partnership. It also requires empowerment and inclusive, accessible and non discriminatory participation, paying special attention to people disproportionately affected by disasters, especially the poorest. A gender, age, disability and cultural perspective should be integrated in all policies and practices, and women and youth leadership should be promoted. In this context, special attention should be paid to the improvement of organized voluntary work of citizens;

(e) Disaster risk reduction and management depends on coordination mechanisms within and across sectors and with relevant stakeholders at all levels, and it requires the full engagement of all State institutions of an executive and legislative nature at national and local levels and a clear articulation of responsibilities across public and private stakeholders, including business and academia, to ensure mutual outreach, partnership, complementarity in roles and accountability and follow-up;

(f) While the enabling, guiding and coordinating role of national and federal State Governments remain essential, it is necessary to empower local authorities and local communities to reduce disaster risk, including through resources, incentives and decision-making responsibilities, as appropriate;

(g) Disaster risk reduction requires a multi-hazard approach and inclusive risk-informed decision-making based on the open exchange and dissemination of disaggregated data, including by sex, age and disability, as well as on easily accessible, up-to-date, comprehensible, science-based, non-sensitive risk information, complemented by traditional knowledge;

(h) The development, strengthening and implementation of relevant policies, plans, practices and mechanisms need to aim at coherence, as appropriate, across sustainable development and growth, food security, health and safety, climate change and variability, environmental management and disaster risk reduction agendas. Disaster risk reduction is essential to achieve sustainable development;

(i) While the drivers of disaster risk may be local, national, regional or global in scope, disaster risks have local and specific characteristics that must be understood for the determination of measures to reduce disaster risk;

(j) Addressing underlying disaster risk factors through disaster risk-informed public and private investments is more cost-effective than primary reliance on post-disaster response and recovery, and contributes to sustainable development;

10. A/CONF.172/9, chap. I, resolution 1, annex I.

(k) In the post-disaster recovery, rehabilitation and reconstruction phase, it is critical to prevent the creation of and to reduce disaster risk by “Building Back Better” and increasing public education and awareness of disaster risk;

(l) An effective and meaningful global partnership and the further strengthening of international cooperation, including the fulfilment of respective commitments of official development assistance by developed countries, are essential for effective disaster risk management;

(m) Developing countries, in particular the least developed countries, small island developing States, landlocked developing countries and African countries, as well as middle-income and other countries facing specific disaster risk challenges, need adequate, sustainable and timely provision of support, including through finance, technology transfer and capacity-building from developed countries and partners tailored to their needs and priorities, as identified by them.

IV. Priorities for action

20. Taking into account the experience gained through the implementation of the Hyogo Framework for Action, and in pursuance of the expected outcome and goal, there is a need for focused action within and across sectors by States at local, national, regional and global levels in the following four priority areas:

Priority 1: Understanding disaster risk.

Priority 2: Strengthening disaster risk governance to manage disaster risk.

Priority 3: Investing in disaster risk reduction for resilience.

Priority 4: Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction.

21. In their approach to disaster risk reduction, States, regional and international organizations and other relevant stakeholders should take into consideration the key activities listed under each of these four priorities and should implement them, as appropriate, taking into consideration respective capacities and capabilities, in line with national laws and regulations.

22. In the context of increasing global interdependence, concerted international cooperation, an enabling international environment and means of implementation are needed to stimulate and contribute to developing the knowledge, capacities and motivation for disaster risk reduction at all levels, in particular for developing countries.

Priority 1: Understanding disaster risk

23. Policies and practices for disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment. Such knowledge can be leveraged for the purpose of pre-disaster risk assessment, for prevention and mitigation and for the development and implementation of appropriate preparedness and effective response to disasters.

National and local levels

24. To achieve this, it is important:

(a) To promote the collection, analysis, management and use of relevant data and practical information and ensure its dissemination, taking into account the needs of different categories of users, as appropriate;

(b) To encourage the use of and strengthening of baselines and periodically assess disaster risks, vulnerability, capacity, exposure, hazard characteristics and their possible sequential effects at the relevant social and spatial scale on ecosystems, in line with national circumstances;

(c) To develop, periodically update and disseminate, as appropriate, location-based disaster risk information, including risk maps, to decision makers, the general public and communities at risk of exposure to disaster in an appropriate format by using, as applicable, geospatial information technology;

(d) To systematically evaluate, record, share and publicly account for disaster losses and understand the economic, social, health, education, environmental and cultural heritage impacts, as appropriate, in the context of event-specific hazard-exposure and vulnerability information;

(e) To make non-sensitive hazard-exposure, vulnerability, risk, disaster and loss-disaggregated information freely available and accessible, as appropriate;

(f) To promote real time access to reliable data, make use of space and in situ information, including geographic information systems (GIS), and use information and communications technology innovations to enhance measurement tools and the collection, analysis and dissemination of data;

(g) To build the knowledge of government officials at all levels, civil society, communities and volunteers, as well as the private sector, through sharing experiences, lessons learned, good practices and training and education on disaster risk reduction, including the use of existing training and education mechanisms and peer learning;

(h) To promote and improve dialogue and cooperation among scientific and technological communities, other relevant stakeholders and policymakers in order to facilitate a science-policy interface for effective decision-making in disaster risk management;

(i) To ensure the use of traditional, indigenous and local knowledge and practices, as appropriate, to complement scientific knowledge in disaster risk assessment and the development and implementation of policies, strategies, plans and programmes of specific sectors, with a cross-sectoral approach, which should be tailored to localities and to the context;

(j) To strengthen technical and scientific capacity to capitalize on and consolidate existing knowledge and to develop and apply methodologies and models to assess disaster risks, vulnerabilities and exposure to all hazards;

(k) To promote investments in innovation and technology development in long-term, multi-hazard and solution-driven research in disaster risk management to address gaps, obstacles, interdependencies and social, economic, educational and environmental challenges and disaster risks;

(l) To promote the incorporation of disaster risk knowledge, including disaster prevention, mitigation, preparedness, response, recovery and rehabilitation, in formal and non-formal education, as well as in civic education at all levels, as well as in professional education and training;

(m) To promote national strategies to strengthen public education and awareness in disaster risk reduction, including disaster risk information and knowledge, through campaigns, social media and community mobilization, taking into account specific audiences and their needs;

(n) To apply risk information in all its dimensions of vulnerability, capacity and exposure of persons, communities, countries and assets, as well as hazard characteristics, to develop and implement disaster risk reduction policies;

(o) To enhance collaboration among people at the local level to disseminate disaster risk information through the involvement of community-based organizations and non-governmental organizations.

Global and regional levels

25. To achieve this, it is important:

(a) To enhance the development and dissemination of science-based methodologies and tools to record and share disaster losses and relevant disaggregated data and statistics, as well as to strengthen disaster risk modelling, assessment, mapping, monitoring and multi-hazard early warning systems;

(b) To promote the conduct of comprehensive surveys on multi-hazard disaster risks and the development of regional disaster risk assessments and maps, including climate change scenarios;

(c) To promote and enhance, through international cooperation, including technology transfer, access to and the sharing and use of non-sensitive data and information, as appropriate, communications and geospatial and space-based technologies and related services; maintain and strengthen in situ and remotely-sensed earth and climate observations; and strengthen the utilization of media, including social media, traditional media, big data and mobile phone networks, to support national measures for successful disaster risk communication, as appropriate and in accordance with national laws;

(d) To promote common efforts in partnership with the scientific and technological community, academia and the private sector to establish, disseminate and share good practices internationally;

(e) To support the development of local, national, regional and global user-friendly systems and services for the exchange of information on good practices, cost-effective and easy-to-use disaster risk reduction technologies and lessons learned on policies, plans and measures for disaster risk reduction;

(f) To develop effective global and regional campaigns as instruments for public awareness and education, building on the existing ones (for example, the "One million safe schools and hospitals" initiative; the "Making Cities Resilient: My city is getting ready" campaign; the United Nations Sasakawa Award for Disaster Risk Reduction; and the annual United Nations International Day for Disaster Reduction), to promote a culture of disaster prevention, resilience and responsible citizenship, generate understanding of disaster risk, support mutual learning and share experiences; and encourage public and private stakeholders to actively engage in such initiatives and to develop new ones at the local, national, regional and global levels;

(g) To enhance the scientific and technical work on disaster risk reduction and its mobilization through the coordination of existing networks and scientific research institutions at all levels and in all regions, with the support of the United Nations Office for Disaster Risk Reduction Scientific and Technical Advisory Group, in order to strengthen the evidence-base in support of the implementation of the present Framework; promote scientific research on disaster risk patterns, causes and effects; disseminate risk information with the best use of geospatial information technology; provide guidance on methodologies and standards for risk assessments, disaster risk modelling and the use of data; identify research and technology gaps and set recommendations for research priority areas in disaster risk reduction; promote and support the availability and application of science and technology to decision-making; contribute to the update of the publication entitled "2009 UNISDR Terminology on Disaster Risk Reduction"; use post-disaster reviews as opportunities to enhance learning and public policy; and disseminate studies;

(h) To encourage the availability of copyrighted and patented materials, including through negotiated concessions, as appropriate;

(i) To enhance access to and support for innovation and technology, as well as in long-term, multi-hazard and solution-driven research and development in the field of disaster risk management.

Priority 2: Strengthening disaster risk governance to manage disaster risk

26. Disaster risk governance at the national, regional and global levels is of great importance for an effective and efficient management of disaster risk. Clear vision, plans, competence, guidance and coordination within and across sectors, as well as participation of relevant stakeholders, are needed. Strengthening disaster risk governance for prevention, mitigation, preparedness, response, recovery and rehabilitation is therefore necessary and fosters collaboration and partnership across mechanisms and institutions for the implementation of instruments relevant to disaster risk reduction and sustainable development.

National and local levels

27. To achieve this, it is important:

(a) To mainstream and integrate disaster risk reduction within and across all sectors and review and promote the coherence and further development, as appropriate, of national and local frameworks of laws, regulations and public policies, which, by defining roles and responsibilities, guide the public and private sectors in: (i) addressing disaster risk in publically owned, managed or regulated services and infrastructures; (ii) promoting and providing incentives, as relevant, for actions by persons, households, communities and businesses; (iii) enhancing relevant mechanisms and initiatives for disaster risk transparency, which may include financial incentives, public awareness-raising and training initiatives, reporting requirements and legal and administrative measures; and (iv) putting in place coordination and organizational structures;

(b) To adopt and implement national and local disaster risk reduction strategies and plans, across different timescales, with targets, indicators and time frames, aimed at preventing the creation of risk, the reduction of existing risk and the strengthening of economic, social, health and environmental resilience;

(c) To carry out an assessment of the technical, financial and administrative disaster risk management capacity to deal with the identified risks at the local and national levels;

(d) To encourage the establishment of necessary mechanisms and incentives to ensure high levels of compliance with the existing safety-enhancing provisions of sectoral laws and regulations, including those addressing land use and urban planning, building codes, environmental and resource management and health and safety standards, and update them, where needed, to ensure an adequate focus on disaster risk management;

(e) To develop and strengthen, as appropriate, mechanisms to follow up, periodically assess and publicly report on progress on national and local plans; and promote public scrutiny and encourage institutional debates, including by parliamentarians and other relevant officials, on progress reports of local and national plans for disaster risk reduction;

(f) To assign, as appropriate, clear roles and tasks to community representatives within disaster risk management institutions and processes and decision-making through relevant legal frameworks, and undertake comprehensive public and community consultations during the development of such laws and regulations to support their implementation;

(g) To establish and strengthen government coordination forums composed of relevant stakeholders at the national and local levels, such as national and local platforms for disaster risk reduction, and a designated national focal point for implementing the Sendai Framework for Disaster Risk Reduction 2015–2030. It is necessary for such mechanisms to have a strong foundation in national institutional frameworks with clearly assigned responsibilities and authority to, inter alia, identify sectoral and multisectoral disaster risk, build awareness and knowledge of disaster risk through sharing and dissemination of non-sensitive disaster risk information and data, contribute to and coordinate reports on local and national disaster risk, coordinate public awareness campaigns on disaster risk, facilitate and support local multisectoral cooperation (e.g. among local governments) and contribute to the determination of and reporting on national and local disaster risk management plans and all policies relevant for disaster risk management. These responsibilities should be established through laws, regulations, standards and procedures;

(h) To empower local authorities, as appropriate, through regulatory and financial means to work and coordinate with civil society, communities and indigenous peoples and migrants in disaster risk management at the local level;

(i) To encourage parliamentarians to support the implementation of disaster risk reduction by developing new or amending relevant legislation and setting budget allocations;

(j) To promote the development of quality standards, such as certifications and awards for disaster risk management, with the participation of the private sector, civil society, professional associations, scientific organizations and the United Nations;

(k) To formulate public policies, where applicable, aimed at addressing the issues of prevention or relocation, where possible, of human settlements in disaster risk-prone zones, subject to national law and legal systems.

Global and regional levels

28. To achieve this, it is important:

(a) To guide action at the regional level through agreed regional and subregional strategies and mechanisms for cooperation for disaster risk reduction, as appropriate, in the light of the present Framework, in order to foster more efficient planning, create common information systems and exchange good practices and programmes for cooperation and capacity development, in particular to address common and transboundary disaster risks;

(b) To foster collaboration across global and regional mechanisms and institutions for the implementation and coherence of instruments and tools relevant to disaster risk reduction, such as for climate change, biodiversity, sustainable development, poverty eradication, environment, agriculture, health, food and nutrition and others, as appropriate;

(c) To actively engage in the Global Platform for Disaster Risk Reduction, the regional and subregional platforms for disaster risk reduction and the thematic platforms in order to forge partnerships, periodically assess progress on implementation and share practice and knowledge on disaster risk-informed policies, programmes and investments, including on development and climate issues, as appropriate, as well as to promote the integration of disaster risk management in other relevant sectors. Regional intergovernmental organizations should play an important role in the regional platforms for disaster risk reduction;

(d) To promote transboundary cooperation to enable policy and planning for the implementation of ecosystem-based approaches with regard to shared resources, such as within river basins and along coastlines, to build resilience and reduce disaster risk, including epidemic and displacement risk;

(e) To promote mutual learning and exchange of good practices and information through, inter alia, voluntary and self-initiated peer reviews among interested States;

(f) To promote the strengthening of, as appropriate, international voluntary mechanisms for monitoring and assessment of disaster risks, including relevant data and information, benefiting from the experience of the Hyogo Framework for Action Monitor. Such mechanisms may promote the exchange of non-sensitive information on disaster risks to the relevant national Government bodies and stakeholders in the interest of sustainable social and economic development.

Priority 3: Investing in disaster risk reduction for resilience

29. Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation.

National and local levels

30. To achieve this, it is important:

(a) To allocate the necessary resources, including finance and logistics, as appropriate, at all levels of administration for the development and the implementation of disaster risk reduction strategies, policies, plans, laws and regulations in all relevant sectors;

(b) To promote mechanisms for disaster risk transfer and insurance, risk-sharing and retention and financial protection, as appropriate, for both public and private investment in order to reduce the financial impact of disasters on Governments and societies, in urban and rural areas;

(c) To strengthen, as appropriate, disaster-resilient public and private investments, particularly through structural, non-structural and functional disaster risk prevention and reduction measures in critical facilities, in particular schools and hospitals and physical infrastructures; building better from the start to withstand hazards through proper design and construction, including the use of the principles of universal design and the standardization of building materials; retrofitting and rebuilding; nurturing a culture of maintenance; and taking into account economic, social, structural, technological and environmental impact assessments;

(d) To protect or support the protection of cultural and collecting institutions and other sites of historical, cultural heritage and religious interest;

(e) To promote the disaster risk resilience of workplaces through structural and non-structural measures;

(f) To promote the mainstreaming of disaster risk assessments into land-use policy development and implementation, including urban planning, land degradation assessments and informal and non-permanent housing, and the use of guidelines and follow-up tools informed by anticipated demographic and environmental changes;

(g) To promote the mainstreaming of disaster risk assessment, mapping and management into rural development planning and management of, inter alia, mountains, rivers, coastal flood plain areas, drylands, wetlands and all other areas prone to droughts and flooding, including through the identification of areas that are safe for human settlement, and at the same time preserving ecosystem functions that help to reduce risks;

(h) To encourage the revision of existing or the development of new building codes and standards and rehabilitation and reconstruction practices at the national or local levels, as appropriate, with the aim of making them more applicable within the local context, particularly in informal and marginal human settlements, and reinforce the capacity to implement, survey and enforce such codes through an appropriate approach, with a view to fostering disaster-resistant structures;

(i) To enhance the resilience of national health systems, including by integrating disaster risk management into primary, secondary and tertiary health care, especially at the local level; developing the capacity of health workers in understanding disaster risk and applying and implementing disaster risk reduction approaches in health work; promoting and enhancing the training capacities in the field of disaster medicine; and supporting and training community health groups in disaster risk reduction approaches in health programmes, in collaboration with other sectors, as well as in the implementation of the International Health Regulations (2005) of the World Health Organization;

(j) To strengthen the design and implementation of inclusive policies and social safety-net mechanisms, including through community involvement, integrated with livelihood enhancement programmes, and access to basic health-care services, including maternal, newborn and child health, sexual and reproductive health, food security and nutrition, housing and education, towards the eradication of poverty, to find durable solutions in the post-disaster phase and to empower and assist people disproportionately affected by disasters;

(k) People with life-threatening and chronic disease, due to their particular needs, should be included in the design of policies and plans to manage their risks before, during and after disasters, including having access to life-saving services;

(l) To encourage the adoption of policies and programmes addressing disaster-induced human mobility to strengthen the resilience of affected people and that of host communities, in accordance with national laws and circumstances;

(m) To promote, as appropriate, the integration of disaster risk reduction considerations and measures in financial and fiscal instruments;

(n) To strengthen the sustainable use and management of ecosystems and implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction;

(o) To increase business resilience and protection of livelihoods and productive assets throughout the supply chains, ensure continuity of services and integrate disaster risk management into business models and practices;

(p) To strengthen the protection of livelihoods and productive assets, including livestock, working animals, tools and seeds;

(q) To promote and integrate disaster risk management approaches throughout the tourism industry, given the often heavy reliance on tourism as a key economic driver.

Global and regional levels

31. To achieve this, it is important:

(a) To promote coherence across systems, sectors and organizations related to sustainable development and to disaster risk reduction in their policies, plans, programmes and processes;

(b) To promote the development and strengthening of disaster risk transfer and sharing mechanisms and instruments in close cooperation with partners in the international community, business, international financial institutions and other relevant stakeholders;

(c) To promote cooperation between academic, scientific and research entities and networks and the private sector to develop new products and services to help to reduce disaster risk, in particular those that would assist developing countries and their specific challenges;

(d) To encourage the coordination between global and regional financial institutions with a view to assessing and anticipating the potential economic and social impacts of disasters;

(e) To enhance cooperation between health authorities and other relevant stakeholders to strengthen country capacity for disaster risk management for health, the implementation of the International Health Regulations (2005) and the building of resilient health systems;

(f) To strengthen and promote collaboration and capacity-building for the protection of productive assets, including livestock, working animals, tools and seeds;

(g) To promote and support the development of social safety nets as disaster risk reduction measures linked to and integrated with livelihood enhancement programmes in order to ensure resilience to shocks at the household and community levels;

(h) To strengthen and broaden international efforts aimed at eradicating hunger and poverty through disaster risk reduction;

(i) To promote and support collaboration among relevant public and private stakeholders to enhance the resilience of business to disasters.

Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction

32. The steady growth of disaster risk, including the increase of people and assets exposure, combined with the lessons learned from past disasters, indicates the need to further strengthen disaster preparedness for response, take action in anticipation of events, integrate disaster risk reduction in response preparedness and ensure that capacities are in place for effective response and recovery at all levels. Empowering women and persons with disabilities to publicly lead and promote gender equitable and universally accessible response, recovery, rehabilitation and reconstruction approaches is key. Disasters have demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of a disaster, is a critical opportunity to "Build Back Better", including through integrating disaster risk reduction into development measures, making nations and communities resilient to disasters.

National and local levels

33. To achieve this, it is important:

(a) To prepare or review and periodically update disaster preparedness and contingency policies, plans and programmes with the involvement of the relevant institutions, considering climate change scenarios and their impact on disaster risk, and facilitating, as appropriate, the participation of all sectors and relevant stakeholders;

(b) To invest in, develop, maintain and strengthen people-centred multi-hazard, multisectoral forecasting and early warning systems, disaster risk and emergency communications mechanisms, social technologies and hazard-monitoring telecommunications systems; develop such systems through a participatory process; tailor them to the needs of users, including social and cultural requirements, in particular gender; promote the application of simple and low-cost early warning equipment and facilities; and broaden release channels for natural disaster early warning information;

(c) To promote the resilience of new and existing critical infrastructure, including water, transportation and telecommunications infrastructure, educational facilities, hospitals and other health facilities, to ensure that they remain safe, effective and operational during and after disasters in order to provide live-saving and essential services;

(d) To establish community centres for the promotion of public awareness and the stockpiling of necessary materials to implement rescue and relief activities;

(e) To adopt public policies and actions that support the role of public service workers to establish or strengthen coordination and funding mechanisms and procedures for relief assistance and plan and prepare for post-disaster recovery and reconstruction;

(f) To train the existing workforce and voluntary workers in disaster response and strengthen technical and logistical capacities to ensure better response in emergencies;

(g) To ensure the continuity of operations and planning, including social and economic recovery, and the provision of basic services in the post-disaster phase;

(h) To promote regular disaster preparedness, response and recovery exercises, including evacuation drills, training and the establishment of area-based support systems, with a view to ensuring rapid and effective response to disasters and related displacement, including access to safe shelter, essential food and non-food relief supplies, as appropriate to local needs;

(i) To promote the cooperation of diverse institutions, multiple authorities and related stakeholders at all levels, including affected communities and business, in view of the complex and costly nature of post-disaster reconstruction, under the coordination of national authorities;

(j) To promote the incorporation of disaster risk management into post-disaster recovery and rehabilitation processes, facilitate the link between relief, rehabilitation and development, use opportunities during the recovery phase to develop capacities that reduce disaster risk in the short, medium and long term, including through the development of measures such as land-use planning, structural standards improvement and the sharing of expertise, knowledge, post-disaster reviews and lessons learned and integrate post-disaster reconstruction into the economic and social sustainable development of affected areas. This should also apply to temporary settlements for persons displaced by disasters;

(k) To develop guidance for preparedness for disaster reconstruction, such as on land-use planning and structural standards improvement, including by learning from the recovery and reconstruction programmes over the decade since the adoption of the Hyogo Framework for Action, and exchanging experiences, knowledge and lessons learned;

(l) To consider the relocation of public facilities and infrastructures to areas outside the risk range, wherever possible, in the post-disaster reconstruction process, in consultation with the people concerned, as appropriate;

(m) To strengthen the capacity of local authorities to evacuate persons living in disaster-prone areas;

(n) To establish a mechanism of case registry and a database of mortality caused by disaster in order to improve the prevention of morbidity and mortality;

(o) To enhance recovery schemes to provide psychosocial support and mental health services for all people in need;

(p) To review and strengthen, as appropriate, national laws and procedures on international cooperation, based on the Guidelines for the Domestic Facilitation and Regulation of International Disaster Relief and Initial Recovery Assistance.

Global and regional levels

34. To achieve this, it is important:

(a) To develop and strengthen, as appropriate, coordinated regional approaches and operational mechanisms to prepare for and ensure rapid and effective disaster response in situations that exceed national coping capacities;

(b) To promote the further development and dissemination of instruments, such as standards, codes, operational guides and other guidance instruments, to support coordinated action in disaster preparedness and response and facilitate information sharing on lessons learned and best practices for policy practice and post-disaster reconstruction programmes;

(c) To promote the further development of and investment in effective, nationally compatible, regional multi-hazard early warning mechanisms, where relevant, in line with the Global Framework for Climate Services, and facilitate the sharing and exchange of information across all countries;

(d) To enhance international mechanisms, such as the International Recovery Platform, for the sharing of experience and learning among countries and all relevant stakeholders;

(e) To support, as appropriate, the efforts of relevant United Nations entities to strengthen and implement global mechanisms on hydrometeorological issues in order to raise awareness and improve understanding of water-related disaster risks and their impact on society, and advance strategies for disaster risk reduction upon the request of States;

(f) To support regional cooperation to deal with disaster preparedness, including through common exercises and drills;

(g) To promote regional protocols to facilitate the sharing of response capacities and resources during and after disasters;

(h) To train the existing workforce and volunteers in disaster response.

V. Role of stakeholders

35. While States have the overall responsibility for reducing disaster risk, it is a shared responsibility between Governments and relevant stakeholders. In particular, non-State stakeholders play an important role as enablers in providing support to States, in accordance with national policies, laws and regulations, in the implementation of the present Framework at local, national, regional and global levels. Their commitment, goodwill, knowledge, experience and resources will be required.

36. When determining specific roles and responsibilities for stakeholders, and at the same time building on existing relevant international instruments, States should encourage the following actions on the part of all public and private stakeholders:

(a) Civil society, volunteers, organized voluntary work organizations and community-based organizations to participate, in collaboration with public institutions, to, inter alia, provide specific knowledge and pragmatic guidance in the context of the development and implementation of normative frameworks, standards and plans for disaster risk reduction; engage in the implementation of local, national, regional and global plans and strategies; contribute to and support public awareness, a culture of prevention and education on disaster risk; and advocate for resilient communities and an inclusive and all-of-society disaster risk management that strengthen synergies across groups, as appropriate. On this point, it should be noted that:

(i) Women and their participation are critical to effectively managing disaster risk and designing, resourcing and implementing gender-sensitive disaster risk reduction policies, plans and programmes; and adequate capacity building measures need to be taken to empower women for preparedness as well as to build their capacity to secure alternate means of livelihood in post-disaster situations;

(ii) Children and youth are agents of change and should be given the space and modalities to contribute to disaster risk reduction, in accordance with legislation, national practice and educational curricula;

(iii) Persons with disabilities and their organizations are critical in the assessment of disaster risk and in designing and implementing plans tailored to specific requirements, taking into consideration, inter alia, the principles of universal design;

(iv) Older persons have years of knowledge, skills and wisdom, which are invaluable assets to reduce disaster risk, and they should be included in the design of policies, plans and mechanisms, including for early warning;

(v) Indigenous peoples, through their experience and traditional knowledge, provide an important contribution to the development and implementation of plans and mechanisms, including for early warning;

(vi) Migrants contribute to the resilience of communities and societies, and their knowledge, skills and capacities can be useful in the design and implementation of disaster risk reduction;

(b) Academia, scientific and research entities and networks to focus on the disaster risk factors and scenarios, including emerging disaster risks, in the medium and long term; increase research for regional, national and local application; support action by local communities and authorities; and support the interface between policy and science for decision-making;

(c) Business, professional associations and private sector financial institutions, including financial regulators and accounting bodies, as well as philanthropic foundations, to integrate disaster risk management, including business continuity, into business models and practices through disaster-risk-informed investments, especially in micro, small and medium-sized enterprises; engage in awareness-raising and training for their employees and customers; engage in and support research and innovation, as well as technological development for disaster risk management; share and disseminate knowledge, practices and non sensitive data; and actively participate, as appropriate and under the guidance of the public sector, in the development of normative frameworks and technical standards that incorporate disaster risk management;

(d) Media to take an active and inclusive role at the local, national, regional and global levels in contributing to the raising of public awareness and understanding and disseminate accurate and non-sensitive disaster risk, hazard and disaster information, including on small-scale disasters, in a simple, transparent, easy-to-understand and accessible manner, in close cooperation with national authorities; adopt specific disaster risk reduction communications policies; support, as appropriate, early warning systems and life-saving protective measures; and stimulate a culture of prevention and strong community involvement in sustained public education campaigns and public consultations at all levels of society, in accordance with national practices.

37. With reference to General Assembly resolution 68/211 of 20 December 2013, commitments by relevant stakeholders are important in order to identify modalities of cooperation and to implement the present Framework. Those commitments should be specific and time-bound in order to support the development of partnerships at local, national, regional and global levels and the implementation of local and national disaster risk reduction strategies and plans. All stakeholders are encouraged to publicize their commitments and their fulfilment in support of the implementation of the present Framework, or of the national and local disaster risk management plans, through the website of the United Nations Office for Disaster Risk Reduction.

VI. International cooperation and global partnership

General considerations

38. Given their different capacities, as well as the linkage between the level of support provided to them and the extent to which they will be able to implement the present Framework, developing countries require an enhanced provision of means of implementation, including adequate, sustainable and timely resources, through international cooperation and global partnerships for development, and continued international support, so as to strengthen their efforts to reduce disaster risk.

39. International cooperation for disaster risk reduction includes a variety of sources and is a critical element in supporting the efforts of developing countries to reduce disaster risk.

40. In addressing economic disparity and disparity in technological innovation and research capacity among countries, it is crucial to enhance technology transfer, involving a process of enabling and facilitating flows of skill, knowledge, ideas, know-how and technology from developed to developing countries in the implementation of the present Framework.

41. Disaster-prone developing countries, in particular the least developed countries, small island developing States, landlocked developing countries and African countries, as well as middle-income countries facing specific challenges, warrant particular attention in view of their higher vulnerability and risk levels, which often greatly exceed their capacity to respond to and recover from disasters. Such vulnerability requires the urgent strengthening of international cooperation and ensuring genuine and durable partnerships at the regional and international levels in order to support developing countries to implement the present Framework, in accordance with their national priorities and needs. Similar attention and appropriate assistance should also be extended to other disaster-prone countries with specific characteristics, such as archipelagic countries, as well as countries with extensive coastlines.

42. Disasters can disproportionately affect small island developing States, owing to their unique and particular vulnerabilities. The effects of disasters, some of which have increased in intensity and have been exacerbated by climate change, impede their progress towards sustainable development. Given the special case of small island developing States, there is a critical need to build resilience and to provide particular support through the implementation of the SIDS Accelerated Modalities of Action (SAMOA) Pathway[11] in the area of disaster risk reduction.

43. African countries continue to face challenges related to disasters and increasing risks, including those related to enhancing resilience of infrastructure, health and livelihoods. These challenges require increased international cooperation and the provision of adequate support to African countries to allow for the implementation of the present Framework.

11. General Assembly resolution 69/15, annex.

44. North-South cooperation, complemented by South-South and triangular cooperation, has proven to be key to reducing disaster risk and there is a need to further strengthen cooperation in both areas. Partnerships play an additional important role by harnessing the full potential of countries and supporting their national capacities in disaster risk management and in improving the social, health and economic well-being of individuals, communities and countries.

45. Efforts by developing countries offering South-South and triangular cooperation should not reduce North-South cooperation from developed countries as they complement North-South cooperation.

46. Financing from a variety of international sources, public and private transfer of reliable, affordable, appropriate and modern environmentally sound technology, on concessional and preferential terms, as mutually agreed, capacity-building assistance for developing countries and enabling institutional and policy environments at all levels are critically important means of reducing disaster risk.

Means of implementation

47. To achieve this, it is necessary:

(a) To reaffirm that developing countries need enhanced provision of coordinated, sustained and adequate international support for disaster risk reduction, in particular for the least developed countries, small island developing States, landlocked developing countries and African countries, as well as middle-income countries facing specific challenges, through bilateral and multilateral channels, including through enhanced technical and financial support and technology transfer on concessional and preferential terms, as mutually agreed, for the development and strengthening of their capacities;

(b) To enhance access of States, in particular developing countries, to finance, environmentally sound technology, science and inclusive innovation, as well as knowledge and information-sharing through existing mechanisms, namely bilateral, regional and multilateral collaborative arrangements, including the United Nations and other relevant bodies;

(c) To promote the use and expansion of thematic platforms of cooperation, such as global technology pools and global systems to share know-how, innovation and research and ensure access to technology and information on disaster risk reduction;

(d) To incorporate disaster risk reduction measures into multilateral and bilateral development assistance programmes within and across all sectors, as appropriate, related to poverty reduction, sustainable development, natural resource management, the environment, urban development and adaptation to climate change.

Support from international organizations

48. To support the implementation of the present Framework, the following is necessary:

(a) The United Nations and other international and regional organizations, international and regional financial institutions and donor agencies engaged in disaster risk reduction are requested, as appropriate, to enhance the coordination of their strategies in this regard;

(b) The entities of the United Nations system, including the funds and programmes and the specialized agencies, through the United Nations Plan of Action on Disaster Risk Reduction for Resilience, United Nations Development Assistance Frameworks and country programmes, to promote the optimum use of resources and to support developing countries, at their request, in the implementation of the present Framework, in coordination with other relevant frameworks, such as the International Health Regulations (2005), including through the development and the strengthening of capacities and clear and focused programmes that support the priorities of States in a balanced, well-coordinated and sustainable manner, within their respective mandates;

(c) The United Nations Office for Disaster Risk Reduction, in particular, to support the implementation, follow-up and review of the present Framework by: preparing periodic reviews on progress, in particular for the Global Platform for Disaster Risk Reduction, and, as appropriate, in a timely manner, along with the follow-up process at the United Nations, supporting the development of coherent global and regional follow-up and indicators, and in coordination, as appropriate, with other relevant mechanisms for sustainable development and climate change, and updating the existing web-based Hyogo Framework for Action Monitor accordingly; participating actively in the work of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators; generating evidence-based and practical guidance for implementation in close collaboration with States and through the mobilization of experts; reinforcing a culture of prevention among relevant stakeholders through supporting development of standards by experts and technical organizations, advocacy initiatives and dissemination of disaster risk information, policies and practices, as well as by providing education and training on disaster risk reduction through affiliated organizations; supporting countries, including through national platforms or their equivalent, in their development of national plans and monitoring trends and patterns in disaster risk, loss and impacts; convening the Global Platform for Disaster Risk Reduction and supporting the organization of regional platforms for disaster risk reduction in cooperation with regional organizations; leading the revision of the United Nations Plan of Action on Disaster Risk Reduction for Resilience; facilitating the enhancement of, and continuing to service, the United Nations Office for Disaster Risk Reduction Scientific and Technical Advisory Group in mobilizing science and technical work on disaster risk reduction; leading, in close coordination with States, the update of the publication entitled "2009 UNISDR Terminology on Disaster Risk Reduction", in line with the terminology agreed upon by States; and maintaining the stakeholders' commitment registry;

(d) International financial institutions, such as the World Bank and regional development banks, to consider the priorities of the present Framework for providing financial support and loans for integrated disaster risk reduction to developing countries;

(e) Other international organizations and treaty bodies, including the Conference of the Parties to the United Nations Framework Convention on Climate Change, international financial institutions at the global and regional levels and the International Red Cross and Red Crescent Movement to support developing countries, at their request, in the implementation of the present Framework, in coordination with other relevant frameworks;

(f) The United Nations Global Compact, as the main United Nations initiative for engagement with the private sector and business, to further engage with and promote the critical importance of disaster risk reduction for sustainable development and resilience;

(g) The overall capacity of the United Nations system to assist developing countries in disaster risk reduction should be strengthened by providing adequate resources through various funding mechanisms, including increased, timely, stable and predictable contributions to the United Nations Trust Fund for Disaster Reduction and by enhancing the role of the Trust Fund in relation to the implementation of the present Framework;

(h) The Inter-Parliamentary Union and other relevant regional bodies and mechanisms for parliamentarians, as appropriate, to continue supporting and advocating disaster risk reduction and the strengthening of national legal frameworks;

(i) The United Cities and Local Government organization and other relevant bodies of local governments to continue supporting cooperation and mutual learning among local governments for disaster risk reduction and the implementation of the present Framework.

Follow-up actions

49. The Conference invites the General Assembly, at its seventieth session, to consider the possibility of including the review of the global progress in the implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030 as part of its integrated and coordinated follow-up processes to United Nations conferences and summits, aligned with the Economic and Social Council, the High-level Political Forum for Sustainable Development and the quadrennial comprehensive policy review cycles, as appropriate, taking into account the contributions of the Global Platform for Disaster Risk Reduction and regional platforms for disaster risk reduction and the Hyogo Framework for Action Monitor system.

50. The Conference recommends to the General Assembly the establishment, at its sixty-ninth session, of an open-ended intergovernmental working group, comprising experts nominated by Member States, and supported by the United Nations Office for Disaster Risk Reduction, with involvement of relevant stakeholders, for the development of a set of possible indicators to measure global progress in the implementation of the present Framework in conjunction with the work of the Inter-Agency and Expert Group On Sustainable Development Goal Indicators. The Conference also recommends that the working group consider the recommendations of the United Nations Office for Disaster Risk Reduction Scientific and Technical Advisory Group on the update of the publication entitled "2009 UNISDR Terminology on Disaster Risk Reduction" by December 2016, and that the outcome of its work be submitted to the Assembly for its consideration and adoption.

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Chart of the Sendai Framework for Disaster Risk Reduction
2015-2030

Scope and purpose

The present framework will apply to the risk of small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters, caused by natural or manmade hazards as well as related environmental, technological and biological hazards and risks.
It aims to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors

Expected outcome

The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries

Goal

Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience

Targets

Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020-2030 compared to 2005-2015	Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared to 2005-2015	Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030	Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030	Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020	Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030	Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030

Priorities for Action

There is a need for focused action within and across sectors by States at local, national, regional and global levels in the following four priority areas.

Priority 1 Understanding disaster risk	**Priority 2** Strengthening disaster risk governance to manage disaster risk	**Priority 3** Investing in disaster risk reduction for resilience	**Priority 4** Enhancing disaster preparedness for effective response, and to «Build Back Better» in recovery, rehabilitation and reconstruction
Disaster risk management needs to be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment	Disaster risk governance at the national, regional and global levels is vital to the management of disaster risk reduction in all sectors and ensuring the coherence of national and local frameworks of laws, regulations and public policies that, by defining roles and responsibilities, guide, encourage and incentivize the public and private sectors to take action and address disaster risk	Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation	Experience indicates that disaster preparedness needs to be strengthened for more effective response and ensure capacities are in place for effective recovery. Disasters have also demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of the disaster, is an opportunity to «Build Back Better» through integrating disaster risk reduction measures. Women and persons with disabilities should publicly lead and promote gender-equitable and universally accessible approaches during the response and reconstruction phases

Guiding Principles

Primary responsibility of States to prevent and reduce disaster risk, including through cooperation	Shared responsibility between central Government and national authorities, sectors and stakeholders as appropriate to national circumstances	Protection of persons and their assets while promoting and protecting all human rights including the right to development	Engagement from all of society	Full engagement of all State institutions of an executive and legislative nature at national and local levels	Empowerment of local authorities and communities through resources, incentives and decision-making responsibilities as appropriate	Decision-making to be inclusive and risk-informed while using a multi-hazard approach

Coherence of disaster risk reduction and sustainable development policies, plans, practices and mechanisms, across different sectors	Accounting of local and specific characteristics of disaster risks when determining measures to reduce risk	Addressing underlying risk factors cost-effectively through investment versus relying primarily on post-disaster response and recovery	«Build Back Better» for preventing the creation of, and reducing existing, disaster risk	The quality of global partnership and international cooperation to be effective, meaningful and strong	Support from developed countries and partners to developing countries to be tailored according to needs and priorities as identified by them

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THE FUKUSHIMA DAIICHI ACCIDENT

TECHNICAL VOLUME 3
EMERGENCY PREPAREDNESS AND RESPONSE

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

THE FUKUSHIMA DAIICHI ACCIDENT

TECHNICAL VOLUME 3
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The United Nations Scientific Committee on the Effects of Atomic Radiation supported the IAEA by sharing the relevant database of references from its 2013 report and allowing information and figures from this report to be reproduced.

The IAEA thanks the large number of experts who were involved in this report. It is the result of the dedicated efforts of many people. All participants listed at the end of this technical volume made valuable contributions, but a particularly heavy load was borne by the Co-Chairs and coordinators of the working groups. The efforts of many expert reviewers, including members of the International Technical Advisory Group, are also gratefully acknowledged.

THE REPORT ON THE FUKUSHIMA DAIICHI ACCIDENT

At the IAEA General Conference in September 2012, the Director General announced that the IAEA would prepare a report on the Fukushima Daiichi accident. He later stated that this report would be "an authoritative, factual and balanced assessment, addressing the causes and consequences of the accident, as well as lessons learned".[1]

The report is the result of an extensive international collaborative effort involving five working groups with about 180 experts from 42 Member States (with and without nuclear power programmes) and several international bodies. This ensured a broad representation of experience and knowledge. An International Technical Advisory Group provided advice on technical and scientific issues. A Core Group, comprising IAEA senior level management, was established to give direction and to facilitate the coordination and review. Additional internal and external review mechanisms were also instituted. The organizational structure for the preparation of this publication is illustrated in Fig. 1.

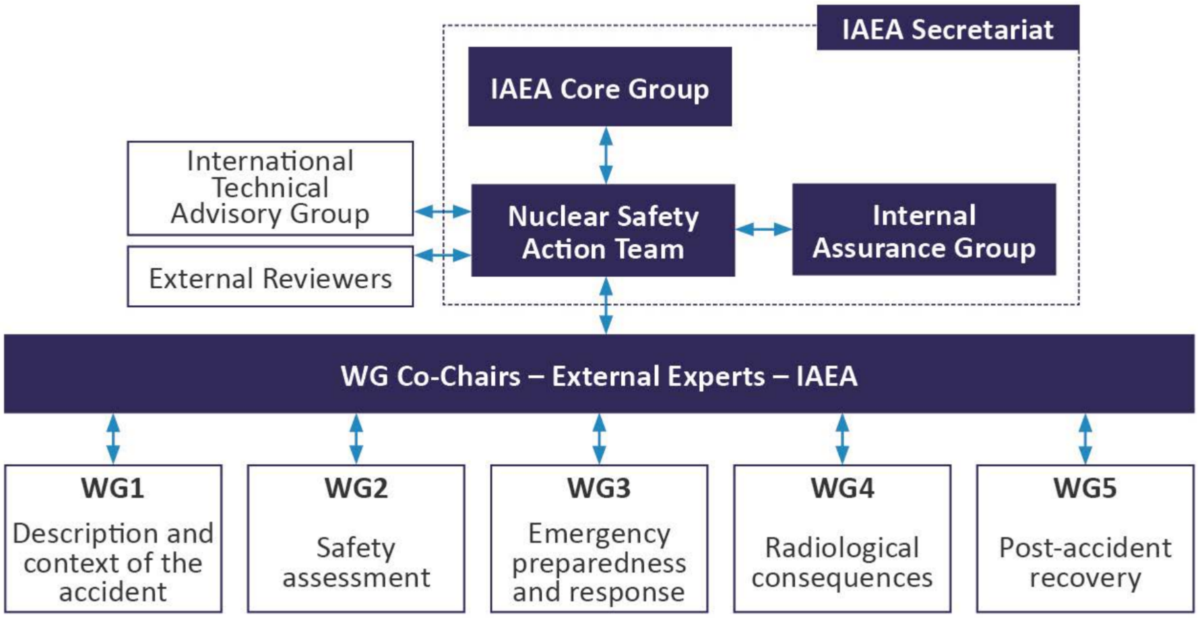

FIG. 1. IAEA organizational structure for the preparation of the report on The Fukushima Daiichi Accident.

The Report by the Director General consists of an Executive Summary and a Summary Report. It draws on five detailed technical volumes prepared by international experts and on the contributions of the many experts and international bodies involved.

The five technical volumes are for a technical audience that includes the relevant authorities in IAEA Member States, international organizations, nuclear regulatory bodies, nuclear power plant operating organizations, designers of nuclear facilities and other experts in matters relating to nuclear power.

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Introductory Statement to Board of Governors (2013), https://www.iaea.org/newscenter/statements/introductory-statement-board-governors-3.

The relationship between the content of the Report by the Director General and the content of the technical volumes is illustrated in Fig. 2.

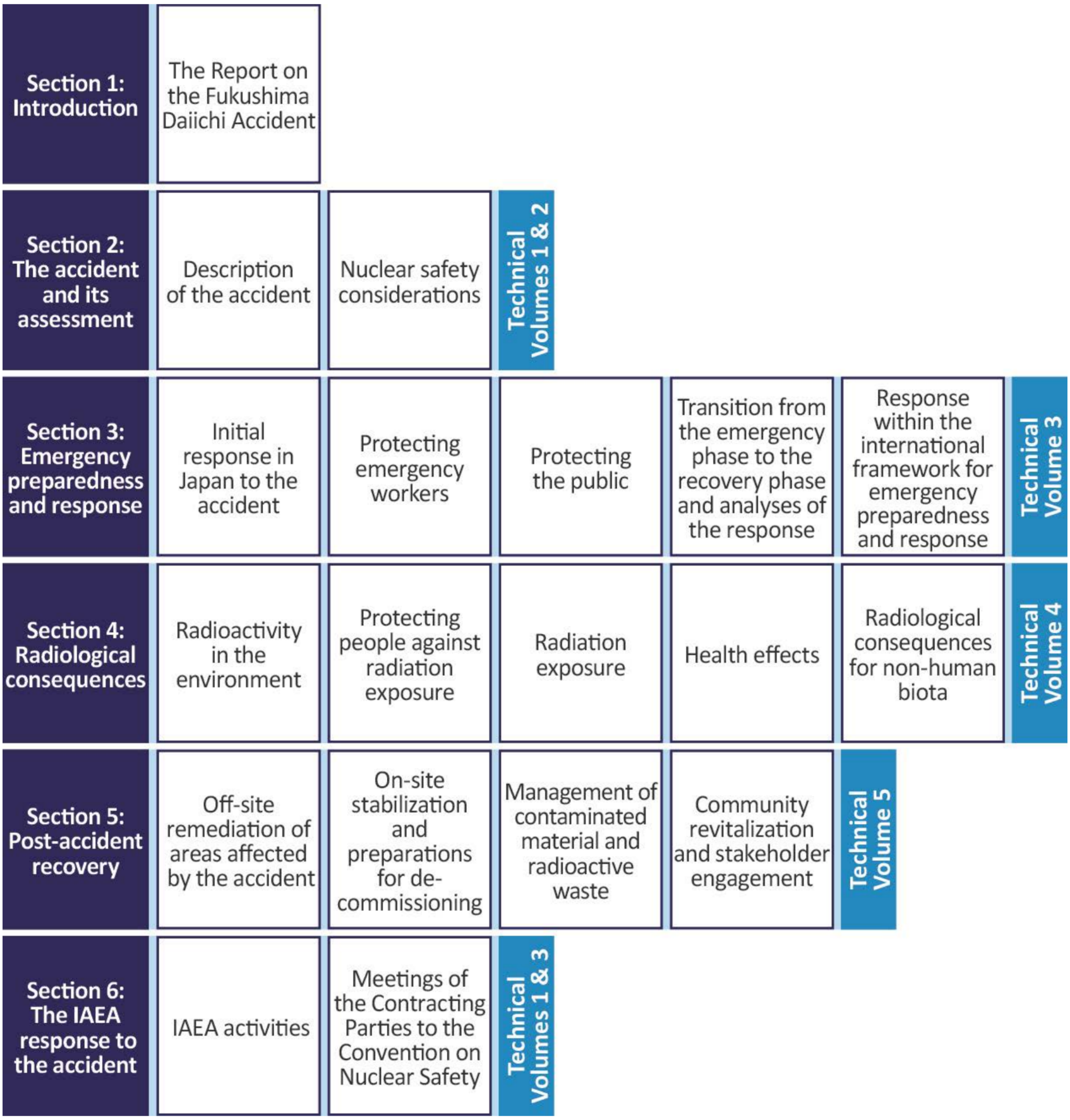

FIG. 2. Structure of the Summary Report and its relationship to the content of the technical volumes.

CONTENTS

3.3.10. Observations and lessons

- **Arrangements need to be in place to allow decisions to be made on the implementation of predetermined urgent protective actions for the public based on predefined plant conditions.**
  These arrangements are necessary because decision support systems, including those using computer models, may not be able to predict the size and timing of a radioactive release (the source term), the movement of plumes, deposition levels or resulting doses quickly or accurately enough in an emergency to be able to provide the sole basis for decisions on initial urgent protective actions.
  At the preparedness stage, there is a need to develop an emergency classification system based on observable conditions and measurable criteria (emergency action levels). This system enables the declaration of an emergency shortly after the detection of conditions at a plant that indicate actual or projected damage to the fuel and initiation of predetermined urgent protective actions for the public (in the predefined zones) promptly following classification of the emergency by the operator. This emergency classification system needs to cover a full range of abnormal plant conditions.
- **Arrangements need to be in place to enable urgent protective actions to be extended or modified in response to developing plant conditions or monitoring results. Arrangements are also needed to enable early protective actions to be initiated on the basis of monitoring results.**
  At the preparedness stage, there is a need to establish arrangements to, among others: (1) define emergency planning zones and areas; (2) establish dose and operational criteria (levels of measurable quantities) for taking urgent protective actions and other response actions, including dealing with special population groups within emergency zones (e.g. patients in hospitals); (3) enable urgent protective actions to be taken before or shortly after a release of radioactive material; (4) enable prompt establishment of access controls in areas where urgent protective actions are in place; (5) extend protective actions beyond the established emergency planning zones and areas if necessary; (6) establish dose and operational criteria for taking early protective actions and other response actions, e.g. relocation and food restrictions, that are justified and optimized, taking into account a range of factors such as radiological and non-radiological consequences, including economic, social and psychological consequences; and (7) establish arrangements for revision of operational criteria for taking early protective actions on the basis of the prevailing conditions.
  Emergency planning zones and areas, within which arrangements for the implementation of urgent and other protective actions are made, need to be established with severe nuclear emergencies taken into account. Such zones are to be established at the preparedness stage as part of a comprehensive protection strategy. There is also a need to establish arrangements to extend actions beyond the established planning zones and areas, if needed under conditions prevailing in an emergency.
  As part of preparedness for urgent protective actions, sheltering needs to be considered as a short term protective action, accompanied by iodine thyroid blocking.
  Arrangements need to take into account the possibility of restricting consumption and distribution of possibly contaminated local produce, milk from grazing animals and drinking water before the monitoring and analysis of samples are carried out.
- **Arrangements need to be in place to ensure that protective actions and other response actions in a nuclear emergency do more good than harm. A comprehensive approach to decision making needs to be in place to ensure that this balance is achieved.**
  These arrangements need to be developed with a clear understanding of the full range of possible health hazards presented in a nuclear emergency and of the potential radiological and non-radiological consequences of any protective actions.
  Protective actions need to be taken in a timely and safe manner, taking into account possible unfavourable conditions (e.g. severe weather or damage to infrastructure).

Preparations in advance are necessary to ensure the safe evacuation of special facilities, such as hospitals and nursing homes. Continued care or supervision must be provided for those who need it.

The need for the provision of instructions to all categories of farmers and for assisting those individuals who have been relocated also needs to be addressed.

— **Arrangements need to be in place to assist decision makers, the public and others (e.g. medical staff) to gain an understanding of radiological health hazards in a nuclear emergency in order to make informed decisions on protective actions. Arrangements also need to be in place to address public concerns locally, nationally and internationally.**

Public concerns need to be effectively addressed in a nuclear emergency. This includes the means to relate measurable quantities (e.g. dose rates) and projected radiation doses to radiological health hazards in a manner that allows decision makers (and the public) to make informed decisions concerning protective actions. Addressing public concerns contributes to mitigating both the radiological and the non-radiological consequences of the emergency.

These arrangements need to ensure prompt explanation of any health risks and possible appropriate individual actions for reducing these risks. Arrangements need to be in place to provide the public with useful, consistent and understandable information throughout a nuclear emergency, including an answer to the public's principal concern about potential health consequences; and to provide the public with an explanation of the basis for protective action recommendations.

International concerns could be addressed, in part, by means of certification systems to demonstrate that tradable goods meet international standards and to reassure importing States and the public.

— **Medical staff (health care professionals) need to be trained in basic medical response to a nuclear emergency and in adequate management of (possibly) contaminated patients to avoid delays in the treatment of injured people.**

Facilities that could be used as potential reception centres for triage, screening, decontamination and primary care of patients (either emergency workers or the public) need to be identified at the preparedness stage to facilitate the mobilization of resources during an emergency. Those treating or transporting contaminated patients would need to take the same kinds of precautions that would normally be applied when dealing with potentially infectious patients.

— **Emergency arrangements need to include provisions at the preparedness stage for implementing restrictions on the use and distribution of non-food commodities which have been, or could be, contaminated as a result of the emergency.**

Generic and operational criteria are needed to assess, where necessary, the adequacy of goods for use and distribution, and to establish a system for ensuring that controls are placed on those goods intended for international trade. These arrangements need to minimize major disruptions in international trade, while ensuring protection of the public.

— **Radioactive waste arising from the emergency needs to be managed in a manner that does not compromise the protection strategy.**

Detailed technical guidance for the management of radioactive waste, including food waste and waste generated from decontamination and remediation activities, needs to be developed at the preparedness stage. The guidance needs to include consideration that possible locations for facilities to store the radioactive waste on an interim basis and for long term disposal may need to be identified in advance. These arrangements need to be determined and agreed with the involvement of all relevant stakeholders, such as the local communities, at the preparedness stage.