Appeal No. PA14-330

Information and Privacy Commissioner of Ontario

IN THE MATTER OF Appeal No. PA14-330
under the
Freedom of Information and Protection of Privacy Act, RSO 1990, c F 31

SUPPLEMENTARY SUBMISSION OF THE APPELLANT

CANADIAN ENVIRONMENTAL LAW ASSOCIATION
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INDEX

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Freedom of Information and Protection of Privacy Act, RSO 1990, c F 31

AFFIDAVIT OF SHAWN-PATRICK STENSIL
Affirmed October 23, 2018

I, SHAWN-PATRICK STENSIL, of the City of Toronto, in the Province of Ontario, **AFFIRM**:

1. I am the requestor in Appeal No. PA14-330 before the Information and Privacy Commissioner of Ontario ("IPC"). I have personal knowledge of the matters to which I hereinafter depose. Where this knowledge is based on information and belief, my affidavit so indicates.

Background

2. In 2014, I submitted the following *Freedom of Information and Protection of Privacy Act*, RSO 1990, c F31 ("*FIPPA*") request:

> This is to make a formal request for the "source term" information for all Ex-Plant Release Categories included in the most recent probabilistic risk assessments for the Darlington as well as the Pickering A and B nuclear stations. Please note that the CNSC recently amended REGDOC-2.4.2 on Probabilistic Safety Assessment (PSA) to provide explicit direction to licensees of their obligation to release PSA information that is not security sensitive. That revised guide states: "In accordance with licensees' public information programs established under RD/GD-99.3, Public Information Disclosure, a summary of the results and assumptions of PSA should be made available to interested stakeholders. It should be noted that any information pertaining to specific fault sequences and vulnerability of a facility include security-sensitive information and is subject to applicable information security provisions." Also note CNSC staff stated at May 7th meeting of the Commission that they moving forward will "assist offsite authorities in emergency planning by providing a planning basis that includes release and source term information." (see pg. 22, 14-H2.A) This highlights that such information is not related to plant fault sequences or vulnerabilities, but is needed to evaluate the adequacy of offsite emergency planning.

3. Ontario Power Generation ("OPG") denied the request under sections 14, 16 and 20 of *FIPPA* on June 20, 2014.

4. I filed an appeal to the IPC, which was forwarded to adjudication on April 27, 2015.

5. OPG filed submissions with the IPC in July 2015. On February 25, 2016, I submitted an affidavit and representations to the IPC.

6. Since that time, the Canadian Nuclear Safety Commission ("CNSC") and the Ontario Ministry of Community Safety and Correctional Services have released several documents to the public with source term information.

7. This new information was not available in 2016 when my submissions were filed.

8. The information disclosed to me since my submissions were filed is similar, and overlaps with, the information requested in this appeal.

9. In October 2017, in response to an *Access to Information Act*, RSC 1985, c A-1 ("*ATIA*") request, the CNSC provided me with its letter to Ontario's Office of the Fire Marshal and Emergency Management relating to CNSC's guidance on the source term to be used in revising the Provincial Nuclear Emergency Response Plan, the accident analysis and assumptions, and source term data. Attached as **Exhibit 'A'** is a copy of CNSC's letter to the Office of the Fire Marshal and Emergency Management dated March 30, 2017.

10. CNSC states at page 1 of its letter that "the source term was generated from the results of the 2011 Darlington Probabilistic Safety Assessment (PSA) submitted by OPG to CNSC staff." I believe this is the same source document at issue in this appeal.

11. The CNSC released its *Technical Basis for Multi-Unit Severe Accident Source Term* report to me on November 24, 2017 in response to another *ATIA* request, attached as **Exhibit 'B'**. This report provides source term information for Release Category 1 from the 2011 Darlington Probabilistic Risk Assessment, as indicated at pages 4 and 11 of the report. This is one of the source documents at issue in this appeal, as referenced in the Mediator's Report at page 3.

12. This document includes a portion of the same source term information at issue in this appeal. The report also includes detailed information on the accident sequences, including specific reference to plant damage states, which lead to radioactive releases categorized as Release Category 1. Appendix B is a table with detailed radioisotope cumulative source terms for Release Category 1.

13. The Ontario government consulted with the public during its review of the Provincial Nuclear Emergency Response Plan. During the consultation, the provincial government provided me with technical studies used to inform the review, including *Argos Modelling of Accident A and Accident B Scenarios*. The report includes source terms which were used to model the offsite impacts of nuclear accidents. Attached as **Exhibit 'C'** is an excerpt of *Argos Modelling of Accident A and Accident B Scenarios* dated May 15, 2017.

14. Based on my review of other documents in the public domain, I am confident that the source term information contained in Exhibit C is also derived from the Darlington Probabilistic Risk Assessment.

15. On September 5, 2018, CNSC released its accident rating for an OPG emergency response exercise at the Pickering nuclear generating station through *ATIA*. The documents provide source term information and the accident sequence leading to the release. Attached as **Exhibit 'D'** is a copy of the CNSC's rating of OPG's December 2017 accident simulation.

16. Despite all of the source term information that has been released, I am continuing with this appeal because I do not have all of the source term information relating to the Darlington site and do not have source term information for the Pickering site. OPG regularly updates its probabilistic risk assessments, including source terms. In order for me to scrutinize the safety of OPG's nuclear reactors, and the adequacy of provincial and federal oversight of public safety, I need access to source term information on an ongoing basis.

Conclusion

17. My interest in disclosure of the requested source term information is to ensure that the public has sufficient information to scrutinize nuclear emergency plans and understand their risk in the event of a nuclear accident.

18. I make this supplementary affidavit in support of appeal PA14-330 and for no improper purpose.

AFFIRMED before me in the City of Toronto, in the Province of Ontario, this 23rd day of October, 2018.	))))	
	)	______________________________ Shawn-Patrick Stensil
______________________________ Commissioner for taking affidavits	)	

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

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PROTECTED A

Your File Votre référence

Our File Notre référence
A-2017-00057 / MK

OCT - 5 2017

This is Exhibit..........................referred to in the affidavit of.. affirmed before me, this.................................. day of..20........

....
A COMMISSIONER FOR TAKING AFFIDAVITS

Mr. Shawn-Patrick Stensil
Energy and Climate Campaigner
Greenpeace Canada
33 Cecil St.
Toronto, ON M5T 1N1

Dear Mr. Stensil:

This letter is in response to your request under the *Access to Information Act* for:

> ***"According to a May 2017 study carried out by Health Canada (entitled "ARGOS Modelling of Accident A and Accident B Scenarios") "...the CNSC underwent an analysis of source terms from a broad technical basis with related conservatisms that could be witnessed in a severe event to guide the Ontario Office of the Fire Marshal and Emergency Management (OFMEM) review of the Provincial Nuclear Emergency Response Plan (PNERP)." The report indicates that the CNSC provided this information to OFMEM in March 2017. I would like all correspondence sent to OFMEM providing this information. Also provide any meeting minutes or presentations from meetings where the CNSC discussed this guidance with OFMEM. Please also provide hand-written notes from those meetings. "***

Enclosed please find copies of all the accessible records you requested.

You have the right to file a complaint with the Information Commissioner of Canada about this aspect of the processing of your request for a period of 60 days following the receipt of this notice. The address is:

Information Commissioner of Canada
30 Victoria Street
Gatineau, Québec
K1A 1H3

If you have any questions regarding this request, do not hesitate to contact Maria Krioutchkova, at 613-944-1973.

Sincerely,

Emily Gusba
Director, Information Management Division
Access to Information and Privacy
Attach.

Canada

Daoust, Judith (CNSC/CCSN)

From:	Sigouin2, Luc (CNSC/CCSN)
Sent:	March-31-17 3:26 AM
To:	Dominique Nsengiyumva (dominique.nsengiyumva@hc-sc.gc.ca); Bergman, Lauren (HC/SC); Kevin Buchanan (kevin.buchanan2@canada.ca)
Subject:	RE: Final - Letter to David Nodwell - Planning Accident B Discription and Conservative Assumptions

Dear HC colleagues,

Per below, CNSC has sent an updated source term and context to OFMEM. I expect that OFMEM will provide to you shortly for your assessment.

Regards,

Luc

From: Pilon, Julie (CNSC/CCSN) **On Behalf Of** Newland, David (CNSC/CCSN)
Sent: March-30-17 12:20 PM
To: dave.nodwell@ontario.ca
Cc: Newland, David (CNSC/CCSN); Heppell-Masys, Kathleen (CNSC/CCSN); Sigouin2, Luc (CNSC/CCSN); Mesmous, Noreddine (CNSC/CCSN); Akl, Yolande (CNSC/CCSN)
Subject: Final - Letter to David Nodwell - Planning Accident B Discription and Conservative Assumptions

Dear Mr. Nodwell,

Please find attached the CNSC's response regarding source term to be used for a revision of the PNERP. The original signed letter will follow in the mail.

If you have any questions regarding this information, I can be reached at 613.995-2031 or david.newland@canada.ca

Yours sincerely,

David Newland
Director General
Directorate of Assessment and Analysis

March 30th, 2017 eDoc: 5197714

Mr. David Nodwell
Deputy Chief, Planning and Program Development (OFMEM)
Office of the Fire Marshal and Emergency Management
Forensic Services and Coroner's Complex
25 Morton Shulman Avenue
Toronto, ON M3M 1J8

Dear Mr. Nodwell,

Further to discussions between OFMEM and CNSC, I would like to formalize CNSC's guidance regarding the source term to be used for a revision of the PNERP. Please find attached enclosure 1, which provides details regarding the isotopes release quantities and the release duration. In addition, we briefly provide some contextual information related to the source term provided to OFMEM for consideration in the revision of the PNERP. We briefly describe the broad technical basis for the source term and discuss the related conservatisms assumed.

The source term was generated from the results of the 2011 Darlington Probabilistic Safety Assessment (PSA) submitted by OPG to CNSC staff.

The multi-unit severe accident which results in an early unmitigated release is a total station blackout event that leads to a complete and prolonged loss of all AC power (Class IV, Class III, and emergency power supplies) for all four units of the Darlington Nuclear Generation Station. It is a very low probability accident leading to severe core damage and large releases of fission products that would be rated as a level 7 accident on the International Nuclear and Radiological Event Scale (INES).

This accident analysis contains a number of conservative assumptions that were used in the simulation as follows:

1. The event corresponds to a four-unit severe accident. The probability of individual sequences leading to such a total station blackout event, together with other additional failures, is of the order of 10^{-7}.

2. The accident is assumed to proceed at the same rate in all four units, leading to simultaneous release of radio nuclides to the atmosphere from each reactor.

3. Systems expected to mitigate the magnitude of the source term and delay the timing of release into the environment are assumed to be unavailable. For example: it is assumed

that failure occurs of all AC electrical systems resulting in no power available for cooling-systems, the emergency containment filtered venting system is not credited (action of this system would relieve containment pressure avoiding containment failure, and during venting, would very efficiently filter out most radiological isotopes), and other sources of passive water cooling were not credited.

4. No operator actions are credited to halt or mitigate the first release of the event. During the course of an accident there are multiple opportunities for operators to arrest the progress of or terminate the accident, in particular, the equipment installed as result of the Fukushima accident. It is assumed that after the first release, operator intervention is successful to mitigate the accident and thus prevent subsequent releases.

I would finally note that given the combined number of conservative assumptions across all aspects of the complete analysis (choice of event and mitigation, weather conditions, dispersion, etc.) it may be beneficial to explore sensitivity analyses in the future to better understand the balance of conservatism across the various inputs.

If you have any questions regarding this information, I can be reached at 613-995-2031 or david.newland@canada.ca.

Yours sincerely,

David Newland
Director General
Directorate of Assessment and Analysis

Enclosure: (1)

c.c.:/c.c. : K. Heppell-Masys, L. Sigouin, N. Mesmous, Y. Akl

Enclosure : Detailed Radioisotope Cumulative Source Terms

Isotope	*1st Release* Release Fraction	Time Release Starts	Release (TBq)	Release Duration (hr)
Kr-85		9	2.28E+02	3.7
Kr-85m		9	3.11E+04	3.7
Kr-87		9	5.78E+04	3.7
Kr-88		9	8.23E+04	3.7
Xe-131m	0.93%	9	7.34E+02	3.7
Xe-133		9	2.21E+05	3.7
Xe-133m		9	3.14E+04	3.7
Xe-135		9	1.80E+04	3.7
Xe-135m		9	4.45E+04	3.7
I-131		9	**2.23E+04**	3.7
I-132	0.19%	9	3.31E+04	3.7
I-133		9	4.69E+04	3.7
I-135		9	4.39E+04	3.7
Cs-134		9	2.50E+02	3.7
Cs-136	0.19%	9	3.76E+02	3.7
Cs-137		9	**4.98E+02**	3.7
Rb-86	0.19%	9	6.62E+00	3.7
Te-127		9	0.00E+00	3.7
Te-127m		9	0.00E+00	3.7
Te-129		9	0.00E+00	3.7
Te-129m		9	0.00E+00	3.7
Te-131	0.00%	9	0.00E+00	3.7
Te-131m		9	0.00E+00	3.7
Te-132		9	0.00E+00	3.7
Te-133		9	0.00E+00	3.7
Te-133m		9	0.00E+00	3.7
Sb-127		9	4.54E+02	3.7
Sb-128	0.04%	9	7.67E+01	3.7
Sb-129		9	1.61E+03	3.7
Sr-89	0.00%	9	8.04E+00	3.7
Sr-90		9	1.54E-01	3.7

	1st Release			
Isotope	Release Fraction	Time Release Starts	Release (TBq)	Release Duration (hr)
Sr-91		9	1.21E+01	3.7
Sr-92		9	1.28E+01	3.7
Sr-93		9	1.43E+01	3.7
Y-90m		9	7.26E-06	3.7
Y-91		9	7.26E-06	3.7
Y-91m	0.00%	9	3.16E-01	3.7
Y-92		9	5.87E-01	3.7
Y-93		9	6.68E-01	3.7
Mo-99	0.02%	9	4.57E+03	3.7
Ba-139		9	3.46E+02	3.7
Ba-140	0.00%	9	3.36E+02	3.7
Ba-141		9	3.17E+02	3.7
Ba-142		9	3.03E+02	3.7
La-140		9	7.91E-01	3.7
La-141	0.00%	9	7.31E-01	3.7
La-142		9	7.10E-01	3.7

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

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Our File Notre référence
A-2017-00157 / SL

NOV 24 2017

This is Exhibit..........................referred to in the
affidavit of...
affirmed before me, this.................................
day of...20........

....
A COMMISSIONER FOR TAKING AFFIDAVITS

Mr. Shawn-Patrick Stensil
Energy and Climate Campaigner
Greenpeace Canada
33 Cecil St.
Toronto, ON M5T 1N1

Dear Mr. Stensil:

This letter is in response to your request under the *Access to Information Act* for:

> ***"Modified text on 2017-10-26:***
> ***In a March 8, 2017 email, Michael Rinker states "DAA is in the process of doing a QA on the source term work." Please provide a copy of this QA.***
>
> ***Original text:***
> ***In a March 8, 2017email Mark Rinkler states "DAA is in the process of doing a QA on the source term work." Please provide a copy of this QA."***

Enclosed please find copies of all the accessible records you requested. The QA that is mentioned in the e-mail by Michael Rinker was completed in the *Technical Basis for Multi-Unit Severe Accident Source Term* document that is being provided to you. There is no separate QA document that was produced; all internal reviews and sign-offs were completed within the attached document.

You have the right to file a complaint with the Information Commissioner of Canada about this aspect of the processing of your request for a period of 60 days following the receipt of this notice. The address is:

Information Commissioner of Canada
30 Victoria Street
Gatineau, Québec
K1A 1H3

Canada

If you have any questions regarding this request, do not hesitate to contact Sylvia Ladanyi, at 613-996-8157.

Sincerely,

Emily Gusba
Director, Information Management Division
Access to Information and Privacy

Attach: 17 pages

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Directorate of Assessment and Analysis

Technical Basis for Multi-Unit Severe Accident Source Term

Classification: Protected B
Version 2

E-DOCS Number: 5197725

March 24, 2017

This document is not controlled once printed.

Name	Role	Signature	Date
T. Nguyen Technical Specialist Reactor Behaviour Division	Preparation		*March 23, 2017*
Q. Lei Technical Specialist Reactor Behaviour Division	Preparation		*March 23, 2017*
P. Devitt Specialist Reactor Behaviour Division	Preparation		*March 23, 2017*
K.C Leung Specialist Reactor Behaviour Division	Preparation		*March 23, 2017*
S. Yalaoui Technical Specialist Probabilistic Safety Analysis and Reliability Division	Preparation		*March 23, 2017*
N. Mesmous Director Reactor Behaviour Division	Approval		*March 23, 2017*
Y. Akl Director Probabilistic Safety Analysis and Reliability Division	Approval		*March 23, 2017*

Table of Contents

1. Objective

The objective of this report is to provide the technical basis and discuss the conservatism used in the generation of the multi-unit severe accident source terms.

2. Background for event selection

Severe accidents affecting 4 units are binned into plant damage state "PDS3". PDS3 is a collection of sequences that lead to a total loss of heat sinks in multiple units. The accident sequence in this category, presented in the 2011 Level 2 OPG Darlington Probabilistic Risk Assessment (DARA) [1] broadly falls into one of two types: either total station blackout or station wide loss of all station service water. The loss of service water events progress more slowly than the total station blackout events. Therefore, a total station blackout event is selected as the representative sequence for a multi-unit accident.

Of the total station blackout events, those initiated by a secondary side break which impacts the ability of the operator to perform recovery actions are the most severe. Hence, the large steam line break causing consequential loss of offsite power (Class IV), followed by station loss of power from diesel generators (Class III) and loss of the emergency power supply (EPS) is selected as the representative sequence for PDS3 [1].

This accident sequence contributes to a large release accident, categorized as release category 1 (RC1). RC1 is defined as a release of more than 2-3% of the core inventory of I-131 to the environment. The combined frequency of all RC1 events in the 2011 level 2 DARA is 4.86×10^{-6} events per year. Almost all accident sequences (99.8%) which lead to a RC1 release come from the PDS3 accident sequences [1].

Accident progression event trees (APET) are presented for the PDS3 accident sequence, referred to as APET1 to APET6. The APET4 is the reference case for the PDS3 accident sequence in the 2011 DARA. APET1 is a sensitivity case that is considered limiting for early releases for the PDS3 accident sequence.

The two APET cases presented differ on the assumption of the corium spread area after corium relocates to the fueling machine duct in the later stages of accident progression. While this difference in the two APET sensitivity cases is not of consequence until late into the accident, there are minor differences in accident progression timing due to MAAP4 being very sensitive to parameter changes.

The reference case (APET4) represents a larger corium spread area which allows for a greater cooling surface area by the flooded fueling machine duct floor. The larger corium spread area is considered a more realistic assumption of corium behaviour. In contrast, the limiting case for early release (APET1) represents a smaller spread area which reduces the capability to cool the corium. As the corium spread area is smaller in APET1, the corium height is higher which causes the corium to be uncovered earlier in the accident (58 h vs. 86 h).

In addition, in 2011 OPG performed a sensitivity analysis as part of the Environmental Impact Assessment [2] and showed that for the post refurbishment configuration (implementation of Safety Improvement opportunities) RC1 will be reduced to 5.1×10^{-8} per reactor year (98.9% decrease).

3. Initiating conditions and system availabilities

The initiating event is a main steam line break at Unit 2 (accident unit) and is described below:

- The reactor is shut down successfully.
- The secondary side break causes the generators for the other units to trip. Shutdown of the four Darlington generators leads to loss of site Class IV power.
- The loss of Class IV power means the heat transport pumps are not running.
- Feedwater is depleted in the accident unit, and interunit feedwater tie (IUFT) is not available due to the loss of Class III power, so secondary side heat sinks are not available.
- Class III and EPS power are not available due to random failures. The loss of these power supplies has the following effects:
  - The shutdown cooling (SDC) pumps are not available.
  - The instrument air is not available.
  - The emergency coolant injection (ECI) and the moderator heat sinks fail.
  - The end shield cooling fails.
  - The Emergency Service Water is unavailable.
- Failure to cool down and loss of alternative current (AC) power leads to a loss of heat sinks, causing heat transport system heat-up and pressurization and then consequential pressure tube and calandria tube failure.

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4. Accident progression, key mitigation actions and effects of assumptions

Following is a summary table outlining the significant events of a total station blackout, as described above, with the potential key mitigation actions to stop or mitigate the accident progression. Table 1 also outlines the effects of these assumptions.

Table 1- Total Station Blackout Scenario Progression with Potential Operator's Actions to Stop or Mitigate Accident Progression

Significant events	Time, hr	Potential key actions to stop or mitigate accident progression	Effects of Assumptions
All power lost – reactor is shut down but all active cooling systems' circulation is off	0	Restore grid power to primary heat transport system and feedwater pumps to establish heat sink Restore standby generators to power primary heat transport system and feedwater pumps to establish heat sink	These restoration actions are not accounted for. If they are available and implemented, the fuel will be cooled by the available heat sinks, accident progression will stop early and there will be no fission product release
Boiler dryout leading to a loss of heat sink to remove the core decay heat	5.0	Restore emergency power supply to power feedwater pumps and establish heat sink	The action is not accounted for. Otherwise, the secondary side heat sink will be re-established
		Depressurize boilers and open valves for emergency feedwater supply into boilers from the station water sources	The boiler dryout time of 5 hours given here credits the control room operator's action to depressurize boilers (using batteries) and allow an automatic supply of some portion of water to the boilers from the station water sources If the available station water sources are fully accounted for, the boiler

Significant events	Time, hr	Potential key actions to stop or mitigate accident progression	Effects of Assumptions
			dryout time will delay to a minimum of 9 h, giving more time to deploy the emergency mitigating equipment to stop the accident progression
		Use emergency mitigating equipment to pump external sources of water into boilers	The action is not accounted for. Otherwise, boilers will continue to be an effective heat sink to cool the fuel
Start of core disassembly leading to core collapse **First stage of release to the atmosphere**	Both Cases (Limiting & Reference Case) 9.0	Use emergency mitigating equipment to pump external sources of water to the calandria Bring in external generators to re-establish power to emergency coolant injection system pumps to maintain long-term core cooling	These actions are not accounted for. If accounted for, further core degradation will stop and there will be no further core debris present in the calandria
Containment failed due to pressurization of containment from shield tank overpressure **Second stage of release to the atmosphere**	Limiting Case: 22.9 Reference Case: 22.5	Vent containment through the containment filter venting system (CFVS) Restore cooling of containment Use emergency mitigating equipment to	Shield tank overpressure protection (STOP) is provided, as a post-Fukushima enhancement to severe accident management, to prevent this catastrophic failure. In this case, STOP from the design modification

A0066999_8-000008

Significant events	Time, hr	Potential key actions to stop or mitigate accident progression	Effects of Assumptions
Calandria vessel fails **Third stage of release to the atmosphere**	Limiting Case: 24.6 Reference Case: 24.0	pump external sources of water to the calandria or shield tank.	was not accounted for. Crediting STOP will prevent shield tank failure and further delay in containment failure and large release All the actions are not accounted for
Start of molten core concrete interaction (MCCI) once the corium is uncovered of water. **Fourth stage of release to the atmosphere**	Limiting Case: 58.4 Reference Case: 86.3	Flooding of the fueling machine duct using any means available	The shield tank water inventory that spilled into in the fueling machine duct when the shield tank underwent catastrophic overpressure (see above) is available to submerge the corium. Additional water injected to flood the fueling machine duct floor would be able to submerge the corium and provide sufficient cooling to halt MCCI.

5. Source terms

The following tables are a summary of the source term for a four-unit severe accident. The full source term results accounting for other isotopes, in addition to I-131and Cs-137, that may contribute to the dose consequence are shown in Appendices B.

Table 2a – Cumulative Source Term Release for a Four-Unit Severe Accident up to 24h without decay

Release with Approximate Time and Duration (hr)	Limiting Case (APET1) [3]	Reference Case (APET4) [4]	Remarks
Release 1 Core disassembly leading to core collapse Limiting Case: At 9.0 hr over 3.7 hr Reference Case: at 9.1 hr over 2.8 hr	22,300 TBq for I-131 498 TBq for Cs-137 56,700 TBq for I-131 equivalent **INES 7**	14100 TBq for I-131 126 TBq for Cs-137 36000 TBq for I-131 equivalent **INES 6**	IAEA guidelines indicate an INES 7 criteria based on activity is above 50000 TBq of I-131 equivalent releases [5]. IAEA guidelines indicate an INES 6 criteria based on activity is between 5000 to 50000 TBq of I-131 equivalent releases [5].
Release 2 Containment failure from shield tank overpressure Limiting Case: At 22.9 hr until 24 hr Reference Case: At 22.5 hr until 24 hr	28,000 TBq for I-131 625 TBq for Cs-137 71,500 TBq for I-131 equivalent **INES 7**	21100 TBq for I-131 471 TBq for Cs-137 53800 TBq for I-131 equivalent **INES 7**	In this simulation, a scaled-containment model is used, which assumes that all the four units undergo the exact same accident progression. As a result, the model overestimates the containment pressure spike from shield tank overpressure. In reality, it is unlikely that it will occur at the exactly same time in all four units. This modeling assumption leads to a significant overestimation of the magnitude of the release and an early timing for the release. If the simulation was performed using a more realistic staggered accident progression or if the design enhancement of Shield Tank Overpressure Protection (STOP) is accounted for, containment would not fail due to shield tank overpressure.

A0066999_10-000010

Table 2b – Cumulative Source Term Release for a Four-Unit Severe Accident up to 24h with decay

Release with Approximate Time and Duration (hr)	Limiting Case (APET1) [3]	Reference Case (APET4) [4]	Remarks
Release 1 Core disassembly leading to core collapse Limiting Case: At 9.0 hr over 3.7 hr Reference Case: at 9.1 hr over 2.8 hr	21,600 TBq for I-131 498 TBq for Cs-137 53,500 TBq for I-131 equivalent **INES 7**	13,700 TBq for I-131 315 TBq for Cs-137 33,900 TBq for I-131 equivalent **INES 6**	IAEA guidelines indicate an INES 7 criteria based on activity is above 50000 TBq of I-131 equivalent releases [5]. IAEA guidelines indicate an INES 6 criteria based on activity is between 5000 to 50000 TBq of I-131 equivalent releases [5]. Decay is calculated using the methodology described in Appendix A.
Release 2 Containment failure from shield tank overpressure Limiting Case: At 22.9 hr until 24 hr Reference Case: At 22.5 hr until 24 hr	25,800 TBq for I-131 625 TBq for Cs-137 62,700 TBq for I-131 equivalent **INES 7**	19,500 TBq for I-131 471 TBq for Cs-137 47,200 TBq for I-131 equivalent **INES 6**	In this simulation, a scaled-containment model is used, which assumes that all the four units undergo the exact same accident progression. As a result, the model overestimates the containment pressure spike from shield tank overpressure. In reality, it is unlikely that it will occur at the exactly same time in all four units. This modeling assumption leads to a significant overestimation of the magnitude of the release and an early timing for the release. If the simulation was performed using a more realistic staggered accident progression or if the design enhancement of Shield Tank Overpressure Protection (STOP) is accounted for, containment would not fail due to shield tank overpressure. Decay is calculated using the methodology described in Appendix A.

6. References

1. Ontario Power Generation, Darlington NGS Level 2 at Power Internal Events Risk Assessment, NK38-REP03611-10044, Rev. 0, August, 2011
2. Ontario Power Generation, Multi-Functions and Accidents Technical Support Documents, Darlington Nuclear Generating Station Refurbishment and Continued Operation Environmental Assessment, e-Docs#384807, December, 2011
3. PDS3_ACM43_CEI 1-PRV.D81. Relevant Analysis File for project PN104 (At-Power Level 2 PRA for Internal Initiating Events for DNGS). PN104/CD/025 R01. Disc 7. AMEC. November 29, 2011.
4. PDS3_CEI 4-PRV.D81. Relevant Analysis File for project PN104 (At-Power Level 2 PRA for Internal Initiating Events for DNGS). PN104/CD/025 R01. Disc 7. AMEC. November 29, 2011.
5. The International Nuclear and Radiological Event Scale User's Manual. 2008 Edition. International Atomic Energy Agency. Emended March 2013.

Appendix A: Methodology for Source Term Analysis

The results from Appendices B and C were attained using the following methodology:

1. Get list of isotopes
2. Find when releases start and end
    a. Export the CsI release fractions from the DARA 2011 PDS3 MAAP plotfil 81
        i. CsI is used due to Cs-137 and I-131 being the main contributors of dose consequences
    b. Filter out insignificant levels of leakage by keeping only values one standard deviation above the mean
    c. Use remaining values to determine start and end of releases
3. From the exported DARA 2011 PDS3 plotfil, find release fractions for each isotope
    a. Release fractions of each isotope are categorized into fission product groups in MAAP4
        i. Isotopes are matched with their respective fission product groups (i.e. Cs-134, Cs-136, and Cs-137 use Fission Product Group 2 which corresponds to the release fractions of CsI)
    b. Release fraction taken at end of release duration
    c. Start of release at the beginning of release duration
4. Account for radioactive decay to get the release magnitude (see Table 2b)
    a. Apply radioactive decay through $N=N_0e^{-\lambda t}$, where
        i. N_0 is initial core inventory (taken from Darlington Safety Report)
        ii. λ is the decay constant of 1/ half life (half life taken from Darlington Safety Report)
        iii. t is the time of the release

Appendix B: Detailed Radioisotope Cumulative Source Terms

The following table was generated using Plotfil 81 of PDS3 APET1 (limiting case) [3].

Table 3 – Detailed cumulative source terms for PDS3 limiting case without decay up to 24h

	1st Release				*2nd Release until 24 hr*		
Isotope	Release Fraction	Time Release Starts	Release (TBq)	Release Duration (hr)	Release Fraction	Time Release Starts	Release (TBq)
Kr-85		9	2.28E+02	3.7		22.9	1.75E+04
Kr-85m		9	3.11E+04	3.7		22.9	2.40E+06
Kr-87		9	5.78E+04	3.7		22.9	4.45E+06
Kr-88		9	8.23E+04	3.7		22.9	6.34E+06
Xe-131m	0.93%	9	7.34E+02	3.7	71.51%	22.9	5.65E+04
Xe-133		9	2.21E+05	3.7		22.9	1.70E+07
Xe-133m		9	3.14E+04	3.7		22.9	2.42E+06
Xe-135		9	1.80E+04	3.7		22.9	1.38E+06
Xe-135m		9	4.45E+04	3.7		22.9	3.42E+06
I-131		9	**2.23E+04**	3.7		22.9	**2.80E+04**
I-132	0.19%	9	3.31E+04	3.7	0.24%	22.9	4.16E+04
I-133		9	4.69E+04	3.7		22.9	5.89E+04
I-135		9	4.39E+04	3.7		22.9	5.51E+04
Cs-134		9	2.50E+02	3.7		22.9	3.14E+02
Cs-136	0.19%	9	3.76E+02	3.7	0.24%	22.9	4.72E+02
Cs-137		9	**4.98E+02**	3.7		22.9	**6.25E+02**
Rb-86	0.19%	9	6.62E+00	3.7	0.23%	22.9	7.93E+00
Te-127		9	0.00E+00	3.7		22.9	0.00E+00
Te-127m		9	0.00E+00	3.7		22.9	0.00E+00
Te-129		9	0.00E+00	3.7		22.9	0.00E+00
Te-129m		9	0.00E+00	3.7		22.9	0.00E+00
Te-131	0.00%	9	0.00E+00	3.7	0.00%	22.9	0.00E+00
Te-131m		9	0.00E+00	3.7		22.9	0.00E+00
Te-132		9	0.00E+00	3.7		22.9	0.00E+00
Te-133		9	0.00E+00	3.7		22.9	0.00E+00
Te-133m		9	0.00E+00	3.7		22.9	0.00E+00
Sb-127	0.04%	9	4.54E+02	3.7	0.14%	22.9	1.49E+03
Sb-128		9	7.67E+01	3.7		22.9	2.52E+02

Isotope	1st Release Release Fraction	Time Release Starts	Release (TBq)	Release Duration (hr)	2nd Release until 24 hr Release Fraction	Time Release Starts	Release (TBq)
Sb-129		9	1.61E+03	3.7		22.9	5.28E+03
Sr-89		9	8.04E+00	3.7		22.9	8.26E+00
Sr-90		9	1.54E-01	3.7		22.9	1.58E-01
Sr-91	0.00%	9	1.21E+01	3.7	0.00%	22.9	1.24E+01
Sr-92		9	1.28E+01	3.7		22.9	1.32E+01
Sr-93		9	1.43E+01	3.7		22.9	1.47E+01
Y-90m		9	7.26E-06	3.7		22.9	7.46E-06
Y-91		9	7.26E-06	3.7		22.9	7.46E-06
Y-91m	0.00%	9	3.16E-01	3.7	0.00%	22.9	3.25E-01
Y-92		9	5.87E-01	3.7		22.9	6.03E-01
Y-93		9	6.68E-01	3.7		22.9	6.86E-01
Mo-99	0.02%	9	4.57E+03	3.7	0.02%	22.9	5.00E+03
Ba-139		9	3.46E+02	3.7		22.9	3.56E+02
Ba-140	0.00%	9	3.36E+02	3.7	0.00%	22.9	3.46E+02
Ba-141		9	3.17E+02	3.7		22.9	3.26E+02
Ba-142		9	3.03E+02	3.7		22.9	3.12E+02
La-140		9	7.91E-01	3.7		22.9	8.12E-01
La-141	0.00%	9	7.31E-01	3.7	0.00%	22.9	7.52E-01
La-142		9	7.10E-01	3.7		22.9	7.29E-01

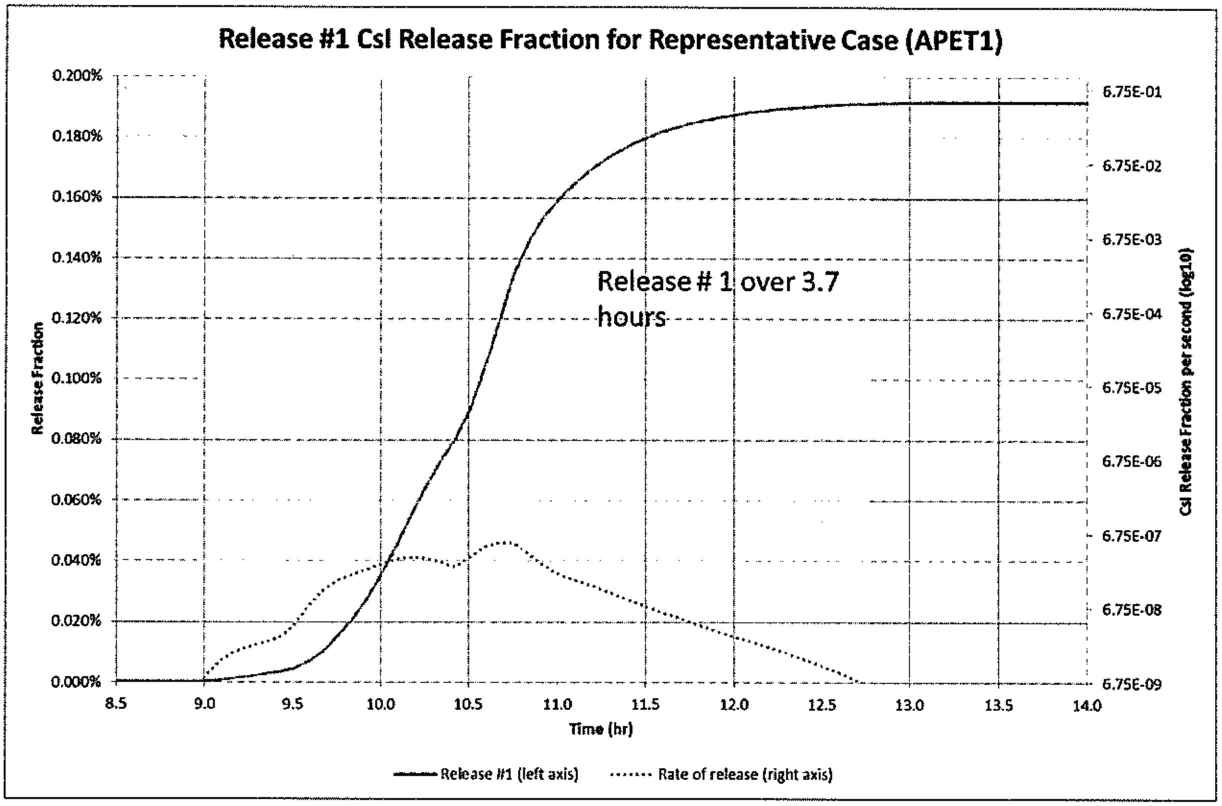
The following table was generated using Plotfil 81 of PDS3 APET1 (limiting case) [3] and accounting for radioactive decay using the methodology described in Appendix A.

Table 4 – Detailed cumulative source terms for PDS3 limiting case with decay up to 24h

	1st Release				*2nd Release until 24 hr*		
Isotope	Release Fraction	Time Release Starts	Release (TBq)	Release Duration (hr)	Release Fraction	Time Release Starts	Release (TBq)
Kr-85		9	2.28E+02	3.7		22.9	1.75E+04
Kr-85m		9	7.71E+03	3.7		22.9	6.86E+04
Kr-87		9	4.19E+02	3.7		22.9	1.59E+01
Kr-88		9	8.78E+03	3.7		22.9	2.13E+04
Xe-131m	0.93%	9	7.18E+02	3.7	71.51%	22.9	5.35E+04
Xe-133		9	2.10E+05	3.7		22.9	1.50E+07
Xe-133m		9	2.80E+04	3.7		22.9	1.80E+06
Xe-135		9	9.10E+03	3.7		22.9	2.44E+05
Xe-135m		9	1.93E-06	3.7		22.9	1.49E-20
I-131		9	**2.16E+04**	3.7		22.9	**2.58E+04**
I-132	0.19%	9	2.14E+03	3.7	0.24%	22.9	3.92E+01
I-133		9	3.45E+04	3.7		22.9	2.68E+04
I-135		9	1.73E+04	3.7		22.9	5.15E+03
Cs-134		9	2.50E+02	3.7		22.9	3.14E+02
Cs-136	0.19%	9	3.69E+02	3.7	0.24%	22.9	4.49E+02
Cs-137		9	**4.98E+02**	3.7		22.9	**6.25E+02**
Rb-86	0.19%	9	6.53E+00	3.7	0.23%	22.9	7.66E+00
Te-127		9	0.00E+00	3.7		22.9	0.00E+00
Te-127m		9	0.00E+00	3.7		22.9	0.00E+00
Te-129		9	0.00E+00	3.7		22.9	0.00E+00
Te-129m		9	0.00E+00	3.7		22.9	0.00E+00
Te-131	0.00%	9	0.00E+00	3.7	0.00%	22.9	0.00E+00
Te-131m		9	0.00E+00	3.7		22.9	0.00E+00
Te-132		9	0.00E+00	3.7		22.9	0.00E+00
Te-133		9	0.00E+00	3.7		22.9	0.00E+00
Te-133m		9	0.00E+00	3.7		22.9	0.00E+00
Sb-127		9	4.24E+02	3.7		22.9	1.25E+03
Sb-128	0.04%	9	3.84E+01	3.7	0.14%	22.9	4.32E+01
Sb-129		9	3.89E+02	3.7		22.9	1.43E+02

	1st Release				*2nd Release until 24 hr*		
Isotope	Release Fraction	Time Release Starts	Release (TBq)	Release Duration (hr)	Release Fraction	Time Release Starts	Release (TBq)
Sr-89		9	8.00E+00	3.7		22.9	8.16E+00
Sr-90		9	1.54E-01	3.7		22.9	1.58E-01
Sr-91	0.00%	9	6.33E+00	3.7	0.00%	22.9	2.39E+00
Sr-92		9	1.23E+00	3.7		22.9	3.39E-02
Sr-93		9	1.74E-21	3.7		22.9	2.57E-55
Y-90m		9	1.03E-06	3.7		22.9	5.18E-08
Y-91		9	7.22E-06	3.7		22.9	7.37E-06
Y-91m	0.00%	9	1.69E-04	3.7	0.00%	22.9	1.53E-09
Y-92		9	1.01E-01	3.7		22.9	6.80E-03
Y-93		9	3.62E-01	3.7		22.9	1.44E-01
Mo-99	0.02%	9	4.16E+03	3.7	0.02%	22.9	3.93E+03
Ba-139		9	3.80E+00	3.7		22.9	3.70E-03
Ba-140	0.00%	9	3.29E+02	3.7	0.00%	22.9	3.28E+02
Ba-141		9	3.96E-07	3.7		22.9	7.24E-21
Ba-142		9	1.46E-13	3.7		22.9	3.32E-37
La-140		9	6.77E-01	3.7		22.9	5.48E-01
La-141	0.00%	9	1.49E-01	3.7	0.00%	22.9	1.31E-02
La-142		9	1.17E-02	3.7		22.9	2.10E-05

Appendix C: Release characteristics for first release



This is Exhibit............................referred to in the
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day of..20........

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A COMMISSIONER FOR TAKING AFFIDAVITS

ARGOS Modelling of Accident A and Accident B Scenarios

May 15 2017, Report Version 5

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Abstract

The Radiation Protection Bureau of Health Canada has undertaken nuclear emergency consequence modelling using Health Canada's Accident Reporting and Guidance Operational System. This modelling included two hypothetical source terms provided by the Canadian Nuclear Safety Commission, Accident A and Accident B. Two approaches were taken to the atmospheric dispersion modelling, one using a Gaussian dispersion model with basic meteorological inputs that were considered representative of average weather conditions and the second using a Lagrangian dispersion model with real forecast meteorology for specific dates, with a total of 9 dates analysed per accident. For each simulation, the maximum and, in the case of Accident B, the mean total effective dose (TED) and thyroid dose for a 5-year-old child and an adult were assessed with increasing distance from the nuclear power plant with no dose reduction factors applied and in consideration of dose reduction due to sheltering. In the case of the Lagrangian produced results, the maximum and mean doses were reported individually and were also averaged over the 9 dates analysed. The dose results were then compared to several criteria related to the implementation of specific protective actions, including the Generic Criteria recommended in the draft *Canadian Guidelines for Protective Actions during a Nuclear Emergency* (HC, 2016). For the averaged Lagrangian produced results for a sheltered adult, it was found that the Generic Criteria for evacuation was exceeded to a distance of 4 km for Accident A based on the maximum TED and was not exceeded for Accident B based on the maximum or mean TED. The Generic Criteria for stable iodine thyroid blocking was exceeded out to a distance of 11 km for Accident A based on the maximum thyroid dose and to a distance of 9 km and 40 km for Accident B based on the mean and maximum thyroid dose, respectively. Depending on the source term, the specific meteorological conditions, the sensitivity of the receptor (i.e. the 5-year-old child in comparison to the adult), and the exposure assumptions used (i.e. sheltered vs. non-sheltered), the maximum and mean distances at which the criteria were exceeded varied, in some cases to much greater distances. These distances should be interpreted in relation to the specific conditions under which they were calculated. For comparison, the Gaussian produced results for a sheltered adult showed the same Generic Criteria for evacuation was not exceeded for Accident A based on the maximum TED and was exceeded to a distance of 3 km and 7 km for Accident B based on the mean and maximum TED, respectively; while the thyroid dose results showed the Generic Criteria for stable iodine thyroid blocking was exceeded to a distance of 8 km for Accident A based on the maximum thyroid dose and 42 km and 125 km for Accident B based on the mean and maximum thyroid dose, respectively. The two models were seen to be in general agreement noting that the Gaussian dispersion model is significantly

less accurate beyond an approximate distance of 20 – 30 km. The later distances reported for both the Lagrangian and Gaussian models should not form a basis for planning for the implementation of protective actions without considering the fact that the risk of exceeding the criteria at increasing distances is progressively more dependent on the atmospheric conditions at the time of the emergency. As such, while the development of detailed plans for the implementation of protective actions in all directions from the nuclear power plant may be appropriate at some of the shorter distances that are clearly indicated, it may be more appropriate at greater distances to develop contingency plans for initiating protective actions that allow for a response that can be tailored to the unique conditions of the emergency based on atmospheric modelling, environmental monitoring and other factors. Concurrent to the writing of this report, the CNSC underwent an analysis of source terms from a broad technical basis with related conservatisms that could be witnessed in a severe event to guide the Ontario Office of the Fire Marshal and Emergency Management (OFMEM) review of the Provincial Nuclear Emengency Response Plan (PNERP). The suggested source term was not modeled in this report. The source term contained in the guidance was more severe than Accident A and less severe than Accident B. This report therefore represent a range of results and consequence management recommendations that bracket the outcome expected from the source term contained within the CNSC's final guidance. When interpreting the results contained throughout this report, it should be acknowledged that the scenarios are hypothetical and that there are inherent uncertainties associated with this type of predictive modelling as well as specific limitations associated with the approaches used. While these results provide useful information, they should not serve as the sole source of information for nuclear emergency preparedness activities.

Introduction

Health Canada maintains the tools necessary to undertake nuclear emergency consequence modelling, since the organisation is identified in the Federal Nuclear Emergency Plan (FNEP) as having a responsibility to provide dose assessment capability and advice in the case of an event that occurs within federal jurisdiction or when requested to support an impacted province or territory (HC, 2014). The Radiation Protection Bureau (RPB) of Health Canada operates the Accident Reporting and Guidance Operational System (ARGOS), which can be run with the built in Gaussian dispersion model *RIsø Mesoscale PUFF* (RIMPUFF) or in combination with the Lagrangian atmospheric dispersion model *Modèle Lagrangien de Dispersion de Particules* (MLDP) developed and operated by the Environmental Emergency Response Section of the Canadian Centre for Meteorological and Environmental Prediction (CCMEP), within the Meteorological Service of Canada, Environment and Climate Change Canada (ECCC, 2008; HC, 2008). In a recent multi-organisational project lead by the RPB that reviewed all radiological consequence assessment tools currently in use in Canada by the various organisations involved in responding to a nuclear emergency, it was confirmed that ARGOS, when used in combination with MLDP, is the only model currently in use in Canada that is appropriate for modelling impacts at distances greater than about 20 – 30 kilometers (km) from a Nuclear Power Plant (NPP) (HC, 2016a).

The purpose of this modelling exercise was to consider the potential consequences of a severe nuclear emergency and how the spatial distribution of these consequences could be used to inform emergency planning activities. This report provides information on the scenarios that were modelled, the results that have been obtained to date, an interpretation of what these results may mean in the context of emergency planning and the limitations that should be considered when interpreting the results.

Methods

For the purpose of this modelling exercise two hypothetical source terms were provided by the Canadian Nuclear Safety Commission (CNSC), Accident A and Accident B. At the time these were provided to Health Canada, there was concurrent analysis by the CNSC to describe the broad technical basis for a source term and related conservatisms for use by the Office of the Fire Marshal and Emergency Management (OFMEM) to guide revisions to the Provincial Nuclear Emergency Response Plan (PNERP). The final guidance provided to OFMEM included a source term that was more severe than Accident A, and less severe than Accident B. The source term it contained was not modeled in this report; and soure terms used were hypothetical and unique to events labeled Accident A and Accident B. The source term contained in the CNSC guidance to OFMEM can be found at Annex A and is included only as a point of reference to the work presented in this report.

Accident A consisted of 12 isotopes released over the duration of 3 hours (Table 1). Accident B consisted of 48 isotopes released over the duration of 1 hour. The source term for Accident B exceeded the maximum number of isotopes (20) allowed when running one instance of the MLDP atmospheric dispersion model using ARGOS. The maximum number of isotopes was originally limited to 20 in order to ensure a fast running model for real-time emergency response. Operational experience gained through actual nuclear incidents has shown that a source term of 20 isotopes is sufficient to provide an adequate dose estimate for emergency response. A description of the basis on which isotopes were removed from the source term and the impact that this reduction is estimated to have had on the results is provided in Annex B of this report. The final Accident B source term after being reduced to 20 isotopes is provided in Table 2. Additional source term parameters that are required inputs into ARGOS include the release altitude, heat flux, and iodine fractions. Values for these parameters, when known, were provided by the CNSC. In the case of the heat flux, the ARGOS default value was used. The same additional source term parameters were used for Accident A and Accident B. An assessment of the potential impact of changing one of these parameters, namely the iodine fractions, is included in Annex C. While the results of this assessment shows that changing the iodine fractions does have an impact on dose and the distances to which protective actions (specifically, stable iodine thyroid blocking) would be recommended, the iodine fractions that were used in this exercise result in higher doses at greater distances and therefore can be considered as adding another level of conservatism to the results provided here.

Table 1: Source term for Accident A as provided by the CNSC.

Nuclide	Activity (Bq)
^{140}Ba	8.14×10^{11}
^{141}Ce	2.40×10^{11}
^{144}Ce	8.17×10^{10}
^{134}Cs	3.21×10^{13}
^{137}Cs	1.02×10^{14}
^{131}I	3.93×10^{15}
^{132}I	5.80×10^{11}
^{133}I	2.79×10^{15}
^{135}I	2.50×10^{14}
^{103}Ru	1.00×10^{15}
^{106}Ru	1.14×10^{14}
^{133}Xe	1.99×10^{18}

Table 2: Source term for Accident B as provided by the CNSC and reduced to 20 isotopes.

Nuclide	Activity (Bq)
^{140}Ba	6.33×10^{14}
^{134}Cs	2.61×10^{14}
^{136}Cs	3.84×10^{14}
^{137}Cs	5.21×10^{14}
^{131}I	3.10×10^{16}
^{133}I	4.67×10^{16}
^{85}Kr	2.43×10^{16}
^{140}La	1.10×10^{14}
^{99}Mo	2.18×10^{15}
^{86}Rb	7.22×10^{12}
^{127}Sb	7.24×10^{14}
^{89}Sr	5.59×10^{14}
^{90}Sr	1.08×10^{13}
^{127m}Te	1.31×10^{14}
^{129m}Te	2.92×10^{15}
^{131m}Te	1.15×10^{15}
^{132}Te	1.29×10^{16}
^{133}Xe	9.31×10^{17}
^{90}Y	1.01×10^{12}
^{91}Y	5.74×10^{14}

For time-saving purposes it was decided to only complete the modelling for a single NPP location in Ontario. All of the simulations were run using ARGOS Version 9.4 RTM. Two approaches were taken to the atmospheric dispersion modelling. Meteorological inputs that are representative of the average weather conditions were used for inputs to the Gaussian puff dispersion model RIMPUFF (Table 3). This approach is consistent with methodologies seen in other publications related to offsite emergency planning, including Canadian Standards Association (CSA) *N288.2-14: Guidelines for calculating the radiological consequences to the public of a release of airborne radioactive material for nuclear reactor accidents* (CSA, 2014a) and International Atomic Energy Agency (IAEA) *Emergency Preparedness and Response - Nuclear Power Plant (EPR-NPP) Public Protective Actions* (IAEA, 2013). Although this approach follows from these national and international recommendations, the use of any

Gaussian model has implicit limitations in terms of application in time and space. The Gaussian model assumes that the single input of meteorological information holds true for the entire duration and distance of the dispersion. In reality, this assumption does not hold true and the application of a Gaussian model should be considered less accurate at distances greater than about 20 – 30 km.

Table 3: Meteorological inputs used for to run the Gaussian dispersion model for Accident A and Accident B

Parameter	Input	Rationale for Input Selection
Wind direction (2 m)	270º	Arbitrary direction, has no implications on results.
Wind speed (2 m)	3.7 m/s	Average annual windspeed for Oshawa for 2015.[1]
Air temperature (2 m)	5ºC	Typical temperature for a fall day recommended as being similar to the annual average (CCMEP, personal communication).
Soil temperature	5ºC	Typical temperature for a fall day recommended as being similar to the annual average (CCMEP, personal communication).
Cloud cover	6/8	Typical temperature for a call day recommended by CCMEP as being similar to the annual average (CCMEP, personal communication). Combined with the windspeed, this cloud cover results in Pasquill Stability Class Category D, recommended by the IAEA (IAEA, 2013).
Surface roughness	Grass	Conservative assumption with little roughness to prevent plume progression.

[1] http://oshawa.weatherstats.ca/charts/wind_speed-25years.html

A more appropriate model for completing dispersion to a greater distance is the Lagrangian atmospheric dispersion model. This type of model utilizes 3-D meteorology, including complex wind patterns, to more accurately simulate movement in the atmosphere at greater distances. Using a model that is capable of simulating this type of spatial variation in winds is also of particular importance when modeling at a location like Darlington, which is located on the shore of Lake Ontario. This water-land contrast generates complex shore breeze phenomena which can only be captured using this type of model. The atmospheric dispersion for Accident A was simulated using the atmospheric dispersion model *Modèle Lagrangien de Dispersion de Particules d'ordre un* (MLDP1) using a grid size of 1 km and a domain varying from 100 to 140 km from the source. Due to the larger source term and the potential for impacts at greater distance, the atmospheric dispersion for Accident B was simulated using *Modèle Lagrangien de Dispersion de Particules d'ordre zéro* (MLDP0) and a grid size of 5 km. MLDP1 is typically used for simulations run on a local (less than 10 km) or regional (less than approximately 100 km) scale, while MLDP0 is used for events with continental (from 100 km up to 1,000 km) or global consequences (more than 10,000 km). The simulations were run using real forecast weather for a variety of dates within the months of June and July of 2016. The exact dates were selected arbitrarily, but were intended to try and capture some degree of variability in meteorological patterns. All simulations were initiated at midnight local time (i.e. 04:00 UTC). This has been described in similar studies as a conservative choice of meteorology since, on average, nighttime atmospheric stratification limits the vertical dispersion of the release (SSK, 2014).

When producing the dose estimates, the adult and the most sensitive receptor were considered. While ARGOS produces results for 5 receptor age categories (adult, 15-year-old, 10-year-old, 5-year-old, 1-year-old), the 5-year-old child was verified to be the most sensitive (i.e. received the highest doses) in all cases. Two dose end points were assessed, specifically the total effective dose (TED) after 7 days and the equivalent dose to the thyroid (thyroid dose), both reported in the units milliSieverts (mSv). These two dose end points were selected due to their direct application to the criteria used to implement two important protective actions, specifically evacuation and stable iodine thyroid blocking. The specific criteria used included the Generic Criteria recommended in the draft *Canadian Guidelines for Protective Actions during a Nuclear Emergency* for evacuation and stable iodine thyroid blocking (HC, 2016b), the Protective Action Levels (PALs) for evacuation specified in the current Emergency Management Ontario (EMO) *Provincial Nuclear Emergency Plan* (EMO, 2009) and the Ministry of Health and Long-Term Care (MOHLTC) *Radiation Health Response Plan, Annex I: Potassium Iodine (KI) Guidelines* (MOHLTC, 2014). The relevant criteria used are provided for reference in Table 4 for evacuation and Table 5 for stable iodine thyroid blocking.

Table 4. Criteria for evacuation as recommended in the draft *Canadian Guidelines for Protective Actions during a Nuclear Emergency* (HC, 2016b) and the current EMO *Provincial Nuclear Emergency Plan* (EMO, 2009).

Protective action	**Dose type**	**Criteria**	**Source**
Evacuation (upper bound)	Total effective dose	100 mSv	EMO, 2009
Evacuation (lower bound)	Total effective dose	10 mSv	EMO, 2009
Evacuation	Total effective dose	50 mSv	HC, 2016b

Table 5. Criteria for stable iodine thyroid blocking as recommended in the draft *Canadian Guidelines for Protective Actions during a Nuclear Emergency* (HC, 2016b) and the MOHLTC *Radiation Health Response Plan, Annex I: Potassium (KI) Guidelines* (MOHLTC, 2014)

Protective action	**Dose type**	**Criteria**	**Source**
Stable iodine thyroid blocking	Equivalent dose to the thyroid	50 mSv	MOHLTC, 2014
Stable iodine thyroid blocking	Equivalent dose to the thyroid	50 mSv	HC, 2016b

In addition to the two dose endpoints, two exposure scenarios were also considered: no dose reduction (i.e. the case of a receptor located outdoors for the duration of the exposure) and application of dose reduction due to sheltering indoors. For sheltering indoors, the pathway specific dose reduction factors used were those specified in IAEA *EPR-NPP Public Protective Actions* (IAEA, 2013) for sheltering in a wooden house during and after a release and are provided in Table 6.

Table 6: Pathway specific dose reduction factors recommended by the IAEA for sheltering in a wooden house during and after the release (IAEA, 2013).

Pathway	**Reduction factor**
Groundshine	0.4
Cloudshine	0.6
Inhalation	0.5

The results for TED and thyroid dose for an adult and 5-year-old child, considering no dose reduction and dose reduction from sheltering, are reported with increasing distance from the NPP. In order to report the dose in this format, a spatial analysis of the TED and thyroid dose "plumes" produced by ARGOS was required. The "plumes", each composed of cells containing the dose information and sized based on the grid size selected, were exported from ARGOS as shapefiles and were re-projected into ArcGIS Desktop 10.2 using the Lambert conformal conic projection, which provides good directional and shape relationships for mid-latitude regions having a mainly east-to-west extent and standard parallels at 49˚. The ARGOS-produced shapefiles were intersected with a second input shapefile containing multiple concentric circles at 1 km intervals that covered a distance of up to 125 km from the NPP for the adult receptor in Accident A, 150 km from the NPP for the 5-year-old receptor in Accident A and 300 km for both the adult and 5-year-old receptor in Accident B. The cut-off distances are selected automatically by the code once the doses are repeatedly found to be zero. At each 1 km distance interval, all of the intersecting cells were scanned and two values were reported: the mean dose (i.e. the average of the values in all cells intersecting at that distance) and the maximum dose (i.e. maximum value in any cell intersected at that distance, essentially equivalent to the dose along the plume centreline). This process was repeated for both TED and thyroid dose and for all simulations completed. Note that only the maximum dose with distance for Accident A is included in this report, while both the mean and maximum doses for Accident B are reported.

In the case of Accident B, in addition to TED and thyroid dose, the deposition of two specific isotopes, namely ^{137}Cs and ^{131}I, were considered in terms of their potential impact on agricultural land and production of food products that may require restriction during and after an emergency. To accomplish this analysis, the tool Turbo FRMAC 2015 Version 7.007 (Sandia Corporation, 2014) was used for calculate derived response levels (DRLs). The calculated DRLs represent concentrations of radionuclides on the ground that could result in food products that when consumed over the course of an entire year may cause the dose to exceed some pre-established dose criteria. The dose criteria used for this purpose were those from the draft *Canadian Guidelines for Protective Actions during a Nuclear Emergency* (HC, 2016b), specifically the Generic Criteria for the restriction of distribution and ingestion of potentially contaminated drinking water, milk and other foods and beverages and for stable iodine thyroid blocking (specifically for the milk ingestion pathway). These criteria are provided for reference in Table7.

Table 7. Criteria used for the calculation of the DRLs, based on the recommended Generic Criteria in the draft *Canadian Guidelines for Protective Actions during a Nuclear Emergency* (HC, 2016b).

Protective action	Dose type	Criteria	Source
Restriction of distribution and ingestion of potentially contaminated drinking water, milk and other foods and beverages	Total effective dose	1 mSv for each food category	MOHLTC, 2014
Stable iodine thyroid blocking	Equivalent dose to the thyroid	50 mSv	HC, 2016b

The assumptions used in the calculation of the DRLs were primarily derived from CSA *N288.1-14: Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities* (CSA, 2014b) and are provided in Annex D. In the same manner as was done for TED and thyroid dose, “plumes” of the ground deposition of ^{137}Cs and ^{131}I were exported from each run completed in ARGOS, re-projected into ArcGIS Desktop 10.2 and intersected at 1 km intervals. As with TED and thyroid dose, the mean and maximum deposition values at each interval was collected in order to be compared to the calculated DRLs.

Results

This section contains only a summary of the results. Tables containing the full results are available in Annex E for TED and thyroid dose results for the RIMPUFF model run, Annex F for the TED and thyroid dose results for the MLDP model runs and Annex G for the deposition of ^{137}Cs and ^{131}I in the MLDP model runs.

The RIMPUFF produced TED with distance results calculated using the representative average weather conditions inputs (Table 3) for Accident A and Accident B, for both an adult and for a 5-year-old child, were compared to the criteria provided in Table 4. Table 8 provides the distances out to which these criteria are exceeded, indicating the distances at which the protective action of interest (i.e. evacuation) may be recommended depending on the specific criteria selected. These distances are based on the TED assuming the individual is sheltered indoors and therefore take into consideration the dose reduction factors from Table 6.

Table 8. Distances out to which the evacuation criteria are exceeded based on the RIMPUFF produced TED with distance results using representative average weather conditions for Accident A and Accident B. TED is calculated assuming dose reduction from sheltering indoors.

Evacuation criteria	Adult			5-year-old		
	Accident A Max	**Accident B Mean**	**Accident B Max**	**Accident A Max**	**Accident B Mean**	**Accident B Max**
100 mSv TED	-	2 km	4 km	-	3 km	6 km
50 mSv TED	-	3 km	7 km	2 km	5 km	12 km
10 mSv TED	4 km	12 km	39 km	6 km	21 km	70 km

The RIMPUFF produced thyroid dose with distance results calculatedusing the representative average weather conditions (Table 3) for Accident A and Accident B, for both an adult and for a 5-year-old child, were compared to the criteria provided in Table 5. Table 9 provides the distances out to which these criteria are exceeded, indicating the distances at which the protective action of interest (i.e. stable iodine thyroid blocking) may be recommended. These distances are based on the thyroid dose assuming the individual is sheltered indoors and therefore take into consideration the dose reduction factors from Table 6.

Table 9. Distances out to which the iodine thyroid blocking criteria are exceeded based on the RIMPUFF produced thyroid dose results using representative average weather conditions for Accident A and Accident B. Thyroid dose is calculated assuming dose reduction from sheltering indoors.

Iodine thyroid blocking criteria	Adult			5-year-old		
	Accident A Max	**Accident B Mean**	**Accident B Max**	**Accident A Max**	**Accident B Mean**	**Accident B Max**
50 mSv equivalent dose to the thyroid	8 km	42 km	125 km	14 km	91 km	145 km

In the case of the MLDP produced results, the TED and thyroid dose with distance results were assessed for each individual run and compared to the criteria in Table 4 and Table 5, respectively. These results can be found in Annex F. In addition to this, the results from the daily runs (9 individual runs each for Accident A and Accident B) were averaged to produce an average dose with distance result. While the results from the individual runs are still worth considering, they represent a small sample size of the possible meteorological conditions that could occur over the course of the year. The average dose with distance results for all of the runs combined provides us with some insight into the potential severity of the consequences for a range of possible meteorological conditions rather than considering individual cases which could potentially prove to be outliers.

In consideration of the average doses with distance, Table 10 provides the distances out to which the adult and 5-year-old TED results exceed the criteria provided in Table 4, indicating distances at which the protective action of interest (i.e. evacuation) may be recommended depending on the specific criteria selected. These distances are based on the TED assuming that the individual is sheltered indoors and therefore take into consideration the dose reduction factors from Table 6.

Table 10. Distances out to which the evacuation criteria are exceeded based on the average of the mean TED with distance results and the average of the maximum (max) TED with distance results for the MLDP runs for Accident A and Accident B. TED is calculated assuming dose reduction from sheltering indoors.

Evacuation criteria	**Adult**			**5-year-old**		
	Accident A Max	**Accident B Mean**	**Accident B Max**	**Accident A Max**	**Accident B Mean**	**Accident B Max**
100 mSv TED	-	-	-	2 km	-	-
50 mSv TED	4 km	-	-	4 km	-	9 km
10 mSv TED	16 km	7 km	23 km	18 km	9 km	35 km

Again, in consideration of the average doses with distance, Table 11 provides the distances out to which the adult and 5-year-old thyroid doses exceed the criteria provided in Table 5, indicating distances at which the protective action of interest (i.e. stable iodine thyroid blocking) may be recommended. These distances are based on the thyroid dose assuming the individual is sheltered indoors and therefore take into consideration the dose reduction factors from Table 6. The mean and maximum distances reported in Table 12 account for the reduced ^{131}I activity in Annex A, but for a 1 hour release. Distances were not reduced to properly account for the effects of a 3.7 hour release duration.

Table 11. Distances out to which the stable iodine thyroid blocking criteria are exceeded based on the average of the mean thyroid dose with distance results and the average of the maximum (max) thyroid dose with distance results for the MLDP runs for Accident A and Accident B. Thyroid dose is calculated assuming dose reduction from sheltering indoors.

Iodine thyroid blocking criteria	**Adult**			**5-year-old**		
	Accident A Max	**Accident B Mean**	**Accident B Max**	**Accident A Max**	**Accident B Mean**	**Accident B Max**
50 mSv equivalent dose to the thyroid	11 km	9 km	40 km	20 km	26 km	72 km

Table 12. Distances out to which the stable iodine thyroid blocking criteria are exceeded based on the average of the mean thyroid dose with distance results and the average of the maximum (max) thyroid dose with distance results for the MLDP Accident B runs with a reduction factor applied for the ^{131}I activity given in Annex A. Thyroid dose is calculated assuming dose reduction from sheltering indoors and a reduction in ^{131}I activity.

Iodine thyroid blocking criteria	Adult		5-year-old	
	Accident B Mean	Accident B Max	Accident B Mean	Accident B Max
50 mSv equivalent dose to the thyroid	7 km	33 km	21 km	63 km

As previously described, the mean values for Accident B in Tables 10 and 11 are the average of the mean doses with distances (the average value of all cells at a radial distance) for the 9 modelled runs for each accident. These results are significant because at the reported distances, the criteria are exceeded, on average, across the entire plume. Therefore, the average of the mean distances should be used in nuclear emergency planning to help define a zone where exceeding the criteria indicating the need for protective actions is highly probable to that distance, in a range of directions. Detailed planning arrangements may be appropriate to these distances. It also needs to be considered that the doses reported in Tables 10 and 11 are those that have applied dose reduction from sheltering. This implies that emergency plans will have to consider the need for sheltering to greater distances. The effect of sheltering impacts the TED results, but also the thyroid dose results to an even greater degree. For example, considering Accident B, the average of the mean thyroid dose for a 5 year old child exceeds the criteria for stable iodine thyroid blocking at 26 km. For an unsheltered 5-year-old child, this distance is increased to 44 km. For an adult, the criterion for stable iodine thyroid blocking is exceeded at 9 km if sheltered or 24 km if unsheltered. Full sheltered and unsheltered dose results are provided in Annex F.

In comparison to the mean values, maximum values for Accident A and Accident B in Tables 10 and 11 are the averages of the maximum dose with distance results (essentially the dose along the plume centreline) for the 9 modeled runs for each accident. As such, the maximum results are significant in that they represent distances at which exceeding the criteria for protective actions is probable, but only in a particular downwind direction. The maximum range result for the exceeded thyroid dose to a sheltered adult was 40 km and 72 km for a 5 year old child. Depending on other planning factors, either detailed or contingency planning arrangements may be appropriate to these distances. Contingency arrangments would need to consider the use of atmospheric dispersion modelling and environmental monitoring to ensure the appropriate response based on the specific conditions of the emergency. Again, the doses reported in Table 10 and 11 are those that have applied dose reduction from sheltering which will need to be considered in developing emergency plans. Full unsheltered dose results are provided in Annex F.

Although not reported in Table 10 and 11, the daily results for each of the Accident A and Accident B run can be found in Annex F. These results are also significant because they have not been averaged and each modeled run represents a possible outcome based on real forecast meteorological conditions. Of interest is the situation occurring on July 15th 2016. On this date, considering only the thyroid dose, the maximum dose with distance results for an adult exceeded the criteria for stable iodine thyroid blocking up to a distance of 110 km, which could be reduced to 85 km by applying dose reduction from sheltering. On the same day for a 5-year-old child, the maximum dose with distance exceeded the criteria out to 170 km, which could be reduced to 115 km with sheltering with dose reduction from sheltering. The MLDP produced results on this day yielded similar results to the RIMPUFF produced results in Table 9. Both the results produced using MLDP on July 15th 2016 and using the RIMPUFF model should be considered in the context under which they were calculated. The individual daily runs results provided in Annex F would only be appropriate for use in the development of contingency planning arrangments that would need to address a risk in a very specific direction based on atmospheric dispersion modelling and environmental monitoring that reflect the specific conditions of the emergency.

To further explore the changes in dose with distance, an analysis was done to look at the percentage contribution of each of the individual pathways (cloudshine, groundshine and inhalation) to TED for Accident B. The figures showing this analysis are also provided in Annex F. The results show that the amount of contribution to TED from each pathway can vary greatly depending on the meteorological conditions at the time of the emergency. This effect was even more pronounced for the most sensitive receptor, the 5-year-old child. Different types of protective actions may be more or less effective at reducing doses from each of the specific pathways; therefore, these results again indicate why contingency planning, that using atmospheric dispersion modelling and environment monitoring to reflect the specific conditions of the emergency, is more appropriate at greater distances.

In assessing the potential risk to ingestion dose, two main ingestion scenarios were assessed:

1) Ground contamination of ^{137}Cs that would result in plant produce (i.e. root vegetables, leafy greens or grains), ingestion of which would result in a TED in excess of 1 mSv.
2) Ground contamination of ^{131}I that would result in animal produce (i.e. milk), ingestion of which would result in a thyroid dose in excess of 50 mSv.

As with TED and thyroid dose, the ^{137}Cs and ^{131}I deposition with distance results were averaged for each of the individual daily MLDP runs. The average deposition with distance was compared to the calculated DRLs. The distances out to which the DRLs are exceeded, thereby indicating the distance to which the protective action of interest (i.e. food restrictions) may need to be recommended, are provided in Table 13. This assessment was only completed for Accident B.

Table 13: Distances at which the DRLs are exceeded based on deposition of ^{137}Cs (root vegetables, leafy greens and grains) and ^{131}I (milk)

Food product	Accident B Mean	Accident B Max
Root vegetables	7 km	17 km
Leafy greens	19 km	38 km
Grains	30 km	72 km
Milk	26 km	57 km

It is interesting to note the degree of variation in the distances at which the DRLs are exceeed depending on the specific food product. These distances, as well as the individual daily run results provided in Annex G, should be considered in the development of plans for protection against ingestion of potentially contaminated foodstuffs.

Limitations and Uncertainties

When interpreting the results contained within this report, it should be kept in mind that the source terms have been used as provided by the CNSC (with the exception of the reduction of Accident B to 20 isotopes) without any consideration of their likelihood. Additionally, it must been acknowledged that there are inherent uncertainties associated with undertaking this type of predictive modelling. The meteorological fields driving the dispersion model are limited to discrete resolutions in time and space. For example, the RDPS used to drive MLDP1 has a horizontal resolution of 10 km and a forecast duration of 48 h. The Global Deterministic Prediction System (GDPS) used to drive MDLP0 has a horizontal resolution of 25 km and a forecast duration of 10 days. Physical phenomena such as precipitation which occur at smaller scales are not resolved but must be approximated by parameterization schemes. Errors in the numerically modelled fields will affect the dispersion modelling. Within MLDP, physical processes such as turbulence and deposition are also approximated by parameterization. For example, wet deposition in MDLP is treated with a relatively simple scheme: wet scavenging occurs when a tracer particle is in a cloud. The cloud itself is parameterized using the modelled relative humidity. Despite its simplicity, the method has been found to be effective for short and long range transport.

Although these sources of uncertainty are present, the MLDP atmospheric dispersion model is a state of the art model that has been extensively validated through tracer experiments, real-world releases of volcanic, chemical, biological, radiological and nuclear materials and with other atmospheric dispersion models. Validation and comparison of MLDP include the following datasets:

- Radiological and nuclear: ETEX, Algeciras, Fukushima, Chalk River, IRE-Fleurus/Schauinsland-Freiburg, Gentilly, Suffield.
- Chemical: Lac-Mégantic and Gogama train fires, Project Prairie Grass, LROD, GPEX.
- Biological: BC avian flu, UK foot-and-mouth disease, Legionnaires' disease.
- Volcanic clouds: Eyjafallajökull, Hekla, Grímsvötn, Spurr, Cleveland, Redoubt, Okmok, Kasatochi, Pavlof.

In addition to the uncertainties associated with predictive modelling, it must also be acknowledged that there are also some marked limitations in the simulation approach taken. As described in the assessment methods, the simulations were only completed assuming that they originated at a single NPP location in Ontario. Different geographical locations may experience significant differences in terms of local meteorology. This could result in differences in the simulated dispersion patterns and therefore differences in the distances at which the Generic Criteria for evacuation and stable iodine thyroid blocking are exceeded.

A second limitation is that the simulations were run only for select dates within the months of June and July of 2016. This does not fully address the significant differences in meteorological patterns that can occur between different days or seasons throughout a year. For comparison, in a similar study undertaken by the German Commission on Radiological Protection, models were run every day for 365 days in order to properly account for seasonal variation (SSK, 2014). The results contained in this report, while representative of real predicted dispersion patterns, may not be representative of all the possible dispersion patterns that could occur over the course of an entire year.

In order to resolve some of the limitations of the current study, a ‘dispersion model climatology’ approach could be undertaken. Depending on the number of simulations per day, the number of emission scenarios and the number of years of meteorological data, there would need to be between 365 and 8760 simulations per NPP to generate a complete ‘dispersion model climatology’. While this approach would provide a good sampling of all possible meteorological scenarios and would represent a more statistically- robust approach to producing the results, it would also require more time, resources and planning to achieve. The results contained within this report still cover a range of possible scenarios and provide useful information, they should not be considered robust enough to be used as the sole source of information for nuclear emergency preparedness activities.

In terms of the calculation of the DRLs to inform ingestion planning, while the information included in this report may provide some useful basis for discussion, the values produced should in no way be used during an actual emergency response. These values are based on a number of general assumptions and are specific to the accident scenario considered here. In the response to an actual event, any decisions related to food restrictions based on modelling should be specific to that event and should be validated through the use of environmental monitoring, including monitoring of contamination on the ground and laboratory measurements of the food products themselves.

Conclusions

While the results contained in this report provide useful information, they should not be used as the sole source of information for making nuclear emergency preparedness arrangements. It should be acknowledged that the scenarios are hypothetical and the results should be interpreted in light of the uncertainties and limitations associated with this modelling exercise. Thisexercise is limited in that it does not consider the likelihood of the source terms, and does not cover enough days to take into consideration all of the meteorological patterns possible throughout an entire year. A complete ‘dispersion model climatology’ approach considering all of these possible factors would provide a more statistically-robust approach to producing the results but would require more time, resources and planning to achieve.

Within these limitations, the report does provide information that is of relevance to emergency planning and the distances to which detailed and contingency planning may be appropriate based on a severe accident. Although the mean and maximum TEDand thyroid dose for an adult and 5-year-old child were assessed, the adult doses with sheltering factors applied should figure most prominently in any detailed planning. At greater distances, where impacts were seen only based on specific meteorlogical conditions or to specific segments of the population, contingency planning may be more appropriate. At these distances, atmospheric conditions were seen to drastically affect the contribution from the various dose pathways, which could have a significant impact on distances to which criteria were exceeded especially for the 5-year-old child, the most sensitive receptor. This also provides evidence for why contingency planning, which includes the use of atmospheric dispersion modelling and environmental monitoring to be able to respond to the specific conditions of the emergency, is more appropriate at these distances.

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Annex A: Source Term (CNSC guidance to OFMEM dated 30 March 2017)

Enclosure : Detailed Radioisotope Cumulative Source Terms

	1st Release			
Isotope	Release Fraction	Time Release Starts	Release (TBq)	Release Duration (hr)
Kr-85	0.93%	9	2.28E+02	3.7
Kr-85m		9	3.11E+04	3.7
Kr-87		9	5.78E+04	3.7
Kr-88		9	8.23E+04	3.7
Xe-131m		9	7.34E+02	3.7
Xe-133		9	2.21E+05	3.7
Xe-133m		9	3.14E+04	3.7
Xe-135		9	1.80E+04	3.7
Xe-135m		9	4.45E+04	3.7
I-131	0.19%	9	2.23E+04	3.7
I-132		9	3.31E+04	3.7
I-133		9	4.69E+04	3.7
I-135		9	4.39E+04	3.7
Cs-134	0.19%	9	2.50E+02	3.7
Cs-136		9	3.76E+02	3.7
Cs-137		9	4.98E+02	3.7
Rb-86	0.19%	9	6.62E+00	3.7
Te-127	0.00%	9	0.00E+00	3.7
Te-127m		9	0.00E+00	3.7
Te-129		9	0.00E+00	3.7
Te-129m		9	0.00E+00	3.7
Te-131		9	0.00E+00	3.7
Te-131m		9	0.00E+00	3.7
Te-132		9	0.00E+00	3.7
Te-133		9	0.00E+00	3.7
Te-133m		9	0.00E+00	3.7
Sb-127	0.04%	9	4.54E+02	3.7
Sb-128		9	7.67E+01	3.7
Sb-129		9	1.61E+03	3.7
Sr-89	0.00%	9	8.04E+00	3.7
Sr-90		9	1.54E-01	3.7

	1st Release			
Isotope	Release Fraction	Time Release Starts	Release (TBq)	Release Duration (hr)
Sr-91		9	1.21E+01	3.7
Sr-92		9	1.28E+01	3.7
Sr-93		9	1.43E+01	3.7
Y-90m	0.00%	9	7.26E-06	3.7
Y-91		9	7.26E-06	3.7
Y-91m		9	3.16E-01	3.7
Y-92		9	5.87E-01	3.7
Y-93		9	6.68E-01	3.7
Mo-99	0.02%	9	4.57E+03	3.7
Ba-139	0.00%	9	3.46E+02	3.7
Ba-140		9	3.36E+02	3.7
Ba-141		9	3.17E+02	3.7
Ba-142		9	3.03E+02	3.7
La-140	0.00%	9	7.91E-01	3.7
La-141		9	7.31E-01	3.7
La-142		9	7.10E-01	3.7

Annex B: Basis for Reducing the Accident B Source Term to 20 Isotopes

To reduce the number of isotopes in the Accident B source term to 20, isotopes were removed based on the length of their half-lives. It was assumed that if an isotope had a half-life of less than 1 day it was not likely to contribute significantly to the dose over the period of time in question (i.e. 7 days for TED and following plume passage for thyroid dose) and it was consequently was removed from the source term.

Following this removal process, the resulting Accident B source term was composed of 18 isotopes. In order to return two isotopes to the source term an assessment of the approximate dose contribution from each of the removed radionuclides was undertaken. This assessment was completed using a MS Excel spreadsheet and assuming an adult receptor located at a 30 km distance from the source. Following this assessment, the two short-lived isotopes that were found to contribute the most to dose were added back to the Accident B source term.

To further validate the initial assumption that the short-lived isotopes (i.e. those have a half-life of less than 1 day) would not contribute significantly to the dose and alter the results of the report, a source term consisting of the removed radionuclides was created and run for the same start date/time (i.e. same meteorological conditions) as the final Accident B 20 isotope source term. The results show that the removed radionuclide would not contribute to the dose result by more than ~2% for the TED and by less than ~1% for thyroid dose. These small increases in projected dose did not result in any changes in the distance out to which the Generic Criteria for evacuation and stable iodine thyroid blocking would be exceeded (i.e. where these protective actions *may* be recommended).

It should be noted that some of the removed short-lived isotopes could not be included in this analysis due to their absence from the ARGOS database. Based on the results below, the fact that these isotopes also have short half-lives (on the order of minutes or hours) and that several were only present in the source term in minute quantities, it is not expected that including these isotopes in the Accident B source terms would have an impact on the projected dose results of greater than ~1%.

This document excludes pages 20 through 157 inclusive.

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

P.O. Box 1046, Station B
280 Slater Street
Ottawa, Ontario K1P 5S9
Fax: (613) 995-5086

C.P. 1046, Succursale B
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Ottawa (Ontario) K1P 5S9
Télécopieur: (613) 995-5086

PROTECTED A
Your File Votre référence

Our File Notre référence
A-2018-00070 / AI

SEP - 5 2018

This is Exhibit..........................referred to in the affidavit of...
affirmed before me, this.....................................
day of..20........

....
A COMMISSIONER FOR TAKING AFFIDAVITS

Mr. Shawn-Patrick Stensil
Energy and Climate Campaigner
Greenpeace Canada
33 Cecil St.
Toronto, ON M5T 1N1

Dear Mr. Stensil:

This letter is in response to your request under the *Access to Information Act* for:

> ***"provide all CNSC-produced correspondence and analysis discussing how the CNSC rated the accident simulated during Exercise Unified Control on December 6 and 7th 2017 on the International Nuclear Event Scale, the projected source term, and the implications for offsite emergency measures. I have previously filed a similar request (2017-00241) but was informed that at that time (February 2018) no such records had been produced yet."***

Enclosed please find copies of all the accessible records you requested. The exemption provision s.19(1) of the *Act* has been applied to the package. A copy of the relevant section is attached.

You have the right to file a complaint with the Information Commissioner of Canada about this aspect of the processing of your request for a period of 60 days following the receipt of this notice. The address is:

Information Commissioner of Canada
30 Victoria Street
Gatineau, Québec
K1A 1H3

If you have any questions regarding this request, please contact Addie Ivanova at 613-944-1973 or by email at addie.ivanova@canada.ca.

Sincerely,

Nicholle Holbrook
A/Senior ATIP Advisor
Access to Information and Privacy

Attach. 21 pages

Canada

Access to Information Act

19(1) personal information

Please refer to the following website to view these provisions:

www.laws.justice.gc.ca/en/A-1/index.html

Exercise, Exercise, Exercise

INES EOC Rating Form – Level 4 to 7
Rating Considerations

Posting Considerations

The posting of a Canadian event's INES rating is a responsibility of the CNSC as the authority. The EET is tasked with determining the rating on behalf of Canada. Issuing protective action messages to the public without an INES rating is reasonable; especially, if an INES rating could be misinterpreted by the key audience- preventing safety actions from being efficiency and effectively followed. The key audiences for INES ratings are:

1. Canadian public:
   Those who could be directly impacted by the event
   All Canadians
2. Internationally:
   Neighbouring states who could be directly impacted by the event
   Other Member States

Provisional versus Final Rating Considerations

If the event is likely still evolving or the available rating data is potentially incomplete; the rating should be published as a "Provisional" rating. A provisional rating can include a rating range and should describe why the rating is provisional. Provisional ratings are very useful if the rating results come close to matching two different INES thresholds.

Single or Multiple Rating(s) for Multi-Unit Events

If a station with multiple units has events and the impact remains within each unit's boundary, each unit should be assessed a separate INES rating and published by unit. If multiple units have events and the impacts progress or is progressing beyond boundary of the station, one rating should be published for the station. This consideration should be evaluated with the provisional versus final rating consideration. For example, if the event is evolving and the impact could reasonably be beyond a unit's boundary, a provisional rating for the station should be considered.

Table 1: Match INES General Description Considerations

Table 1, in the INES User's manual, should be consulted to ensure the rating is consistent and matches with the general descriptions of the scale. For reference, the general scale descriptions for Levels 4 to 7 are as follows:

Level	Beyond the Installation	General Description
4	No	• Fuel melt or damage to fuel resulting in more than 0.1% release of core inventory • Release of significant quantities of radioactive material within an installation with a high probability of significant public exposure.
	Yes	• Minor release of radioactive material unlikely to result in implementation of planned countermeasures other than local food controls
	N/A	• One death from radiation
5	No	• Severe damage to reactor core • Release of large quantities of radioactive material within an installation with high probability of significant public exposure
	Yes	• Limited release of radioactive material likely to require implementation of some planned countermeasures
	N/A	• Several deaths from radiation
6	Yes	• Significant release of radioactive material likely to require implementation of planned countermeasures
7	Yes	• Major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures

DO NOT SHARE WITHOUT EET APPROVAL

Turn Over to see INES References

INES EOC Rating Form – Level 4 to 7
INES References

Radiological or Nuclear Event — No → Not Applicable

Yes ↓

Impact on People and the Environment

Release Sec 2.2 — Yes → **Atmospheric from Facility** — No → **From a Source** — No

Release Sec 2.2 — No ↓

Atmospheric from Facility — Yes ↓

Table 2 on page 16 (Equivalent to I-131)	
Tens of TBq (up to 500)	4
Between 500 and 5,000 TBq	5
Between 5,000 and 50,000 TBq	6
Greater than 50,000 TBq	7

From a Source — Yes ↓

Page 15 & Appendix III D_2 values	
Between 250 and 2,500 D_2	4
Greater than 2,500 D_2	5

The D_2 value is "the activity of a radionuclide in a source that, if uncontrolled and dispersed, might result in an emergency that could reasonably be expected to cause severe deterministic health effects".

Impact on Environment Rating

Dose to People Sec 2.3 — Yes →

Level of Exposure (*page 21 or Table 3*)	# of Individuals	
Exposure of a member of the public leading to an effective dose in excess of 10 mSv; or, Exposure of a worker in excess of statutory annual dose limits	100 or more	4
Exposure leading to an effective dose greater than ten times the statutory annual whole body dose limit for workers	10 to 100	4
	100 or more	5
The occurrence or likely occurrence of a non-lethal deterministic effect (consult *Appendix II page 159*)	3 to 30	4
	30 or more	5
The occurrence of a lethal deterministic effect or the likely occurrence of a lethal deterministic effect as a result of a whole body absorbed dose of the order of a few Gy	Less than several (3)	4
	3 to 30	5
	30 or more	6

Dose to People Sec 2.3 — No ↓

Dose estimation methodology

The methodology for estimation of doses to workers and the public should be realistic and follow the standard national assumptions for dose assessment. The assessment should be based on the real scenario, including any protective action taken.

Impact on People Rating

Level	Description	People and the Environment
4	Accident with Local Consequence	Minor release of radioactive material unlikely to require implementation of planned countermeasures other than local food controls. A least one death from radiation.
5	Accident with Wider Consequences	Limited release of radioactive material likely to require implementation of some planned countermeasures. Several deaths from radiation.
6	Serious Accident	Significant release of radioactive material likely to require implementation of planned countermeasures.
7	Major Accident	Major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures.

Impact on Radiological Barriers and Controls at Facilities

Radiological Barriers and Controls at Facilities Sec 3 — *Yes* → **Fuel Damage page 31** — *No*

Radiological Barriers and Controls at Facilities Sec 3 — *No* ↓

Fuel Damage page 31 — Yes ↓

More than about 0.1% of a power reactor's core inventory or the equivalent (few thousand TBq) from non-Power Reactor Facility with high probability of public exposure.	*4*
Melting of more than a few per cent of the fuel of a power reactor or the release of more than a few per cent of the core inventory or equivalent activity from a non-Power Reactor facility.	*5*

For research reactors use 3000 MW (th) as base (see page 32).

Radiological Barrier and Controls Rating

Level	*Description*	*Radiological Barriers and Controls at Facilities*
4	Accident with Local Consequences	Fuel melt or damage to fuel resulting in more than 0.1% release of core inventory. Release of significant quantities of radioactive material within an installation with a high probability of significant public exposure.
5	Accident with Wider Consequences	Severe damage to reactor core. Release of large quantities of radioactive material within an installation with a high probability of significant public exposure. This could arise from a major criticality accident or fire.

DO NOT SHARE WITHOUT EET APPROVAL

Turn Over to see rating considerations

Canadian Nuclear Safety Commission Internal Use – EDOC#

EOC – Dispersion Specialist Report Report No: **PMG_Dispersion_Scenario 14-32**

Transmit to the EOC – Dose Specialist, Preventative Measures Deputy Chief/Information Coordinator			
THIS IS A DRILL	X	**THIS IS NOT A DRILL**	☐
TIME OF REPORT: 13:14	**DATE: Dec 7 2017**	**TIME OF INCIDENT: 9:00**	**DATE: Dec 6 2017**

SOURCE TERM INFORMATION

NOTE: The Source Term table is for information purposes only. It is used to assist the Preventative Measures Group in their overall assessment. The Source Term Specialist is responsible for official submission of the Source Term to the Information Officer for use in the FNEP TAG.

IMPORTANT MODEL PARAMETERS

Source Term

Severe core damage, EFADS failed
24 hour continuous release at 17:00

Type:	Effluent Release Rates - by Nuclide
Measurement desc.:	<undefined>
Sample rate units:	Bq/s
Sample period:	1
Start:	2017/12/07 17:00
Stop:	2017/12/08 17:00

Nuclide	Bq/s
Kr-85	0.00E+00
Kr-85m	4.00E+11
Kr-87	1.44E+07
Kr-88	8.84E+10
Xe-131m	0.00E+00
Xe-133	1.78E+14
Xe-133m	2.04E+13
Xe-135	2.04E+12
Xe-138	0.00E+00
I-131	5.88E+07
I-132	0.00E+00
I-133	5.44E+07

Prepared by: ______________________ (Dispersion Specialist) Initials: ________

Verified by: ______________________ (Source Term Specialist) Initials: ________

Implementation Verified by: ______________________ (Dispersion Specialist) Initials: ________

I-134	0.00E+00
I-135	6.92E+06
Cs-134	5.77E+05
Cs-136	7.69E+05
Cs-137*	1.15E+06
Te-129	5.77E+05
Te-132	9.23E+06
Ba-140	5.57E+06
Sr-91	5.77E+05
Mo-99	5.77E+05
Ru-103	5.77E+05

Release Pathway

Type: Direct to Atmosphere
Release height: 10. m

Release timings
To atmosphere start: 2017/12/07 17:00
To atmosphere stop: 2017/12/08 17:00

Meteorology

Type: Actual Observations
Dataset name: PICA 2017-12-07 1651
Dataset desc: Obs/fcsts for Pickering A - Unit 1

Summary of data at release point:	Type	Dir deg	Speed class	Stab Precip	°C	Temp
2017/12/07 15:00	Obs	260	25.0	unk	Lgt snow	0
2017/12/07 18:00	Fcst	265	25.0	unk	Lgt snow	-1
2017/12/08 09:00	Fcst	250	25.0	unk	None	-5
2017/12/08 12:00	Fcst	240	25.0	unk	None	-1

Source Term

Summary of activity released to atmosphere

	Ci	**% of total**
Noble gas	4.7E+08	100.0
Iodines	2.8E+02	0.0
Other	4.6E+01	0.0
Total	4.7E+08	100.0

Noble gas / I-131 ratio = 3414645:1

List of all radionuclides released with total activity

Nuclide	**Ci**	**Nuclide**	**Ci**	**Nuclide**	**Ci**
Ba-140	1.3E+01	I-135	1.6E+01	Sr-91	1.3E+00
Cs-134	1.3E+00	Kr-85m	9.3E+05	Te-129	1.3E+00
Cs-136	1.8E+00	Kr-87	3.4E+01	Te-132	2.2E+01
Cs-137*	2.7E+00	Kr-88	2.1E+05	Xe-133	4.2E+08
I-131	1.4E+02	Mo-99	1.3E+00	Xe-133m	4.8E+07
I-133	1.3E+02	Ru-103	1.3E+00	Xe-135	4.8E+0

Prepared by: ______________________ (Dispersion Specialist) Initials: ________

Verified by: ______________________ (Source Term Specialist) Initials: ________

Implementation Verified by: ______________________ (Dispersion Specialist) Initials: ________

DISPERSION RESULTS: PLUME AND MAP

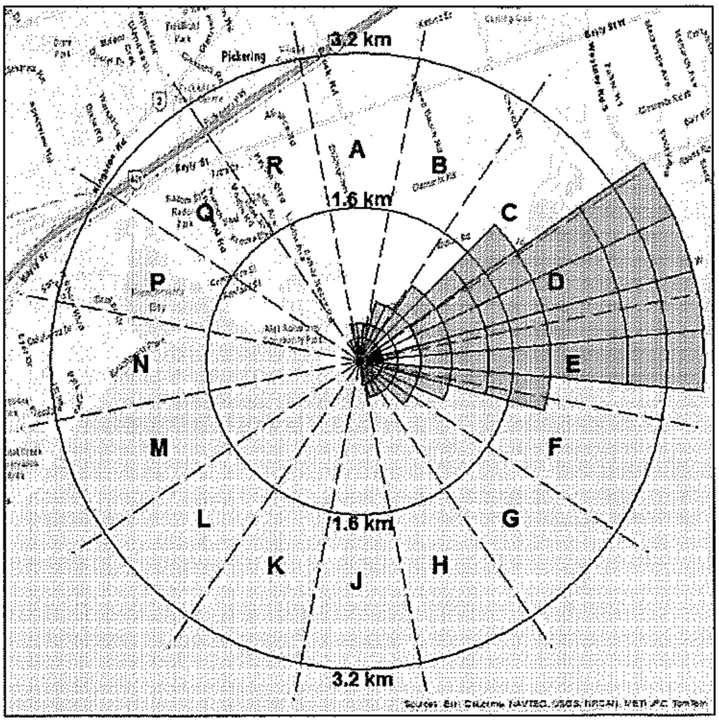
Short Range Dispersion Graph: 0-5 miles

Total Effective Dose Equivalent

Accumulated between 2017/12/07 17:00 and 2017/12/09 17:00

URI Source Term_failed EFADS

Pickering A - Unit 1



Legend

- **0.1 to 10 mSv** **Below EPA PAG Range**
- **10 to 50 mSv** **EPA Early Phase PAG Range**
- **> 50 mSv** **Exceeds EPA PAG Range**

ICRP 26/30 inhalation dose coefficients used in calculations

↑ **N**

RASCAL v4.3.3

Prepared by: ______________________ (Dispersion Specialist) Initials: __________

Verified by: ______________________ (Source Term Specialist) Initials: __________

Implementation Verified by: ______________________ (Dispersion Specialist) Initials: __________

Internal Use – EDOC#

Canadian Nuclear Safety Commission

Report No: **PMG_Dispersion_Scenario 14-32**

EOC – Dispersion Specialist Report

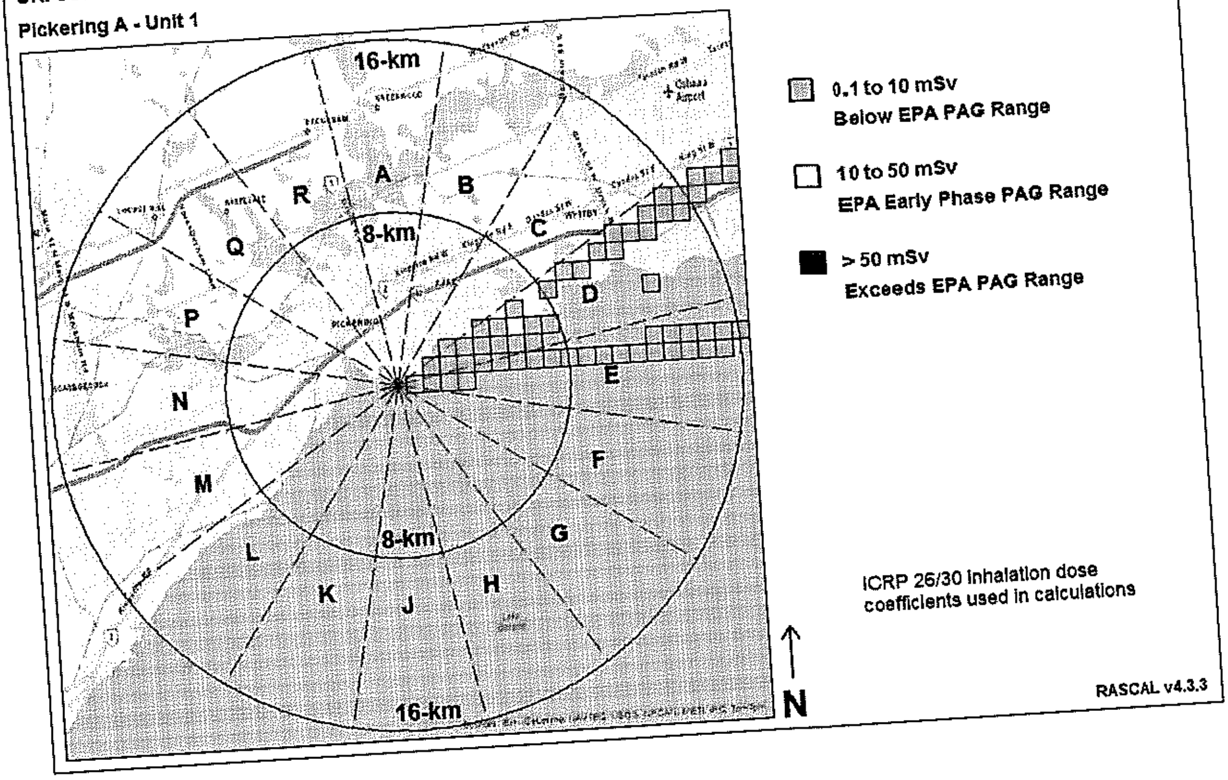
Long Range Dispersion Graph: 0-40 km

Total Effective Dose Equivalent

Accumulated between 2017/12/07 17:00 and 2017/12/09 17:00

URI Source Term_failed EFADS

Pickering A - Unit 1



Prepared by: ______________________

Verified by: ______________________

Implementation Verified by: ______________________

(Dispersion Specialist) Initials: ________

(Source Term Specialist) Initials: ________

(Dispersion Specialist) Initials: ________

A0074700_4-000006

TABLE OF PREDICTED DOSES

Maximum Dose Values (Sv) - Close-In

Dist from release miles (kilometers)	0.1 (0.16)	0.2 (0.32)	0.3 (0.48)	0.5 (0.8)	0.7 (1.13)	1. (1.61)	1.5 (2.41)	2. (3.22)
Total EDE	7.4E-02	3.7E-02	2.2E-02	9.8E-03	5.6E-03	3.2E-03	1.5E-03	8.3E-04
Thyroid CDE	9.3E-03	2.5E-03	1.1E-03	4.1E-04	2.1E-04	1.0E-04	4.6E-05	2.6E-05
Inhalation CEDE	3.0E-04	8.1E-05	3.7E-05	1.3E-05	***	***	***	***
Cloudshine	7.4E-02	3.7E-02	2.2E-02	9.8E-03	5.6E-03	3.2E-03	1.5E-03	8.3E-04
4-day Groundshine	3.3E-04	9.2E-05	4.3E-05	1.7E-05	***	***	***	***
Inter Phase 1st Yr	1.3E-03	3.7E-04	1.8E-04	7.2E-05	4.1E-05	2.3E-05	1.2E-05	***
Inter Phase 2nd Yr	3.3E-04	9.9E-05	4.9E-05	2.1E-05	1.2E-05	***	***	***

Notes:
- Inhalation dose coefficients used: ICRP 26/30
- Doses exceeding EPA PAGs are underlined.
- Early-Phase PAGs: TEDE - 10 mSv, Thyroid (iodine) CDE - 50 mSv
- Intermediate-Phase EPA PAGs: 1st year - 20 mSv, 2nd year - 5 mSv
- *** indicates values less than 10 μSv
- To view all values - use Detailed Results | Numeric Table
- Total EDE = Inhalation CEDE + Cloudshine + 4-Day Groundshine

Maximum Dose Values (Sv) - To 16 km

Dist from release miles (kilometers)	3 (4.8)	4 (6.4)	5 (8.0)	7 (11.3)	10 (16.1)
Total EDE	4.9E-04	4.6E-04	3.7E-04	2.2E-04	2.0E-04
Thyroid CDE	2.4E-05	2.0E-05	1.7E-05	***	***
Inhalation CEDE	***	***	***	***	***
Cloudshine	4.9E-04	4.6E-04	3.7E-04	2.2E-04	2.0E-04
4-day Groundshine	***	***	***	***	***
Inter Phase 1st Yr	***	***	***	***	***
Inter Phase 2nd Yr	***	***	***	***	***

Notes:
- Inhalation dose coefficients used: ICRP 26/30
- Doses exceeding EPA PAGs are underlined.
- Early-Phase PAGs: TEDE - 10 mSv, Thyroid (iodine) CDE - 50 mSv
- Intermediate-Phase PAGs: 1st year - 20 mSv, 2nd year - 5 mSv
- *** indicates values less than 10 μSv
- To view all values - use Detailed Results | Numeric Table
- Total EDE = CEDE Inhalation + Cloudshine + 4-Day Groundshine

Prepared by: ______________________ (Dispersion Specialist) Initials: ________

Verified by: ______________________ (Source Term Specialist) Initials: ________

Implementation Verified by: ______________________ (Dispersion Specialist) Initials: ________

INES Event Rating Form (ERF)

EXERCISE EXERCISE EXERCISE
Version 0

Sender's Name:	Marty Larabie
Sender's Organization:	Canadian Nuclear Safety Commission (Canada)
Event Title:	Exercise Unified Control - CANDU LOCA - >3% Fuel melt/Sheath Damage
Event Date:	2017-12-06
Location / Facility:	PICKERING-1
Event Country:	Canada
Event Type:	Power Reactor
INES Rating:	5 - Accident with wider consequences (Provisional)
Rating Date:	2017-12-07

Impact on people and the environment	
Release beyond authorized limits?	No
Overexposure of a member of the public?	No
Overexposure of a worker?	No
Impact on the radiological barriers and controls at facilities	
Contamination spread within the facility?	Yes
Damage to radiological barriers (incl. fuel damage) within the facility?	Yes
Degradation of Defence In-Depth?	No
Other information	
Person injured physically or casualty?	No
Is there a continuing problem?	No

Event Description

Exercise Exercise Exercise
LOCA at CANDU - Pickering Canada Unit 1

Based on information available. Pickering Unit 1, CANDU PHWR located on the North shore of Lake Ontario, Canada experienced a Loss of Cooling Accident (LOCA) on December 6 and core fuel melt/sheath damage is believed to be above 3% as of December 7.

The provisional rating is Level 5. This rating is consistent with the INES rating methodology section 3 "Impact on Radiological Barriers and Controls at Facilities". An event resulting in the melting of more than the equivalent of a few per cent of the fuel of a power reactor or the release of more than a few per cent of the core inventory of a power reactor from the fuel assemblies.

This rating is provisional and the situation is being monitored. It is believed that a filtered ventilation of containment could be necessary. If ventilation is necessary the estimated release activity over 24 hours will be approximately 11 TBq I-131 equivalent.

Contact CNSC Coms for more details.

Rating Justification

3 "Impact on Radiological Barriers and Controls at Facilities". An event resulting in the melting of more than the equivalent of a few per cent of the fuel of a power reactor or the release of more than a few per cent of the core inventory of a power reactor from the fuel assemblies.

Press Release Attached:	No
Technical Document Attached:	No
Further Information on Web:	

Contact Person:	Marty Larabie
Affiliation:	Canadian Nuclear Safety Commission
Email:	marty.larabie@canada.ca
Telephone:	0016139437182
Organization on Web:	http://www.nuclearsafety.gc.ca

Unterhauser, Robert (CNSC/CCSN)

From: Devitt, Peter (CNSC/CCSN)
Sent: Thursday, December 21, 2017 9:15 AM
To: Larabie, Marty (CNSC/CCSN)
Cc: Mesmous, Noreddine (CNSC/CCSN)
Subject: Exercise Source Term
Attachments: Exercise Exercise Exercise URI source term 1630.csv.TXT

Marty

As discussed here is the last source term calculated using the URI code. Note that it is filtered. For an unfiltered release, multiply everything but the noble gases by 1000.

Peter

Unterhauser, Robert (CNSC/CCSN)

From: Frappier, Gerry (CNSC/CCSN)
Sent: Thursday, December 14, 2017 8:48 AM
To: Larabie, Marty (CNSC/CCSN)
Subject: RE: INES

Thanks Marty. And I got your evaluation sheet so I am good.
I will not be stating what the INES level has been determined to be since your assessment is Provisional and we will need to discuss with Ramzi.
Gerry

From: Larabie, Marty (CNSC/CCSN)
Sent: Thursday, December 14, 2017 6:18 AM
To: Frappier, Gerry (CNSC/CCSN)
Subject: Re: INES
It was a 5 - fuel melt above a few percent.
I can have a copy for you when I get in.
Sent from my Bell Samsung device over Canada's largest network.
-------- Original message --------
From: "Frappier, Gerry (CNSC/CCSN)" <gerry.frappier@canada.ca>
Date: 2017-12-13 11:31 PM (GMT-05:00)
To: "Larabie, Marty (CNSC/CCSN)" <marty.larabie@canada.ca>
Subject: Re: INES
Marty
You were doing assessments during the exercise and I would like to know what was your assessment. I know it was preliminary and was not confirmed by Ramzi but what you gotten to?
Gerry
Sent from my BlackBerry 10 smartphone on the Bell network.

From: Larabie, Marty (CNSC/CCSN)
Sent: Wednesday, December 13, 2017 15:29
To: Mendoza, Dominic (CNSC/CCSN); Jammal, Ramzi (CNSC/CCSN); Frappier, Gerry (CNSC/CCSN)
Subject: Re: INES
Hey Dom,
Gerry had left for day. I will ask Ramzi what messaging he wants with respect to an INES rating. It must be his decision.
Cheers
Marty
Sent from my Bell Samsung device over Canada's largest network.
-------- Original message --------
From: "Mendoza, Dominic (CNSC/CCSN)" <dominic.mendoza@canada.ca>
Date: 2017-12-13 3:15 PM (GMT-05:00)
To: "Larabie, Marty (CNSC/CCSN)" <marty.larabie@canada.ca>
Subject: INES
Hi Mary,
Nice quickly chatting with you this afternoon. Could you send me a quick email back confirming that you had a chat with Gerry on this issue and let me know what was discussed. I would need to brief up to Kathleen on this subject as she may be asked with the INES Rating of the event in the exercise.
Cheers,
Dom

s.19(1)

Unterhauser, Robert (CNSC/CCSN)

From: Jammal, Ramzi (CNSC/CCSN)
Sent: Wednesday, December 13, 2017 5:39 PM
To: Larabie, Marty (CNSC/CCSN)
Subject: Re: INES Short Briefing if needed for tomorrow.

Thanks Marty,
It is important that Gerry and Kathleen come to an agreement on the INES value.
[redacted]

Ramzi Jammal, EVP-PVP
CNSC-CCSN, Canada
+1613-947-8899

From: Larabie, Marty (CNSC/CCSN)
Sent: Wednesday, December 13, 2017 16:46
To: Jammal, Ramzi (CNSC/CCSN)
Subject: Fwd: INES Short Briefing if needed for tomorrow.

Sent from my Bell Samsung device over Canada's largest network.

-------- Original message --------
From: Marty Larabie
Date: 2017-12-13 4:44 PM (GMT-05:00)
To: "Larabie, Marty (CNSC/CCSN)"
Subject: INES Short Briefing if needed for tomorrow.

Ramzi,

Since we never did get a chance to talk during the exercise the following is what I would have prepared for you or something very similar.

The exercised ended before a release could be appropriately assessed. In the methodology release is the first evaluation step, see the following from section 2.2 of the Manual.

The highest four levels on the scale (Levels 4–7) include a definition in terms of the quantity of activity released, defining its size by its radiological equivalence to a given number of terabecquerels of 131I. (The method for assessing radiological equivalence is given in Section 2.2.1). The choice of this isotope is somewhat arbitrary. It was used because the scale was originally developed for nuclear power plants and 131I would generally be one of the more significant isotopes released.

The reason for using quantity released rather than assessed dose is that for these larger releases, the actual dose received will very much depend on the protective action implemented and other environmental conditions. If the protective actions are successful, the doses received will not increase in proportion to the amount released.

s.19(1)

There were no personal doses reported to me to use in the assessment; therefore, section 2.3 of the manual was not used in the rating.

Section 3: IMPACT ON RADIOLOGICAL BARRIERS AND CONTROLS AT FACILITIES

3.1. GENERAL DESCRIPTION The guidance in this section is only applicable to events within authorized facilities, where a site boundary is clearly defined as part of their licensing. It is only applicable at major facilities where there is the potential (however unlikely) for a release of radioactive material that could be rated at Level 5 or above.

- This matches the exercise scenario

Level 5 For events involving reactor fuel (including research reactors): "An event resulting in the melting of more than the equivalent of a few per cent of the fuel of a power reactor or the release of more than a few per cent of the core inventory of a power reactor from the fuel assemblies."

The definition is based on the total inventory of the core of a power reactor, not just the free fission product gases (the "gap inventory"). Such an amount requires significant release from the fuel matrix as well as the gap inventory. It should be noted that the rating based on fuel damage does not depend on the state of the primary circuit. For research reactors, the fraction of fuel affected should be based on quantities of a 3000 MW(th) power reactor.

- based on my conversation with Alex during the exercise, the above would have been the best description of the known fuel damage, based on the activity measured in containment as an indirect estimate of the per cent fuel melt

I am available to discuss further if you need to.

[redacted]

I would like to start following the work instruction I just finished even if it has not been finalised for approval. That is draft INES rating are not released internal or external without CROO (EET) approval.

Cheers

Marty

				Ci/sec	Bq/Sec	Bq/m^3	Vent Rate		
intID	intGroupN	txtIsotope	dblRelease	dblCalculatedReleaseR	Release Rate	Release Concentration	1871	m^3/hr	Bq
1	1	Kr-85	0	0			0.519722	m^3/sec	
2	1	Kr-85m	20.8	10.80531	4.00E+11	7.69E+11			3.46E+16
3	1	Kr-87	0.00075	0.00039	1.44E+07	2.77E+07			1.24E+12
4	1	Kr-88	4.6	2.389636	8.84E+10	1.70E+11			7.64E+15
5	1	Xe-131m	0	0	0.00E+00	0.00E+00			0.00E+00
6	1	Xe-133	9270	4815.635	1.78E+14	3.43E+14			1.54E+19
7	1	Xe-133m	1060	550.6552	2.04E+13	3.92E+13			1.76E+18
8	1	Xe-135	106	55.06552	2.04E+12	3.92E+12			1.76E+17
9	1	Xe-138	0	0	0.00E+00	0.00E+00			0.00E+00
10	2	I-131	0.00306	0.00159	5.88E+07	1.13E+08			5.08E+12
11	2	I-132	0	0	0.00E+00	0.00E+00			0.00E+00
12	2	I-133	0.00283	0.00147	5.44E+07	1.05E+08			4.70E+12
13	2	I-134	0	0	0.00E+00	0.00E+00			0.00E+00
14	2	I-135	0.00036	0.000187	6.92E+06	1.33E+07			5.98E+11
15	3	Cs-134	0.00003	1.56E-05	5.77E+05	1.11E+06			4.99E+10
16	3	Cs-136	0.00004	2.08E-05	7.69E+05	1.48E+06			6.64E+10
17	3	Cs-137	0.00006	3.12E-05	1.15E+06	2.22E+06			9.94E+10
18	4	Sb-127	0	0	0.00E+00	0.00E+00			0.00E+00
19	4	Sb-129	0	0	0.00E+00	0.00E+00			0.00E+00
20	4	Te-129m	0.00003	1.56E-05	5.77E+05	1.11E+06			4.99E+10
21	4	Te-131m	0	0	0.00E+00	0.00E+00			0.00E+00
22	4	Te-132	0.00048	0.000249	9.23E+06	1.78E+07			7.97E+11
23	5	Ba-140	0.00029	0.000151	5.57E+06	1.07E+07			4.81E+11
24	5	Sr-89	0	0	0.00E+00	0.00E+00			0.00E+00
25	5	Sr-90	0	0	0.00E+00	0.00E+00			0.00E+00
26	5	Sr-91	0.00003	1.56E-05	5.77E+05	1.11E+06			4.99E+10
27	6	Mo-99	0.00003	1.56E-05	5.77E+05	1.11E+06			4.99E+10
28	6	Ru-103	0.00003	1.56E-05	5.77E+05	1.11E+06			4.99E+10
29	6	Ru-106	0	0	0.00E+00	0.00E+00			0.00E+00
30	7	La-140	0	0	0.00E+00	0.00E+00			0.00E+00
31	7	Y-91	0	0	0.00E+00	0.00E+00			0.00E+00
32	8	Ce-144	0	0	0.00E+00	0.00E+00			0.00E+00
33	8	Np-239	0	0	0.00E+00	0.00E+00			0.00E+00
34	9	H-3	0	0	0.00E+00	0.00E+00			0.00E+00
1000		Total(NG)	10461.4	5434.551	2.01E+14	3.87E+14			1.74E+19
1001		Total(I2)	0.00625	0.003247	1.20E+08	2.31E+08			1.04E+13
1002		Total(Part)	0.00102	0.00053	1.96E+07	3.77E+07			1.69E+12
1003		Totals	10461.41	5434.555	2.01E+14	3.87E+14			1.74E+19

Exercise, Exercise, Exercise

Record of Decision

INES Assessment of Exercise Unified Control

Present:
Ramzi Jammal – Chief Regulatory Officer and Executive Vice President / Emergency Executive Team
Jason Cameron – Vice President, Regulatory Affairs Branch and Chief Communications Officer /Emergency Executive Team
Gerry Frappier – Director General, Directorate of Power Reactor Regulation/Emergency Executive Team
Alex Viktorov – Director, Pickering Regulatory Program Division / Regulatory Operations Section Chief
Luc Sigouin – Director, Bruce Regulatory Program Division / Emergency Executive Team and Emergency Operations Center Controller
John Burta – Director, Power Reactor Licensing and Compliance Integration Division
Rhonda Walker-Sisttie – Director General, Strategic Communications Directorate / Emergency Executive Team
Sophie Dagenais – Director, Strategic, Regulatory and e-Communications Division
Meghan Gerrish – Senior Communications Advisor / Communications Chief
Marty Larabie – Senior Regulatory Program Officer / INES Officer

Purpose

The Emergency Executive Team (EET) met on April 3, 2018 to determine the INES rating for Exercise Unified Control.

Background

International Nuclear and Radiological Event Scale

The International Nuclear and Radiological Event Scale (INES) is a nuclear accident rating tool used by the Government of Canada, the International Atomic Energy Agency (IAEA) and its Member States to classify nuclear accidents.

A nuclear accident, once it has unfolded, is classified as INES level 1-7 which considers impacts on people and the environment, radiological barriers and controls, and the multiple layers of defence built into the design of nuclear reactors.

The scale is designed to classify the size of a radioactive release and associated public dose. It does not inform emergency response actions. The rating is not used by the Province of Ontario or other provinces, nor are licensees required by the CNSC to consider INES ratings as part of their emergency exercise planning.

The Canadian Nuclear Safety Commission (CNSC) is responsible to calculate and provide provisional and final INES ratings to the IAEA. To put the INES evaluation in perspective, the INES User's manual is very clear on page 14, section 2.1:

> *"The scale should not be confused with emergency classification systems, and should not be used as a basis for determining emergency response actions. Equally, the extent of emergency response to*

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events is not used as a basis for rating. Details of the planning against radiological events vary from one country to another, and it is also possible that precautionary measures may be taken in some cases even where they are not fully justified by the actual size of the release. For these reasons, it is the size of release and the assessed dose that should be used to rate the event on the scale and not the protective actions taken in the implementation of emergency response plans."

Emergency Exercise

The CNSC requires nuclear power plants to conduct a full-scale emergency exercise every three years to test emergency response plans, decision-making functions, response capabilities and interoperability. The goal is to test the licensee, response agencies, and municipal, provincial and federal government responders' ability to mitigate the impact of a nuclear accident.

Ontario Power Generation's Exercise Unified Control at the Pickering Nuclear Generating Station was designed to simulate a radioactive release. Depending on player action, this had the potential to result in a high consequence INES Level 6 or 7 given the radioactivity available for release and assuming a progression of fuel damage.

The exercise design included challenging emergency response plans with the Province of Ontario and implementing protective actions such as public sheltering and evacuation, while exercise participants were not aware of the outcome of their actions or the next inject in the exercise.

Although the exercise timeline did not progress to the simulated radioactive release, protective actions for the public such as sheltering and evacuation were exercised as part of proactively protecting the public within the immediate vicinity of the Pickering nuclear generating station.

Province of Ontario

The Provincial Nuclear Emergency Response Plan (PNERP) states: In order to avoid confusion, the INES shall not be used by Ontario officials for the purpose of either notifications or communications. Licensees are not required to consider INES ratings in an exercise design or plans. The PNERP requires testing of the full cycle of their response capabilities within a 5 year time cycle.

Federal Government

The highest four levels on the INES scale (Levels 4–7) include by convention the quantity of activity released, defining its size by its radiological equivalence to a given number of terabecquerels of Iodine-131. In a real event the ability to estimate to finite number would be challenging taking into account instrument reading and other real world errors.

The Federal Nuclear Emergency Plan and CNSC Strategic Emergency Management Plan calls upon CNSC to perform an INES assessment, as appropriate. This Record of Decision captures the INES assessment of the exercise. The assessment was conducted after the exercise conclusion to mimic a realistic scenario where confirmable information was likely not immediately available during the event.

Exercise, Exercise, Exercise

EET Considerations

Rating due to Dose to People

There were no doses to people reported; therefore, dose was not considered. If the accident had not ended artificially in accordance with the planned exercise, accident progression may have required the calculation and reporting of the dose to people.

Rating due to Release to the Atmosphere from a Nuclear Facility

As per the event scenario, the quantity in containment consisted of 11,000TBq I-131 equivalence which is above the INES Level 6 threshold. However, the exercise ended prior to a planned controlled release where sufficient time for decay and successful filtration would be anticipated to reduce the release to approximately 1/1000 or 11TBq Iodine-131 equivalence, a Level 4 release activity.

Rating due to Impact on Barriers and Controls

Based on exercise event data, the event was described as failed fuel where the radioactive material remained in containment. Fuel melt leading to 11,000 TBq I-131 being produced would be estimated to represent more than few per cent of the core had melted or was damaged. This was the most significant impact to consider in the INES rating.

EET Decision on INES Rating

Exercise INES rating justification for Level 5: An event resulting in the melting of more than the equivalent of a few per cent of the fuel of a power reactor without release to the atmosphere at or above 500 TBq I-131 equivalents.

As the exercise ended after two days, the determination of the INES rating is difficult as the rating depends on how the accident would progress and conclude. The EET considers the following three cases and the associated provisional ratings below, with respect to how Exercise Unified Control may have been classified on the INES scale.

Case 1: If there was a very controlled release of radioactive material equivalent to more than hundreds of TBq I-131 this would result in an INES rating of 5.

Case 2: If the release of radioactive material occurred without decay time, settlement or filtering, and resulted in an equivalent of more than thousands of TBq I-131 (INES suggested boundary of 5,000 TBq), a minimum Provisional rating of Level 6 INES rating would have been assessed.

Case 3: If the accident progressed with additional fuel failure and unsuccessful filtering, resulting in an equivalent of more than several tens of thousands of TBq of I-131 (INES suggested boundary of 50,0000 TBq), the rating could have resulted in a Level 7 INES rating.

The accident could have progressed in different ways based on actions taken, and the effectiveness of emergency mitigation equipment.

Exercise, Exercise, Exercise

RECOMMENDATION

CNSC staff recommends the final exercise INES rating to be classified as INES level 5 due to the simulated, contained fuel failure resulting in a damaged reactor core.

	Notes / Comments	Note: Turn Over to Technical Evaluation
INES	M. Larabie	EET Approved: Yes / No Provisional: Yes / No or Final Yes / No
ROC	A. Viktorov	EET Signature:
EOCD	G. Frappier	Date: 2018/04/20 *Provisional

APPROVED 5 6 7* RATING

Attachments:
INES EOC Rating Form Level 4-7 Rating Considerations EDOC: 5418628
WebEOC Reactor Safety Status Board (Last update) EDOC: 5500923

Contact/Personne-ressource: John Burta, 613-995-0272
Canadian Nuclear Safety Commission/Commission canadienne de sûreté nucléaire

Exercise, Exercise, Exercise

Pickering Exercise Unified Control December 6-7 2017

FROM LAST UPDATED WEBEOC REACTOR SAFETY STATUS BOARD

Date Updated
12/07/2017

Time Updated
17:05

Licensee Procedure(s) in use
SAMG

RSG Response Objective
1.Predict the best estimate source term at 17:00 through FADS and not filtered using URI (with CDS 3)

2. Predict the credible worse case scenario with the lost of recirc cooling using VETA (CDS 4)

Assessment of Licensee Strategy
RSG assessment aligns with OPG's requirement to vent between 15:00-19:00 h to protect containment.

Description of Progression

- Heat sink has been lost as of 11:30 pm last night without cooling. It most likely that the core has collapsed. Timing of collapse is unknown due to lack of plant parameters to confirm.
- Cooling has been re-established. However, method is still unknown
- Containment is pressurizing. Based on latest plant data (09:45), the earliest time to vent through the EFADS is 15:00, Dec. 7 and the latest time is 18:00, Dec. 7
- CDS3, core has collapsed and is located at the calandria vessel (RSG assumption, not confirmed by OPG)
- The irradiated fuel bay are adequately cooled

Forecast Source Term
Case 1: Filtered Release
URI Source Term with release rate (Bq/sec) and release concentration (Bq/m^3)
Source term is decayed
Release from 50m stack for 24 hours starting 1700, release is filtered
Vent rate 1871 m^3/hour
Source term based on containment air sample from recirculating EFADS system

Case 2: Unfiltered Release
URI Source Term with release rate (Bq/sec) and release concentration (Bq/m^3)
Source term is decayed
Release from 50m stack for 24 hours starting 1700, release is unfiltered
Vent rate 1871 m^3/hour
Source term based on containment air sample from recirculating EFADS system

See attached

Exercise, Exercise, Exercise

Pickering Exercise Unified Control December 6-7 2017

FROM LAST UPDATED WEBEOC REACTOR SAFETY STATUS BOARD

Credible Worst Case (CWC) Release

VETA source term based on credible worst case assuming that moderator cooling injection is lost.

Units below are in bequerels for total release.

Non decayed source term with containment reduction factors for holdup.

Unfiltered release with severe core damage with molten core concrete interaction

Release height of 50 m.

Assume a design leakage of 1% containment volume per hour.

Assuming continuous release after release timing.

Release timing assumed at 11:00 pm December 7.

KR-85 5.4400002E+15

KR-85M 4.8300000E+17

KR-87 9.4600001E+17

KR-88 1.3400000E+18

XE-131M 1.9600000E+16

XE-133 3.5400000E+18

XE-133M 1.0900000E+17

XE-135 4.2400000E+17

XE-138 3.0300001E+18

I-131 5.8738557E+16

I-132 8.6631165E+16

I-133 1.2239934E+17

Exercise, Exercise, Exercise

Pickering Exercise Unified Control December 6-7 2017

FROM LAST UPDATED WEBEOC REACTOR SAFETYSTATUS BOARD

I-134	1.3257194E+17
I-135	1.1386748E+17
CS-134	9.1225246E+14
CS-136	1.1550822E+15
CS-137*	1.9557642E+15
TE-129M	2.5959554E+14
TE-131M	8.9923113E+14
TE-132	8.5000313E+15
SB-127	5.6119895E+14
SB-129	1.9034820E+15
BA-140	0.0000000E+00
SR-89	5.2181641E+14
SR-90	1.4046380E+13
SR-91	0.0000000E+00
RU-103	8.2374795E+14
RU-105	6.1042672E+14
RU-106*	1.2996183E+14
Y-91	0.0000000E+00
MO-99	0.0000000E+00
LA-140	0.0000000E+00
CE-144*	0.0000000E+00
H-3	4.1499998E+17

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Exercise, Exercise, Exercise

Pickering Exercise Unified Control December 6-7 2017

FROM LAST UPDATED WEBEOC REACTOR SAFETY STATUS BOARD

Appeal No. PA14-330

Information and Privacy Commissioner of Ontario

IN THE MATTER OF Appeal No. PA14-330
under the
Freedom of Information and Protection of Privacy Act, RSO 1990, c F 31

SUPPLEMENTARY REPRESENTATIONS OF THE APPELLANT

OVERVIEW

1. The disclosure of source term information does not pose a risk to public safety, as evidenced by the recent release of source term information by both the Canadian Nuclear Safety Commission ("CNSC") and the Ontario government. An order to allow the Appellant to submit further evidence pursuant to Rule 20.01 is just and appropriate. Two and half years have passed since the parties made submissions to the Information and Privacy Commissioner of Ontario ("IPC"). The source term information that has been released to the public since that time strongly supports a finding that sections 14 and 16 of *FIPPA* do not apply in this case.

2. Both the IPC and Ontario Power Generation ("OPG") stress that the CNSC's approach to releasing source term information is persuasive and relevant. The Appellant will be prejudiced if OPG's claim that release of the source term information poses a security risk is not evaluated in light of CNSC and Ontario government decisions to release the same or similar information. The prejudice to the Appellant, and the public interest, outweighs any prejudice to OPG resulting from a short delay in the IPC appeal process, or an invitation by the IPC to provide supplemental submissions to address four new documents.

PART I – STATEMENT OF FACTS

A. HISTORY OF THE APPEAL

3. Greenpeace Canada submitted the following *FIPPA* request in 2014:

> This is to make a formal request for the "source term" information for all Ex-Plant Release Categories included in the most recent probabilistic risk assessments for the Darlington as well as the Pickering A and B nuclear stations.[1]

4. OPG denied release of the record in 2014. OPG made submissions to the IPC in July 2015. The Appellant made submissions to the IPC on February 25, 2016.[2]

5. The IPC has not rendered a decision.

6. Since February of 2016, several new documents have been released to the public which contain source term information and accident sequences:

(i) The CNSC released a letter to Ontario's Office of the Fire Marshal and Emergency Management in response to an *Access to Information Act,* RSC 1985, c A-1 ("*ATIA*") which provides CNSC's guidance on the source term to be used to revise the Provincial Nuclear Emergency Response Plan, the accident analysis and assumptions, and source term data. The source term data was generated from the results of the 2011 Darlington Probabilistic Risk Assessment.[3]

(ii) CNSC released its *Technical Basis for Multi-Unit Severe Accident Source Term* report in response to an *ATIA* request, which provides source term information for Release Category 1 from the 2011 Darlington Probabilistic Risk Assessment, one of the source documents at issue in this appeal. The document

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[1] Affidavit of Shawn-Patrick Stensil dated October 23, 2018, Supplementary Submission of the Appellant, Tab 1 ("Stensil Affidavit"), para 2
[2] Stensil Affidavit, paras 3-5
[3] Stensil Affidavit, paras 9-10, Exhibit A, CNSC's letter to the Office of the Fire Marshal and Emergency Management dated March 30, 2017 ("CNSC letter to Fire Marshal"), p 1

provides detailed information on accident sequences, including reference to plant damage states, which lead to radioactive releases categorized as Release Category 1.[4]

(iii) The Ontario government released a document produced by Health Canada entitled *Argos Modelling of Accident A and Accident B Scenarios* as part of its consultation on the Provincial Nuclear Emergency Response Plan, which includes source terms used to model offsite impacts of nuclear accidents.[5]

(iv) In September 2018, in response to an *ATIA* request, CNSC released its accident rating for an accident simulated during an emergency response exercise at OPG's Pickering Nuclear Generating Station, which includes source term information and the accident sequence leading to the release.[6]

PART II – POINTS IN ISSUE

7. It is the Appellant's position that the IPC's procedure should be varied pursuant to Rule 20.01 to allow the Appellant to submit new evidence.

8. The appeal should be allowed and the source term information from OPG's probabilistic risk assessments for the Darlington, Pickering A and Pickering B sites should be disclosed.

PART III – SUBMISSIONS

A. THE APPELLANT'S RECORD MAY BE SHARED

9. The Appellant consents to the IPC sharing its submissions with OPG.

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[4] Stensil Affidavit, paras 11-12; Exhibit B, *Technical Basis for Multi-Unit Severe Accident Source Term* dated March 24, 2017 ("*Technical Basis*") , pp 4, 11

[5] Stensil Affidavit, paras 13-14, Exhibit C, *Argos Modelling of Accident A and Accident B Scenarios* dated May 15, 2017 ("*Argos Modelling*")

[6] Stensil Affidavit, para 15, Exhibit D, CNSC's rating of OPG's December 2017 accident simulation ("OPG accident simulation")

B. THE IPC SHOULD PERMIT THE SUBMISSION OF NEW EVIDENCE

i) The IPC should vary the process

10. The IPC should vary the appeal process pursuant to Rule 20.01 of the IPC's Code of Procedure to allow the Appellant to submit new evidence because two and a half years have elapsed since the parties made their submissions and the new evidence contradicts OPG's claims that release of the information will compromise public safety.[7]

11. The IPC held in PO-2680-R that parties to an appeal must be diligent in bringing relevant newly available evidence to the attention of the IPC prior to a decision being released, rather than making a request for reconsideration once a decision has been made.[8]

ii) The Appellant will suffer prejudice if the evidence is not admitted

12. In PO-3871, the IPC, and OPG in its submissions, stressed that the CNSC's approach to protecting nuclear information is relevant and persuasive.[9] It is critical that the IPC consider the recent decisions of both the CNSC and the Ontario government to release source term information, and related accident sequences, when it decides this appeal.

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[7] Information and Privacy Commissioner of Ontario, *Code of Procedure for appeals under Freedom of Information and Protection of Privacy Act and the Municipal Freedom of Information and Protection of Privacy Act*, October 2004, r 2.01, 2.04, 20.01

[8] *PO-2680-R* (5 June 2008), online: Information and Privacy Commissioner of Ontario <https://www.ipc.on.ca>, p 3

[9] *PO-3871* (31 July 2018), online: Information and Privacy Commissioner of Ontario <https://www.ipc.on.ca>, ("*PO-3871*"), paras 13, 15, 37, 70, 72, 73, 98; OPG Submission, pp 5, 8; Affidavit of Robin Manley dated July 13, 2015, OPG Submission ("Manley Affidavit"), para 3; OPG Letter from Scott Martin to IPC dated July 23, 2015.

13. The Appellant will be prejudiced if a decision is made based on stale and incomplete evidence. In MO-1698, the IPC found that there was substantial prejudice to the Toronto Police Service Board, and the IPC could have reached a different decision, if it did not consider their submissions, even though they were submitted 6 days late.[10]

iii) The prejudice to the Appellant outweighs the prejudice to OPG

14. Rule 20.01 strives for a just and expeditious resolution of appeals. The public interest in disclosure of source term data is significant. The source term information will allow the public to scrutinize the safety of OPG's nuclear reactors, and the adequacy of provincial and federal oversight of nuclear reactors, on an ongoing basis.[11] It is critical that the IPC make a decision that reflects the CNSC and Ontario government's current practice to release source term information and accident sequences. These concerns outweigh prejudice to OPG from a short delay in the appeal process, or the requirement for OPG to file short reply submissions to address four new documents.

C. SECTIONS 14 AND 16 DO NOT APPLY

15. The application of sections 14 and 16 of *FIPPA* to source term information should be rejected in light of the previous disclosures of source term information[12], and the new documents which demonstrate that both the CNSC and the

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[10] *MO-1698* (21 October 2003), online: Information and Privacy Commissioner of Ontario <https://www.ipc.on.ca>, p 2
[11] Stensil Affidavit, para 16
[12] Representations of the Appellant dated February 25, 2016 ("Representations of the Appellant"), paras 18, 24

Ontario government have recently released source term information and accident progression sequences from one of the source documents at issue in this appeal. There is no risk to public safety.

i) CNSC and Ontario government release source term information and accident sequences

16. It is relevant and persuasive that CNSC and the Ontario government release source term information to the public. In PO-3871, the IPC stated that the CNSC's approach to nuclear information is one relevant and persuasive factor that should be taken into account.[13] OPG agrees that the CNSC's approach to disclosing source term information is "relevant and persuasive".[14]

17. The IPC's reasoning in PO-3871 relating to withholding "plant damage states" and release category numbers should not be followed. The IPC relied on PO-2960-I, which is now moot and based on a different and outdated factual record.[15] The evidence submitted in support of this appeal, including the new evidence, demonstrates that CNSC releases source term information, plant damage states, accident progression sequences and release category numbers:

- On October 5, 2017, CNSC disclosed source term information based on the 2011 Darlington Probabilistic Risk Assessment. CNSC's letter explains the assumptions used to model the accident including information on the accident sequence leading to the release, and then provides the cumulative source terms.[16]

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[13] *PO-3871*, para 15
[14] OPG Submission, p 8
[15] See Representations of the Appellant, para 16.
[16] Stensil Affidavit, paras 9-10; CNSC Letter to Fire Marshal, pp 1-4

- CNSC also released the *Technical Basis for Multi-Unit Severe Accident Source Term* which provides the technical basis and conservative assumptions for modelling multi-unit accident source terms. The source terms are from the 2011 Level 2 Darlington Probabilistic Risk Assessment, Release Category 1. CNSC released detailed information on accident sequences and key mitigation actions and assumptions, including specific reference to plant damage states.[17]

- On September 8, 2018, CNSC released its International Nuclear and Radiological Event Scale rating of an accident simulated during an emergency response exercise at OPG's Pickering Nuclear Generating Station. It includes source term information as well as information on the associated accident sequence.[18]

18. Similarly, the Ontario government released Health Canada's modelling of Accident A and Accident B scenarios to the public to inform their participation in the Provincial Nuclear Emergency Response Plan consultation, including source term information.[19]

ii) *The IPC's mandate is focused on making information accessible to the public*

19. The IPC's mandate is to independently oversee government bodies and ensure access to information with limited and specific exemptions.[20] CNSC may address requests for disclosure as part of its regulatory hearings, but it is not an independent oversight body for the public to appeal to if access is refused.[21] Contrary to OPG's assertion, meeting the requirements of CNSC's REGDOC 2.4.2 does not indicate that the records should be withheld pursuant to the *FIPPA* regime.[22]

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[17] Stensil Affidavit, paras 11-12; *Technical Basis,* pp 4-10, 13-17
[18] Stensil Affidavit, para 15; OPG accident simulation
[19] Stensil Affidavit, paras 13-14; *Argos Modelling*
[20] *Freedom of Information and Protection of Privacy Act,* RSO 1990, c F31, s 1; *PO-3871*, paras 16-17
[21] *PO-3871*, para 18
[22] Manley Affidavit, para 3

iii) Conclusion

20. The new evidence shows that OPG's concerns that "people with the technical know-how would be able to co-relate these pieces of information and with nefarious intent cause significant and devastating impact on public safety and the environment"[23] are not well founded. OPG made an identical claim to the IPC about the applicability of sections 14 and 16 to the Table of Contents at issue in PO-3871, also claiming that "people with the technical know-how would be able to co-relate these pieces of information and with nefarious intent cause significant and devastating impact on public safety and the environment", which was rejected.[24] The evidence does not support OPG's claim that there is a public safety risk in this appeal either.

PART IV – ORDER REQUESTED

21. The Appellant requests that the new documents be admitted into evidence pursuant to Rule 20.01. The source term information from OPG's probabilistic risk assessment for the Darlington, Pickering A and Pickering B sites should be disclosed.

ALL OF WHICH IS RESPECTFULLY SUBMITTED

Dated at Toronto this 30th of October, 2018.

Jacqueline Wilson
Counsel for the Appellant

[23] Affidavit of Carlos Lorencez dated July 17, 2015, OPG Submission ("Lorencez Affidavit"), para 7
[24] *PO-3871*, para 40