Appeal No. PA14-543

Information and Privacy Commissioner of Ontario

IN THE MATTER OF Appeal No. PA14-543
under the
Freedom of Information and Protection of Privacy Act, RSO 1990, c F 31

SUR-REPLY SUBMISSION OF THE APPELLANT

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<u>Tab</u>

Appeal No. PA14-543

Information and Privacy Commissioner of Ontario

IN THE MATTER OF Appeal No. PA14-543
under the
Freedom of Information and Protection of Privacy Act, RSO 1990, c F 31

Supplementary Affidavit of Shawn-Patrick Stensil
Affirmed August 15, 2016

I, SHAWN-PATRICK STENSIL, of the City of Toronto, in the Province of Ontario, **MAKE OATH AND SAY:**

1. I am the requestor in the present matter before the Information and Privacy Commissioner of Ontario ("IPC"), Appeal No. PA14-543. 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. The records at issue are a 2014 Ministry of Energy ("Ministry") report and a 2014 Ministry slide deck to be used as part of an Office of the Fire Marshall and Emergency Management ("OFMEM") review of Ontario's off-site nuclear emergency plans. OFMEM is a department of the Ministry of Community Safety and Correctional Services ("MCSCS"). For the purposes of this appeal, OFMEM and MCSCS will be referred to interchangeably.

3. I have read the Ministry's Reply Representations. The Ministry has redacted important arguments and evidence used to support their claims. I

question whether such secretive behaviour is justified. The redactions hamper my ability to respond.

Ongoing Government Consultations with Industry and Other Stakeholders

4. The MCSCS appears to be conducting its review through the Nuclear Emergency Management Coordinating Committee ("NEMCC") and presented the slide deck (records 8-10) at the NEMCC meeting of April 2, 2014.

5. Many of the NEMCC's members are not part of the provincial government, including representatives from the municipalities of Toronto, Durham, Peterborough, Kincardine and Laurentian Hills/ Deep River, and representatives from the nuclear industry, Bruce Power and Ontario Power Generation. Attached as **Exhibit 'A'** is a copy of the NEMCC meeting minutes of April 2, 2014.

6. After the Ministry's presentation, the NEMCC decided to create a working group to "discuss/ resolve specific PNERP [provincial nuclear emergency response plan] issues".

7. As discussed at paragraphs 66 and 67 of my December 10, 2015 affidavit, the NEMCC also discussed how non-industry groups like Greenpeace should be consulted on nuclear emergency plans. Please note that my previous affidavit mistakenly states that this NEMCC meeting took place on October 22, 2014. In fact, NEMCC's discussion about engaging Greenpeace took place at the meeting on April 2, 2014. The date of October 22, 2014 refers to the version date of the notes.

8. I appealed the MCSCS's decision to withhold information about how the NEMCC planned to consult the public in PA15-261. On August 5, 2016, Order PO-3642 directed the MCSCS to release this information. Attached as **Exhibit 'B'** is a copy of Order PO-3642 dated August 5, 2016.

December 2015 stakeholder meeting and follow up

9. In late November, 2015, MCSCS requested input from NEMCC stakeholders on a draft discussion paper on the Provincial Nuclear Emergency Response Plan ("PNERP"). The discussion paper's recommendations were discussed at the NEMCC meeting in December, 2015.

10. The MCSCS appears to have been told by industry and government stakeholders that its draft discussion paper lacked the required information to credibly assess and inform policy recommendations on updating the planning basis for Ontario's offsite emergency plans.

11. MCSCS Assistant Deputy Minister Al Suleman requested technical assistance from CNSC staff for modelling of accidents and off-site impacts to assess the adequacy of emergency measures on December 18, 2015. Attached as **Exhibit 'C'** is a copy of the letter from Al Suleman to CNSC dated December 18, 2015.

12. Mr. Suleman observed that CNSC had advised that a more appropriate basis for modelling severe accident dose consequences would be the Probabilistic Safety Assessments prepared by the nuclear industry:

> It has now been brought to our attention by CNSC staff that a more appropriate basis for severe accident dose consequences would, in

> fact, be the Probabilistic Safety Assessment (PSA) studies prepared by the nuclear generating stations. Given that we neither have access to these studies, nor do we have the in-house resources to scientifically assess them in a timely manner, we kindly request that CNSC resources be made available to provide OFMEM with the distance versus dose consequences and probability of applicable severe accident PSAs for Pickering, Darlington and Bruce.

13. At an April 7, 2016 meeting of the CNSC, Luc Sigouin, Director of Emergency Management Programs at CNSC, noted that the CNSC was providing scientific and technical work to the MCSCS after the discussion at the December NEMCC meeting. Attached as **Exhibit 'D**' is a copy of excerpts from the transcripts of the April 7, 2016 CNSC meeting.

CNSC Release of Source Term Data

14. The Ministry made a new argument at paragraphs 27-28 of its Reply Representations that the source term information being requested is substantively different from previously released source term information. Most of the Ministry's argument on this point is redacted.

15. I am confident that there is no meaningful difference between the source term information that has been released to date and the records at issue in this appeal.

16. The Ministry admitted at paragraph 40 of its 2015 Representations that Appendix B - OPG severe accident response planning (SARP) rationale for SARP Source Term data has been released to the public.

17. Source term data which is similar or equivalent to the data in the SARP report is found at Exhibits G, H and K to my affidavit dated December 10,

2015. These documents provide source term data originally supplied by Ontario Power Generation.

18. As well, in response to MCSCS's December 18, 2015 request for assistance, CNSC released source term data and modelling of the doses to the public for Release Category 1 accident scenarios from the Darlington Probabilistic Safety Assessment. Attached as **Exhibit 'E**' is a copy of the data from CNSC.

19. Release Category 1 releases are major release events. The table produced by the CNSC compares Release Category 1 releases to the estimated SARP releases, as well as to the releases which actually took place during the Fukushima Daiichi and Chernobyl nuclear accidents.

20. I created a graph based on the data released by CNSC to compare the Release Category 1 releases to current Protective Action Levels, the threshold dose levels that trigger implementation of emergency response measures, in the PNERP. Attached as **Exhibit 'F'** is a copy of the graphs for Release Category 1.

21. The graphs show that for Release Category 1 scenarios, the current Protective Action Levels would require evacuation and KI consumption up to 50 km from the Darlington nuclear power plant. This graph demonstrates that the choice about the size of the accident to be planned for in the PNERP – the planning basis - can greatly impact decisions about which emergency measures to put in place. Larger radioactive

releases require the preparation of emergency measures at greater distances from a reactor.

22. In my view, in light of Darlington's location close to the Greater Toronto Area and the current scope of emergency response plans, a Release Category 1 accident would pose a significant challenge to current provincial emergency response capacity.

Public Consultations on the Planning Basis

23. The MCSCS has been consulting with stakeholders, including the nuclear industry, on changes to Ontario's nuclear emergency plans for several years. The MCSCS differentiates between stakeholders and the public.

24. The Ministry has redacted information at paragraph 34 of its Reply Representations regarding the public consultation to take place on the planning basis.

25. However, CNSC has released information about MCSCS's planned public consultation.

26. At a meeting on April 15, 2016, CNSC staff noted that a public consultation on the PNERP was scheduled to take place between July and October 2016 through the Environmental Registry. Cabinet approval of any changes to the PNERP will be sought in January, 2017, after the public consultation. Attached as **Exhibit 'G'** is a copy of CNSC Staff Members notes dated April 15, 2016.

27. The CNSC also discussed the MCSCS's planning basis review at an August 18, 2016 meeting. Attached as **Exhibit 'H'** is a copy of excerpts

from the *Regulatory Oversight Report for Nuclear Power Plants in Canada: 2015 Supplementa*l dated August 18, 2016.

28. CNSC staff noted in a presentation at the August 18, 2016 meeting that initial consultations with select stakeholders on the PNERP have been completed. The first stakeholder consultation on the review of the planning basis was completed in early 2016. Further stakeholder consultation on the PNERP and planning basis is scheduled for late summer and early fall 2016, followed by a full public consultation on both documents in late fall 2016.

29. PNERP revisions will include input from different sources, including the United Nations Scientific Committee on the Effects of Atomic Radiation and the Ministry of the Environment and Climate Change. Attached as **Exhibit 'I'** is a copy of the CNSC presentation *Exercise Unified Response Action Plan Updates* dated August 18, 2016.

International Developments since December, 2015

30. I found a powerpoint presentation posted online by Florian Gering, Emergency Management Division of the German Federal Office for Radiation Protection, in March, 2016. Attached as **Exhibit 'J'** is a copy of Florian Gering's presentation entitled *Updated Emergency Planning Zones in Germany and the Importance of Release Source Term*.

31. Based on models of a Fukushima-equivalent reference accident, the report recommends expanding the geographic areas covered by

emergency plans with respect to evacuation and the distribution of potassium iodide ("KI") pills.

32. I requested an English translation of a 2015 report modelling Fukushima-scale accidents, referred to in Mr. Gering's presentation. Attached as **Exhibit 'K'** is a copy of the accident modelling report entitled *RODOS-based Simulation of Potential Accident Scenarios for Emergency Response Management in the Vicinity of Nuclear Power Plants* dated June, 2015.

33. Table 4.1 on page 15 provides a list of accident scenarios and source terms used in the study. The report models the accident scenarios and emergency response measures needed for each possible planning basis.

Design Basis Threat

34. I have reviewed the International Atomic Energy Agency document entitled *Develop, Use and Maintenance of a Design Basis Threat* submitted by the Ministry. The Ministry has redacted the sections of its Reply Representations which explain the relevance of this document. I see no connection between this document and the analyses at issue in this appeal. A Design Basis Threat is a basis for designing safeguards to protect a nuclear station from sabotage or theft of nuclear material. It is not relevant to the selection of a planning basis or reference accident that will form the basis of off-site emergency plans.

Public Interest in Disclosure

35. In June, 2016, I was copied on a letter to CNSC president Michael Binder from a group of anonymous CNSC specialists detailing how management at the CNSC had discouraged them from informing the public and the independent CNSC Commissioners of risk-related information during recent re-licensing hearings on the Bruce and Darlington nuclear stations. Attached as **Exhibit 'L'** is a copy of the letter from anonymous CNSC employees to CNSC president Michael Binder.

36. The anonymous CNSC employees state that Ontario Power Generation's 2011 level 3 Probabilistic Safety Assessment for the Darlington nuclear station should be released so that the public can "judge whether Ontario's emergency response plan is adequate."

Conclusion

37. My interest in disclosure of the requested information is to ensure that the public can scrutinize the planning basis – or reference accident – chosen by the government as the foundation of Ontario's nuclear emergency plan, not for any private interest.

38. I make this supplementary affidavit in support of appeal PA14-543 and for no improper purpose.

AFFIRMED before me in the City of Toronto, in the Province of Ontario, this 15th day of August, 2016.	))))))	
______________________________ Commissioner for taking affidavits		______________________________ Shawn-Patrick Stensil

Project Name		
Nuclear Emergency Management Coordinating Committee (NEMCC)	Version No. 01.2	Version Date 2014/10/22

Meeting Information			
Subject/Title:	NEMCC Meeting Minutes		
Date/Time:	2014/04/02	**Location:**	Macdonald Block (Kenora and Nipigon Room), 900 Bay Street, Toronto
Objectives:	Nuclear Emergency Management Coordination with Federal, Provincial, Municipal and Nuclear Facilities		

Meeting Participants	
Chair:	Tom Kontra, Deputy Chief, Program Development, Office of the Fire Marshal and Emergency Management (OFMEM)
Attendees:	**Appendix 'A'** Municipalities/Federal Organization/Provincial Ministries/Nuclear Facilities/General Public/presenters
Regrets:	**Appendix 'A'**
Notes Taken By:	Rita Foulds

Meeting Minutes

Item No.	Discussion Points/ Issues Raised/ Decisions Made	Action Items	Responsible	Due Date
1.	Welcome remarks by the Chair followed by round table introductions.			
2.	The chair updated members on OFMEM activities: New Recruitment/Positions for Directors are as follows: – Al Suleman, Director/Deputy, Prevention and Risk Management; – Jim Jessop, Director, Field and Advisory Services / Deputy Fire Marshal; and, – Barney Owens, Director/Deputy Response – Troy Fernandes, Director/Support Services OFMEM is still in transition to harmonize, integrate and cross-train staff on operations.			

This is Exhibit..........................referred to in the affidavit of Shawn-Patrick Stensil affirmed before me, this fifteenth day of August 2016

A COMMISSIONER FOR TAKING AFFIDAVITS

Meeting Minutes

Item No.	Discussion Points/ Issues Raised/ Decisions Made	Action Items	Responsible	Due Date
	OFMEM New Complex at Downsview: – Location is at Keele/401 Centre of Forensic Sciences building. – The facility holds meeting rooms that can accommodate around 400 people, huge paid parking areas available. Close to Wilson subway station. – PEOC under construction, date to move has not been finalized, consideration is given after the forest fire season i.e. Fall 2014	s.65(6)		
3.	Dave Nodwell went through the NEMCC minutes for May 2 and November 25, 2013 meetings.	Minutes were adopted/signed and emailed to members on April 3, 2014	OFMEM	
4.	CELA and Green Peace Engagement Strategies for future engagement: Discussion Points: – Involvement of both organization – Transparency – Public engagement and NGOs	s.13(1)	OFMEM	
5.	<u>Provincial Nuclear Emergency Response Plan (PNERP) – planning basis way forward</u> presented by Wilson Lam and Rachna Clavero from Ministry of Energy	Presentation emailed on April 3, 2014 Working Group to be set to discuss/resolve specific PNERP issues		
6.	<u>Public Alerting</u>: Presented by Tyler Cashion and Jan Skora of Mobility and Wireless Solutions	Presentation emailed on April 3, 2014		

Meeting Minutes

Item No.	Discussion Points/ Issues Raised/ Decisions Made	Action Items	Responsible	Due Date
7.	OFMEM updated members on KI pills: In September 2013 a meeting was held with the representatives of the designated municipalities and nuclear facilities to discuss distribution options.	Each designated municipality to report on the progress at the next NEMCC meeting. s.12(1) s.13(1)		
8.	<u>Nuclear Public Education Committees:</u> Jude Kelly presented members with information on "The Flashlight" Emergency Preparedness Week activities.	Presentation emailed on April 3, 2014		
9.	<u>Exercise Unified Response</u> Due to the absence of OPG representative this item will be discussed at the next meeting	Agenda item for next meeting		

Meeting Minutes

Item No.	Discussion Points/ Issues Raised/ Decisions Made	Action Items	Responsible	Due Date
10.	<u>Ontario Annex to the Federal Nuclear Emergency Response Plan</u> Health Canada updated members on: – The Annex is re-developed to strengthen the level and mechanisms of support provided to the Province during a radiological and nuclear emergency by seamlessly linking the technical activities described in the FNEP and the PNERP – The Annex constitutes a pre-arrangement under the Emergency Management Act (this means that support will be provided in a timely manner without delays associated with executive level approvals) – The Annex contains description of technical/ scientific activities that will be undertaken at each response levels – HC has completed several rounds of consultations with provincial stakeholders – The annex will be shared with the NEMCC members for comments. The final version is due in Fall 2014			
	<u>Canadian Guidelines for Protective Actions during a Nuclear Emergency</u> – The Canadian Guidelines for Intervention During a Nuclear Emergency – 2003 and the Canadian Guidelines for the Restriction of Radioactively Contaminated Food and Water Following a Nuclear Emergency – 2000 will be combined incorporating the recommendations from the Internal Commission for Radiological Protection (ICRP) and International Atomic Energy Agency (IAEA). – The scope of the guidance document has not been changed. Provincial and Territorial governments will continue to have primary responsibility for off-site emergency planning and response.			

Meeting Minutes				
Item No.	**Discussion Points/ Issues Raised/ Decisions Made**	**Action Items**	**Responsible**	**Due Date**
	– The seven Operational Intervention Levels (OILs) adopted from IAEA guidance will reflect in the revised document. – The revised guidance will also include a section on the protection of emergency workers – The guidance has been circulated for review to the FPT_RPC, FPT-RNEMCC and the interdepartmental RNEMCC. Comments from these committees are expected in May 2014.			
11.	James Kilgour, City of Toronto updated members on Radiation Training Modules. • The Radiation Training Review Group had consulted with a number of municipal, provincial and federal stakeholders to seek their comments and advise on way forward. We have well defined course objectives, learning outcomes and target audience for 2 of the 3 desired courses; • Three training modules are desired – Basic Radiation Training, Emergency Worker Training and a First Responder specific type of training; • The volume of people who need this training is in excess of 20,000; • The on-line module and self-study package that was designed for the IMS 100 course on the OFMEMO portal is an ideal model to follow; • EMO agreed to meet and discuss next steps and implementation strategies	James Kilgour to set a meeting with Tom Kontra, Kalpana Rajgopalan to discuss capacity of the OFMEM portal and implementation strategies.		

Meeting Minutes

Item No.	Discussion Points/ Issues Raised/ Decisions Made	Action Items	Responsible	Due Date
	Other Items:			
	Nuclear Liability Act: Update from MMAH The proposed Nuclear Liability and Compensation legislation is still at the first reading stage; it is up to the government when it will be on the agenda for second reading after which it will probably be referred to committee.	MMAH to update members on the results.		
	NEMCC Terms of Reference: to be reviewed by members and comments sent to Rita.	NEMCC ToR to be finalized.		
	Nuclear Exercise Schedule: members to send their exercise schedule to Rita. Next Meeting: 27 October, 2014	Nuclear Exercise Schedule to be shared with members.		

Tom Kontra
Deputy Chief, Program Development
Office of the Fire Marshal and Emergency Management, MCSCS

Appendix 'A'

Chair	
Tom Kontra	Office of the Fire Marshal and Emergency Management, Ministry of Community Safety and Correctional Services (MCSCS)
Members	
David Duchesne	Health Canada
Lorie Whitcombe	Health Canada
Pamela Wentworth	Bruce Power
Jim Coles	Ontario Power Generation
Carol Gregoris	Ontario Power Generation
Rhys Lawrence	Ontario Power Generation
Karen Heinonen	Ontario Power Generation
Cathy Fisher	Atomic Energy Canada Limited
Ela Mcdonald	Laurentian Hills/Deep River Nuclear Emergency Preparedness
James Kilgour	City of Toronto
Warren Leonard	Region of Durham
Jodi Denoble	City of Peterborough
Roberta Trelford	Municipality of Kincardine
Frank Merkt	Municipality of Kincardine
Cindy Lai	Ministry of Community and Social Services/Ministry of Children and Youth Services
Jessica Bauman	Ministry of Community and Social Services/Ministry of Children and Youth Services
David Stegner	Ministry of Attorney General
Carl Seider	Ministry of the Environment
Lothar Doehler	Ministry of Labour
Adam Miller	Ministry of Health and Long Term Care
Donna Dupont	Ministry of Health and Long Term Care
Rachna Clavero	Ministry of Energy
Wilson Lam	Ministry of Energy
Dave Howse	Office of the Fire Marshal and Emergency Management, MCSCS
Tom Kontra	Office of the Fire Marshal and Emergency Management, MCSCS
Tennyson Ng	Office of the Fire Marshal and Emergency Management, MCSCS
Dave Nodwell	Office of the Fire Marshal and Emergency Management, MCSCS
Steve Beatty	Office of the Fire Marshal and Emergency Management, MCSCS
Drew Maddison	Office of the Fire Marshal and Emergency Management, MCSCS
Trevor Sinker	Office of the Fire Marshal and Emergency Management, MCSCS
Jude Kelly	Office of the Fire Marshal and Emergency Management, MCSCS
Kathy Bleyer	Office of the Fire Marshal and Emergency Management, MCSCS
Pedro Bilbao	Office of the Fire Marshal and Emergency Management, MCSCS
Rita Foulds	Office of the Fire Marshal and Emergency Management, MCSCS
Presenters:	
Tyler Cashion	Mobility and Wireless Company
Jan Sakora	Mobility and Wireless Company
Teleconference:	
Bernie Beaudin	Canadian Nuclear Safety Commission
Thuy Nguyen	Canadian Nuclear Safety Commission
Gary Zikovitz	Ministry of the Environment
Karen Smith	Ontario Provincial Police
Carly Hurash	Ministry of Natural Resources
IT Service:	
Richard Elson	Office of the Fire Marshal and Emergency Management, MCSCS

Information and Privacy Commissioner,
Ontario, Canada

This is Exhibit.........................referred to in the affidavit of...Shawn-Patrick Stensil............ affirmed before me, this...fifteenth................ day of......August................................2016....

....
A COMMISSIONER FOR TAKING AFFIDAVITS

Commissaire à l'information et à la protection de la vie privée,
Ontario, Canada

ORDER PO-3642

Appeal PA15-261

Ministry of Community Safety and Correctional Services

August 5, 2016

Summary: The appellant, a representative of a non-governmental organization, sought access to records relating to nuclear emergency management in the province. He appealed the ministry's decision to grant partial access to responsive records. By the close of the inquiry stage, there remained at issue only two discrete severances to the minutes of a meeting of the Nuclear Emergency Management Coordinating Committee that was attended by government and non-government representatives. The ministry claimed the exclusion at 65(6)3 (employment or labour relations) for one severance and the exemption at section 13(1) (advice or recommendations) for the second severance. In this order, the adjudicator applies the record-specific approach to find that the first severance to the meeting minutes is not excluded under section 65(6)3, and she orders the ministry to issue a decision on access to it. She also rejects the ministry's section 13(1) claim for the second severance, and orders that it be disclosed to the appellant.

Statutes Considered: *Freedom of Information and Protection of Privacy Act*, R.S.O. 1990, c. F.31, as amended, ss. 13(1), 65(6)3.

Orders and Investigation Reports Considered: Orders MO-3163, PO-2613, PO-3572.

OVERVIEW:

[1] The appellant represents a non-governmental organization that has been advocating for public review and upgrades to Ontario's offsite nuclear emergency plans. On its behalf, the appellant made a request to the Ministry of Community Safety and Correctional Services (the ministry) under the *Freedom of Information and Protection of Privacy Act* (the *Act*) for records relating to nuclear emergency management. Parts 3 and 4 of his request sought access to:

- The agenda, minutes and power point decks used at the October 2014 meeting of the Nuclear Emergency Management Coordinating Committee; and

- All briefing notes, including presentation decks, provided to the minister in October 2014 regarding nuclear emergency planning and preparedness.

[2] The Nuclear Emergency Management Coordinating Committee is a committee whose membership includes representatives from federal, provincial and municipal governments and industry organizations. The ministry describes the committee as a collaborative mechanism for the protection of public safety in relation to nuclear power plants. The October 2014 meeting was attended by representatives from all levels of government, as well as some stakeholders, chiefly from the utilities sector.

[3] The appellant reports that his organization was invited to present to the committee in November 2013, but has not been publicly consulted on nuclear emergency matters since that time. For this reason, he seeks information about committee deliberations on public consultations with his organization and related groups.

[4] The ministry granted partial access to responsive records. It denied access to other records, in whole or in part, citing exemptions at sections 12(1) (Cabinet records), 13(1) (advice or recommendations), 14(1)(i) (security), 18(1)(d) (financial interests of Ontario) and 22(a) (information publicly available), and the exclusion at section 65(6) (labour relations or employment-related matters) of the *Act*.

[5] The appellant appealed the ministry's decision to this office.

[6] During mediation, the appellant withdrew his appeal in relation to information withheld pursuant to sections 14(1)(i), 18(1)(d) and 22(a) of the *Act*. He also confirmed he does not seek access to the withheld portion of one page. Accordingly, those exemptions and withheld records are not at issue in this appeal.

[7] The appellant confirmed his interest in pursuing access to all other records or parts of records to which the ministry denied access. He also claimed a public interest in disclosure of the withheld information. As a result, the application of the public interest override at section 23 is an issue in this appeal.

[8] At the close of mediation, the ministry continued to rely on sections 12, 13(1) and 65(6) to withhold information on several pages of records. As no further mediation was possible, this file was transferred to the adjudication stage of the appeal process for an inquiry under the *Act*.

[9] During the inquiry process, the ministry and the appellant provided representations that were shared in accordance with this office's *Code of Procedure* and *Practice Direction Number 7*. The ministry issued a revised decision during the inquiry stage, resulting in the disclosure of additional pages and part pages to the appellant and the withdrawal of the ministry's reliance on section 12 of the *Act*. As a result of these developments, there

remain at issue only two discrete severances in meeting minutes documenting an October 22, 2014 meeting of the Nuclear Emergency Management Coordinating Committee. The ministry relies on sections 65(6)3 and 13(1) of the *Act* to withhold these severances.

[10] In this order, I find that both claims fail. I find that the exclusion at section 65(6)3 cannot apply to one severance in the larger record comprising the meeting minutes, and I order the ministry to issue a decision on access to this severance. I also reject the ministry's decision to withhold a second severance on the basis of section 13(1). I order the ministry to disclose this severance to the appellant.

INFORMATION AT ISSUE:

[11] At issue are discrete severances appearing in items 2 and 4 of the meeting minutes for the October 22, 2014 meeting of the Nuclear Emergency Management Coordinating Committee. Both severances appear on the page numbered 92 in the ministry's disclosure package to the appellant.

ISSUES:

A. Does the exclusion for labour relations or employment related matters at section 65(6)3 apply to one severance to the meeting minutes?

B. Does the discretionary exemption for advice or recommendations at section 13(1) apply to a second severance to the meeting minutes? If so, did the ministry exercise its discretion under section 13(1)?

C. If section 13 applies, is there a compelling public interest in disclosure of the withheld information that clearly outweighs the purpose of the section 13 exemption?

DISCUSSION:

A. Does the exclusion for labour relations or employment related matters at section 65(6)3 apply to one severance to the meeting minutes?

[12] The ministry seeks to exclude one discrete bullet point in the meeting minutes on the basis of section 65(6)3 of the *Act*. This section reads:

> Subject to subsection (7), this Act does not apply to records collected, prepared, maintained or used by or on behalf of an institution in relation to
>
> ...
>
> > Meetings, consultations, discussions or communications about labour relations or employment related matters in which the institution has an interest.

[13] If section 65(6) applies to a record, and none of the exceptions found in section 65(7) applies, the record is excluded from the scope of the *Act*.

[14] For section 65(6)3 to apply, the ministry must establish that:

1. the record was collected, prepared, maintained or used by an institution or on its behalf;

2. this collection, preparation, maintenance or usage was in relation to meetings, consultations, discussions or communications; and

3. these meetings, consultations, discussions or communications are about labour relations or employment-related matters in which the institution has an interest.

[15] The information sought to be excluded under section 65(6)3 appears under the heading item 2 in the committee meeting minutes. The majority of the meeting minutes, including the remainder of the discussion under this heading, has been disclosed to the appellant. The severance appears in a portion of the meeting minutes documenting the committee chair's update to committee members on activities of the Office of the Fire Marshal and Emergency Management, and specifically on the progress of the development of a new branch complex. While discussion of the new complex's location and construction has been disclosed to the appellant, one portion of this discussion has been withheld on the basis that it concerns workforce labour relations at the complex, a matter in which the ministry says it has an inherent interest as an employer.

[16] I accept that the severance appears in meeting minutes that were prepared by the Office of the Fire Marshal and Emergency Management, a branch of the ministry, which chaired the meeting at a government office on the ministry's behalf. I also accept that the meeting minutes were prepared "in relation to" meetings, consultations, discussions or communications. "In relation to" in this context has been interpreted to mean it must be reasonable to conclude that there is "some connection" between the record's collection, preparation, maintenance or use and the subjects in paragraphs 1, 2 or 3 of section 65(6).[1] It is evident, based on the nature of record itself, that it was prepared "in relation to," and has some connection to, the discussions at the committee meeting that the record documents.

[17] However, the ministry has not claimed that the exclusion applies to the record—the meeting minutes—as a whole. Instead, the ministry seeks to withhold only one discrete portion of one item of discussion in the record under section 65(6)3. In making this claim, it is possible the ministry is implicitly acknowledging that the record, as whole, was not prepared in relation to discussions about labour relations or employment-related matters within the meaning of section 65(6)3.[2] In that case, the ministry's claim is that a

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[1] Order MO-2589; see also *Ministry of the Attorney General and Toronto Star and Information and Privacy Commissioner*, 2010 ONSC 991 (Div. Ct.).

[2] The term "labour relations" refers to the collective bargaining relationship between an institution and its employees, as governed by collective bargaining legislation, or to analogous relationships. The meaning of

portion of a record can qualify for exclusion, even where the record in which it appears is not itself excluded. This raises the question of whether an exclusion can apply to a record in part. I conclude that it cannot.

[18] This office has consistently taken the position that the exclusions at section 65(6) of the *Act* (and the equivalent section in the *Act*'s municipal counterpart) are record-specific and fact-specific.[3] This means that in order to qualify for an exclusion, a record is examined as a whole. This whole-record method of analysis has also been described as the "record-by-record" approach when applied by this office in considering the application of exemptions to records.[4]

[19] This approach to the consideration of exclusions is illustrated in previous orders of this office that have addressed whether an exclusion applies to a record based on the inclusion within the record of an excluded portion. In these orders, this office has applied the record-specific and fact-specific analysis to consider whether the record, as a whole, qualifies for the claimed exclusion.

[20] In Order MO-3163, for example, the adjudicator considered an internal police training video containing, as examples of inappropriate officer behaviour, two discrete clips for which the police claimed certain exclusions. The adjudicator examined the record—the training video—as a whole, and concluded that it did not qualify for any of the claimed exclusions, irrespective of whether portions of the record (the individual clips) might themselves qualify for exclusion in another context (which question was not before the adjudicator). Similarly, in Order PO-2613, this office held that evidence of an institution's regular use of some portions of a database of job positions, job descriptions, classification standards and evaluations for labour relations or employment-related proceedings and negotiations did not support the exclusion of the database, as a whole, under section 65(6)1 or 65(6)2 of the *Act*.[5] I applied this same whole-record-based

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"labour relations" is not restricted to employer-employee relationships: Order MO-2589; see also *Ministry of the Attorney General and Toronto Star and Information and Privacy Commissioner*, cited above.
The term "employment-related matters" refers to human resources or staff relations issues arising from the relationship between an employer and employees that do not arise out of a collective bargaining relationship: Order PO-2157.

[3] See Orders M-797, P-1575, PO-2531, PO-2632, MO-1218, PO-3456-I and many others.

[4] The "record-by-record" method of analysis for dealing with requests for records of personal information is set out in Order M-352. Under this method, the unit of analysis is the whole record, rather than individual paragraphs, sentences or words contained in a record. In addition, where the information at issue is the withheld portion of a record that has been partially released, the whole of the record (including released portions) is analyzed in determining a requester's right to access the withheld information.

[5] These sections state:

> Subject to subsection (7), this Act does not apply to records collected, prepared, maintained or used by or on behalf of an institution in relation to any of the following:
>
> 1. Proceedings or anticipated proceedings before a court, tribunal or other entity relating to labour relations or to the employment of a person by the institution.
> 2. Negotiations or anticipated negotiations relating to labour relations or to the employment of a person by the institution between the institution and a person, bargaining agent or party to a proceeding or an anticipated proceeding.

approach most recently in Order PO-3572, in which an institution sought to exclude under section 65(6)2 budget records of approximately 10,000 line items each, based on its claim that it maintained or used certain line items in each of the records for labour relations negotiations. In that order, I found that the actual use of some information in the records for an excluded purpose was not sufficient to bring the records, as a whole, within the scope of the claimed exclusion.

[21] In each of these cases, the question is whether the collection, preparation, maintenance or use of the record, as a whole, is sufficiently connected to an excluded purpose so as to remove the entire record from the scope of the *Act*. This approach to the exclusions is consonant with the language of the exclusions, which applies to records that meet the relevant criteria. I also find it corresponds to the Legislature's decision not to incorporate into the *Act* a requirement for the severance of excluded records, in contrast to its treatment of records subject to the *Act*'s exemptions.[6]

[22] In this case, the ministry does not claim that the record, as a whole, is excluded under section 65(6)3. In any event, on my review of the record's contents (the majority of which have been disclosed to the appellant), and in consideration of the record's purpose—to document a meeting whose stated objective is to enhance preparedness and coordination between government, nuclear facilities and other agencies in responding to nuclear and radiological emergencies—I am satisfied that the record would not itself qualify for the section 65(6)3 exclusion. As the application of an exclusion must be considered in the context of the whole record, I conclude that the withheld portion of the record cannot qualify for exclusion, whether or not I were to accept the ministry's claim that this discrete portion is about "workforce labour relations."

[23] As this information is not excluded from the right of access in the *Act*, I will order the ministry to issue a decision on access to it.

B. Does the discretionary exemption for advice or recommendations at section 13(1) apply to a second severance to the meeting minutes? If so, did the ministry exercise its discretion under section 13(1)?

[24] The ministry claims that a second severance in the record is exempt under section 13(1) of the *Act*. This section states:

> A head may refuse to disclose a record where the disclosure would reveal advice or recommendations of a public servant, any other person employed in the service of an institution or a consultant retained by an institution.

In the result, the adjudicator found the database was excluded under section 65(6)3, based his satisfaction that the database, as a whole, had been collected, prepared, maintained or used for meetings, consultations, discussions or communications about labour relations or employment-related matters.

[6] Section 10(2) of the *Act* states: "If an institution receives a request for access to a record that contains information that falls within one of the exemptions under sections 12 to 22 and the head of the institution is not of the opinion that the request is frivolous or vexatious, the head shall disclose as much of the record as can reasonably be severed without disclosing the information that falls under one of the exemptions."

[25] The information at issue appears under the heading item 4 in the committee meeting minutes, documenting the committee's discussion of strategies for the public engagement of non-governmental organizations. The ministry seeks to withhold one discrete portion of the discussion under section 13(1) on the basis that it contains recommendations provided by meeting attendees that would reveal a particular course of action that was being considered at the meeting.

[26] I do not accept the ministry's claim. This is because I am not satisfied that disclosure of the withheld information would reveal advice or recommendations, or that any advice or recommendations was given by public servants or other individuals employed or retained in the service of an institution.

[27] The purpose of section 13 is to preserve an effective and neutral public service by ensuring that people employed or retained by institutions are able to freely and frankly advise and make recommendations within the deliberative process of government decision-making and policy-making.[7]

[28] "Recommendations" refers to material that relates to a suggested course of action that will ultimately be accepted or rejected by the person being advised, and can be express or inferred. "Advice" has a broader meaning, and includes lists of alternative courses of action to be accepted or rejected in relation to a decision that is to be made, and the views or opinions of a public servant as to the range of options to be considered by the decision maker, even if they do not include a specific recommendation on which option to take.[8]

[29] The ministry states that it views the Nuclear Emergency Management Coordinating Committee, whose meeting discussions are captured in the record, as being part of the deliberative process of government decision-making related to the promotion of nuclear safety. It observes that the committee operates in relation to the Provincial Nuclear Emergency Response Plan, which is mandated by statute and is subject to ministerial approval.[9] The ministry thus argues that the withheld information comprises recommendations of a committee involved in the deliberative process of government decision-making, as required by section 13(1).

[30] The committee's membership includes representatives from federal, provincial and local government organizations and agencies. The list of participants at the October 22, 2014 meeting captured in the record indicates that in addition to committee members, meeting attendees included representatives of nuclear facilities and another private sector organization. The information sought to be exempted is not attributed in the record to any particular meeting attendee; in the ministry's representations, it is described as a recommendation made by meeting attendees, which, the ministry notes, includes ministry employees.

---

[7] *John Doe v. Ontario (Finance)*, 2014 SCC 36, at para. 43.
[8] See above at paras. 26 and 47.
[9] The ministry cites section 8 of the *Emergency Management and Civil Protection Act*.

[31] I am not satisfied that the presence of ministry employees among meeting attendees transforms any advice or recommendations of that group into the advice or recommendations of public servants or other individuals employed or retained by an institution. I am also not persuaded by the ministry's characterization of the committee as part of the deliberative process of government decision-making, based on its statement that the committee "operates in relation to" the provincial strategy for nuclear safety. The ministry has not explained the role of committee discussions in any government decision-making and policy-making, or described to whom any advice or recommendations of committee meeting attendees may be directed, or how the withheld information reflects advice or recommendations of meeting attendees that would be considered and accepted or rejected by an ultimate decision-maker. In the absence of evidence to support the claim that the withheld information informs government decision-making, I am not satisfied that the exemption at section 13(1) applies.

[32] Given this, it is unnecessary for me to consider the government's exercise of discretion under section 13(1), or whether the public interest override applies in these circumstances. I order disclosure of the second severance.

ORDER:

1. I do not uphold the ministry's decision under section 65(6)3. I order the ministry to issue a decision on access to the information withheld under this section, treating the date of this order as the date of the request.

2. I do not uphold the ministry's decision under section 13(1). I order the ministry to disclose the information withheld under this section by **August 26, 2016**.

Jenny Ryu
Adjudicator

August 5, 2016

This is Exhibit..........................referred to in the affidavit of...Shawn-Patrick Stensil.............. affirmed before me, this...fifteenth................ day of......August.................................2016....

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A COMMISSIONER FOR TAKING AFFIDAVITS

CNSC CCSN
4987901

Ministry of Community Safety and Correctional Services
Office of the Fire Marshal and Emergency Management
25 Morton Shulman Avenue
Toronto ON M3M 0B1
Tel: 647-329-1100
Fax: 647-329-1143

Ministère de la Sécurité communautaire et des Services correctionnels
Bureau du commissaire des incendies et de la gestion des situations d'urgence
25, avenue Morton Shulman
Toronto ON M3M 0B1
Tél.: 647-329-1100
Téléc.: 647-329-1143

Ontario

5.03.03

FILE DOSSIER	1-14-2
REFERRED TO RÉFÉRÉ À	Jamieson

December 18, 2015

Mr. Terry Jamieson
Vice-President
Canadian Nuclear Safety Commission (CNSC)
CNSC Headquarters
280 Slater Street
P.O. Box 1406, Station B
Ottawa ON K1P 5S9

Dear Mr. ~~Jamieson~~, Terry

As discussed in our telephone conversation of December 16, the Office of the Fire Marshal and Emergency Management (OFMEM) is undertaking a review of its Provincial Nuclear Emergency Response Plan (PNERP). In this regard, last month we issued a Discussion Paper on the (PNERP) Planning Basis, for comment by members of the Nuclear Emergency Management Coordinating Committee (NEMCC), of which CNSC is a member. It was our intention to have a discussion on the overall direction of the Discussion Paper's recommendations at the December 10, 2015 meeting of the committee with detailed stakeholder comments (requested prior to the meeting) being dispositioned soon after.

The Discussion Paper included a review of a number of studies including those related to the Fukushima Daichi accident. In terms of severe accident planning in the Canadian context, the Discussion Paper included a review of the CNSC's "Study of Consequences of a Hypothetical Nuclear Accident and Effectiveness of Mitigation Measures". The basis for that report, the SARP study, was undertaken by OPG at the request of the CNSC for input into the determination of health consequences in case of a severe nuclear emergency. As you would be aware, the SARP study validated that the current PNERP planning basis is sufficiently conservative and the concept of operations sufficiently robust to address the potential public risks associated with Fukushima scale accidents.

It has now been brought to our attention by CNSC staff that a more appropriate basis for severe accident dose consequences would, in fact, be the Probabilistic Safety Assessment (PSA) studies prepared by the nuclear generating stations. Given that we neither have access to these studies, nor do we have the in-house resources to scientifically assess them in a timely manner, we kindly request that CNSC resources be made available to provide OFMEM with the distance versus dose consequences and probability of the applicable severe accident PSAs for Pickering, Darlington and Bruce.

This new obligation to validate the planning basis against the PSA's creates additional pressures in meeting our timeline for stakeholder and public consultations on the new draft PNERP and we appreciate your initial indications that CNSC could assist us in this matter. We look forward to your confirmation of this assistance at your earliest convenience.

Thank you for your consideration and, if you or your staff need any further detail, please contact Dave Nodwell at 647-329-1160 or Dave.Nodwell@ontario.ca.

Wishing you all the best for this Holiday Season.

Sincerely,

A. Suleman, P.Eng.
Director /Deputy, Prevention and Risk Management
Fire Marshal and Chief, Emergency Management

Copy: Ross Nichols, OFMEM
Raoul Awad, CNSC
Luc Sigouin, CNSC

Canadian Nuclear Safety Commission	**Commission canadienne de sûreté nucléaire**
Public meeting	**Réunion publique**
April 7th, 2016	**Le 7 avril 2016**
Public Hearing Room 14th floor 280 Slater Street Ottawa, Ontario	Salle des audiences publiques 14e étage 280, rue Slater Ottawa (Ontario)
Commission Members present	**Commissaires présents**
Dr. Michael Binder Mr. Dan Tolgyesi Dr. Sandy McEwan Ms Rumina Velshi	M. Michael Binder M. Dan Tolgyesi Dr Sandy McEwan Mme Rumina Velshi
Secretary:	**Secrétaire:**
Mr. Marc Leblanc	M. Marc Leblanc
General Counsel:	**Avocate générale :**
Ms Lisa Thiele	Me Lisa Thiele

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affidavit of...Shawn-Patrick Stensil..............
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day of.....August.....................................2016....

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I would now like Mr. Sigouin to provide his update regarding nuclear emergency management.

MR. SIGOUIN: Thank you.

Good morning, everyone. My name is Luc Sigouin. I'm the Director of Emergency Management Programs at CNSC.

I'll provide the Commission with an update on the staff review of the Ontario Planning Basis document that was discussed at the Nuclear Emergency Management Coordinating Committee.

As we discussed at the Darlington hearing in Courtice, the Office of the Fire Marshal and Emergency Management, OFMEM, has undertaken a review of the Provincial Nuclear Emergency Plan, that they call the PNERP, and in particular a review of the Planning Basis.

In late November, CNSC staff received a copy of the PNERP Planning Basis Discussion Paper from the Office of the Fire Marshal and we began our review.

In early December, the Office of the Fire Marshal organized a meeting of the Coordinating Committee, which is a multi-stakeholder meeting involving provincial and municipal government staff as well as operators and some of the primary federal partners, to discuss the Emergency Plan update and the Planning Basis Discussion Paper in particular. CNSC staff attended this meeting and actively participated in discussions with the stakeholders.

Staff completed its review and formally provided comments to the Office of the Fire Marshal in mid-December.

In general, staff's view was that the Discussion Paper was an excellent foundation to the process and that it could be strengthened. We provided constructive comments to the OFMEM and they have agreed to consider our comments.

As well, CNSC staff has offered to assist OFMEM in the scientific and technical work that is required to inform the Planning Basis and this offer has been accepted by OFMEM.

Staff will be meeting with the Fire Marshal's team in mid-April to discuss, among other topics, the preliminary results of our analysis and we expect to provide the Office of the Fire Marshal with the information that they require no later than the end of May.

Although this additional work may have delayed some of the early milestones set by the Office of the Fire Marshal, CNSC staff believe that the additional analysis will strengthen the Provincial Nuclear Emergency Plan and we understand that OFMEM is still planning to complete the Plan review, including public consultations, by the end of this calendar year.

CNSC staff use the updates to the Provincial Nuclear Emergency Response Plan as a continuous improvement activity and that the current emergency plans in place in Ontario provide for adequate protection of residents.

Thank you.

THE PRESIDENT: Thank you.

So let's get into the question period, starting with Monsieur Tolgyesi.

MEMBER TOLGYESI: On this emergency management, you were saying that there is the participation of the Fire Marshal, provincial and CNSC, and you were mentioning municipal participation. Does every municipality delegate a person on that committee, which means that there will be lots of municipalities, or there is a kind of municipality representative?

MR. SIGOUIN: Luc Sigouin for the record.

The municipalities that participate in this Coordinating Committee are what Ontario refers to as the nuclear host municipalities. So it's the municipalities that have Class I nuclear facilities in them that require emergency planning arrangements. So it's Durham Region for Pickering and Darlington, the Kincardine Region for Bruce Power, and Deep River-Laurentian Hills Region for Chalk River. So those are the three municipalities or regions that are represented on the committee.

MEMBER TOLGYESI: I will have one question, Mr. President. This is regarding -- may I talk about Point Lepreau?

In Point Lepreau's update, the before last letter to Mr. Bhardwaj, we will be sending staff to India in order to gain the lessons learned and the key point here is post-refurbishment and re-tubing to determine the root cause and then assess our own with respect to the industry in general and the CANDU.

MEMBER VELSHI: Thank you. Yeah, I just want to acknowledge, I think that's an excellent plan that you have from learning from that.

My other question was on the Provincial Nuclear Emergency Planning basis document. And we have had extensive discussions at our many hearings around stakeholder involvement, and not the stakeholders that you had mentioned, but the public involvement.

And I know that CNSC had made a commitment that would try to facilitate earlier engagement rather than later and so what the update that you've given so far says that that's going to happen later on, you know, after you've had some meetings and so on, and I'm not quite sure whether that was in the spirit of what we had heard that we were going to do or what the expectation was.

So can you maybe elaborate on the public engagement early enough, if the plan is still to have the revision done by the end of your -- when is that going to happen and does that give sufficient time for engagement?

MR. SIGOUIN: Luc Sigouin for the record.

Our understanding of the situation is that the Office of the Fire Marshal is still committed to doing engagement with public stakeholders, with the public.

My understanding is that they haven't reached a point yet where they have enough information to have meaningful interaction and quite likely that that would not be the case until we have finished providing the information to them at the end of May.

We have -- as I mentioned earlier, we have a meeting with them scheduled in mid-April and at that point we will reinforce the expectation of the Commission to have public engagement earlier rather than later and we could have more information on that available for you at that time.

MEMBER VELSHI: Thank you. I look forward to that.

THE PRESIDENT: Let me add. So I thought that the original plan was in May of this year that they will have approval by Cabinet of the new planning base. Sounds to me like this is dragging out a lot longer than expected.

So am I right; because by the end of the year, calendar year, does that include going to Cabinet and getting political approval?

MR. SIGOUIN: Luc Sigouin for the record.

So our understanding of the timeline is that it does include final approval at whatever highest level they require.

As I mentioned, there have been delays

associated with getting the planning basis right and I think OFMEM's approach of ensuring that they get it right as the basis for the rest of updates for the plan is the correct approach and we will have more information on their revised schedule in light of the time it's taking to getting the planning basis correct.

THE PRESIDENT: I would hope that this committee, the quarterly committee will insist on having a schedule, you know, with time and target dates, et cetera, so everybody knows what the game plan is, including the public consultation.

And the other thing is, remember at one time it wasn't clear that they were going to do public consultation and we said that we will do public consultation if they don't.

So I don't know whether that's got clarified.

And the other question is, does the plan will include evacuation and returns?

MR. SIGOUIN: Luc Sigouin for the record.

I'll answer the last part of your question, sir, and Mr. Jamieson has some information on the public consultation.

Our understanding of the review of the plan is that it will include reviewing their protection strategy, their concept of operations, which includes when to evacuate or when to shelter and the CSA N1600 standard on emergency management that has been revised recently includes requirements for the emergency plans to identify transitioning into the post-emergency, post-accident state.

I'm not sure that the province is ready to undertake the full activity of developing the post-accident recovery plans. They're focused right now on updating the emergency plans and including that transition of how they would go to recovery.

I'll let Mr. Jamieson offer some additional information on the consultation that the province is planning.

MR. JAMIESON: Terry Jamieson, Vice-President of the Technical Support Branch.

We're in constant communication with OFMEM on this and, as Mr. Sigouin has said, we will have much more information after our meeting which will take place a week from tomorrow.

In the last telecom that we had with OFMEM they feel they're still on track within their overall schedule for the end of the year and I'd like to emphasize that that schedule includes 45 days of public consultation which is mandated by Ontario law.

THE PRESIDENT: Is Health Canada involved in this consultation?

MR. SIGOUIN: Yes, Health Canada is involved in the process.

THE PRESIDENT: Because, as you know, right now there is a protocol, an old protocol about post-event and getting back and it's very debated internationally post-Fukushima about what the solution is. We've got to get a Canadian position on that.

And, you know, I'm very concerned that if they don't come up with -- if the province doesn't come up with one, we will have to, with Health Canada, have to articulate what the current policy is.

MR. JAMIESON: That's understood, Mr. President, and we're working --

THE PRESIDENT: So somewhere after May we should be able to get a full detailed plan about what's going to happen and when.

MR. SIGOUIN: That's correct. In regards to the update to the nuclear emergency response plan, that's correct.

THE PRESIDENT: Okay. Thank you.

Anybody else want to jump on this?

All right. Thank you. Thank you very much.

The next item is the event initial report regarding the worker that was injured at the Bruce B Nuclear Generating Station as outlined in CMD 16-M18.

THE PRESIDENT: I understand that Mr. Jeff Stevenson is joining us via teleconference.

Can you hear us, Jeff?

MR. STEVENSON: Yes, I can. Thank you.

THE PRESIDENT: Thank you.

And I guess we're first going to hear from Bruce Power and I guess, Mr. Saunders, you are going to share with us some insight into what happened.

Over to you.

CMD 16-M18.1

Oral presentation by Bruce Power

MR. SAUNDERS: Yes, that's correct. Frank Saunders for the record.

I'm just waiting for the presentation here. Okay.

So to start with, just a quick view of the generator and what it is and what was involved in this particular event.

You can see the white in the centre here is the rotor of the generator. It turns on a large axle you see sticking out both ends, we usually refer to that as the bore, but in essence it's an axle. It is hollow in the centre.

When this generator is operating it's full of hydrogen, the hydrogen is the cooling medium in the generator and the hole in the centre of the rotor, though, is protected by seals and hydrogen is not supposed to actually get into that area.

The nature of this work is really based on the lifetime of the generator. There's a requirement that

Darlington NGS Risk Assessment Summary Report - 2012 (Refurb Project)

s.13(1)(c)

	Release #1	Release #2	Release #3		SARP	Fukushima	Chernobyl
	Common mode failure, combined with failures causing station blackout, leading to a loss of heat sink and failure of ECIS and moderator cooling at four units simultaneously.			Steam Generator Tube rupture... Containment bypass, i.e. non-filtered	Comparison		
Baseline Frequency (/reactor-year)	4.90E-06			3.70E-07			
Enhanced Model (/reactor-year)	5.10E-08			3.60E-07			
	Accident "RC1-PDS3"						
Start Time (hrs)	11	25	58				
Duration (hrs)	1.0	1.2	3.9				
*Unit core fraction (% eq'm core)	0.27%	0.64%	8.4%				
Total Core fraction	1.1%	2.6%	33%		0.14%	5.5% / 22%	52% / 122%
Total I-131 (TBq)	31,000	74,000	970,000		3,930	160,000	1,500,000
Total Cs-137 (TBq)	520	1,300	19,000		102	15,000	82,000
INES I-Equiv (TBq)	51,800	126,000	1,730,000		8,010	760,000	4,780,000

INES threshold (TBq of "I=")	
7	50,000
6	5,000

Candu Core (TBq)	
I-131	2,900,000
Cs-137	67,000

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affirmed before me, this...fifteenth..................
day of.....August.................................2016....

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A0058015_1-000061

CSA	Average wind speed	3.7m/s for Oshawa	per CSA
CSA	Stability Class	D	most frequent (also typical night conditions)
IAEA	Assume everyone sheltered (dose reduction factor 0.5 per IAEA)		
	Assume constant wind direction for all releases		

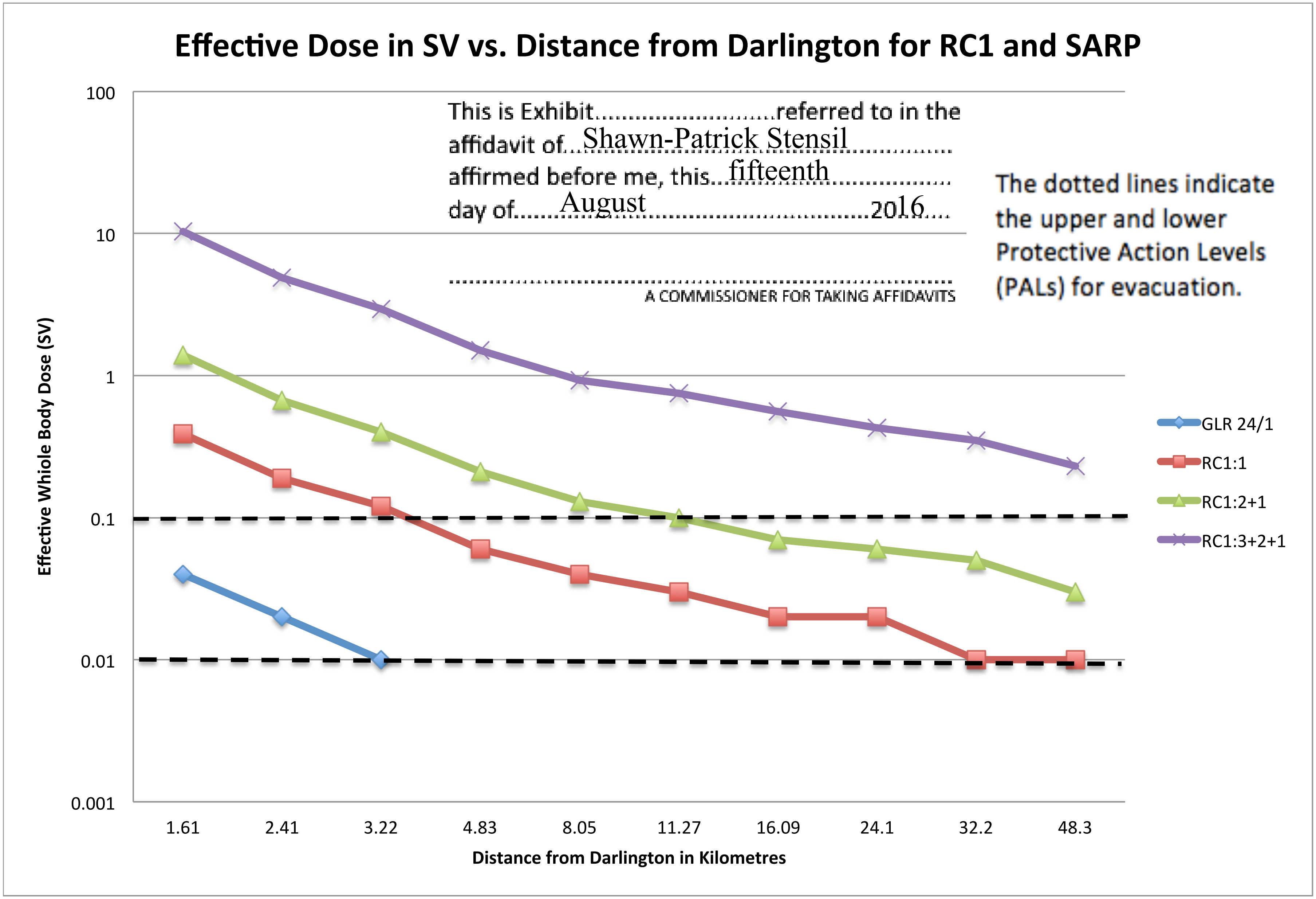
s.13(1)(c)

Effective/WB (Sv) with 0.5 dose reduction

km	***1.61***	***2.41***	***3.22***	***4.83***	***8.05***	***11.27***	***16.09***	***24.10***	***32.20***	***48.30***
GLR 24/1	0.04	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
RC1:1	0.39	0.19	0.12	0.06	0.04	0.03	0.02	0.02	0.01	0.01
RC1:2+1	1.40	0.67	0.40	0.21	0.13	0.10	0.07	0.06	0.05	0.03
RC1:3+2+1	10.36	4.88	2.95	1.50	0.93	0.75	0.56	0.43	0.35	0.23

Thyroid Committed Equivalent (Sv) with 0.5 dose reduction

km	***1.61***	***2.41***	***3.22***	***4.83***	***8.05***	***11.27***	***16.09***	***24.10***	***32.20***	***48.30***
24/1-Thyroid	0.50	0.25	0.15	0.09	0.06	0.04	0.03	0.03	0.02	0.01
RC1T: 1	5.50	2.60	1.55	0.80	0.50	0.39	0.29	0.24	0.19	0.13
RC1T: 2+1	20.50	10.00	6.00	3.10	1.90	1.45	1.10	0.90	0.70	0.48
RC1T: 3+2+1	155.00	75.00	45.00	23.50	14.50	11.00	8.50	7.00	5.50	3.70


Effective Dose in SV vs. Distance from Darlington for RC1 and SARP
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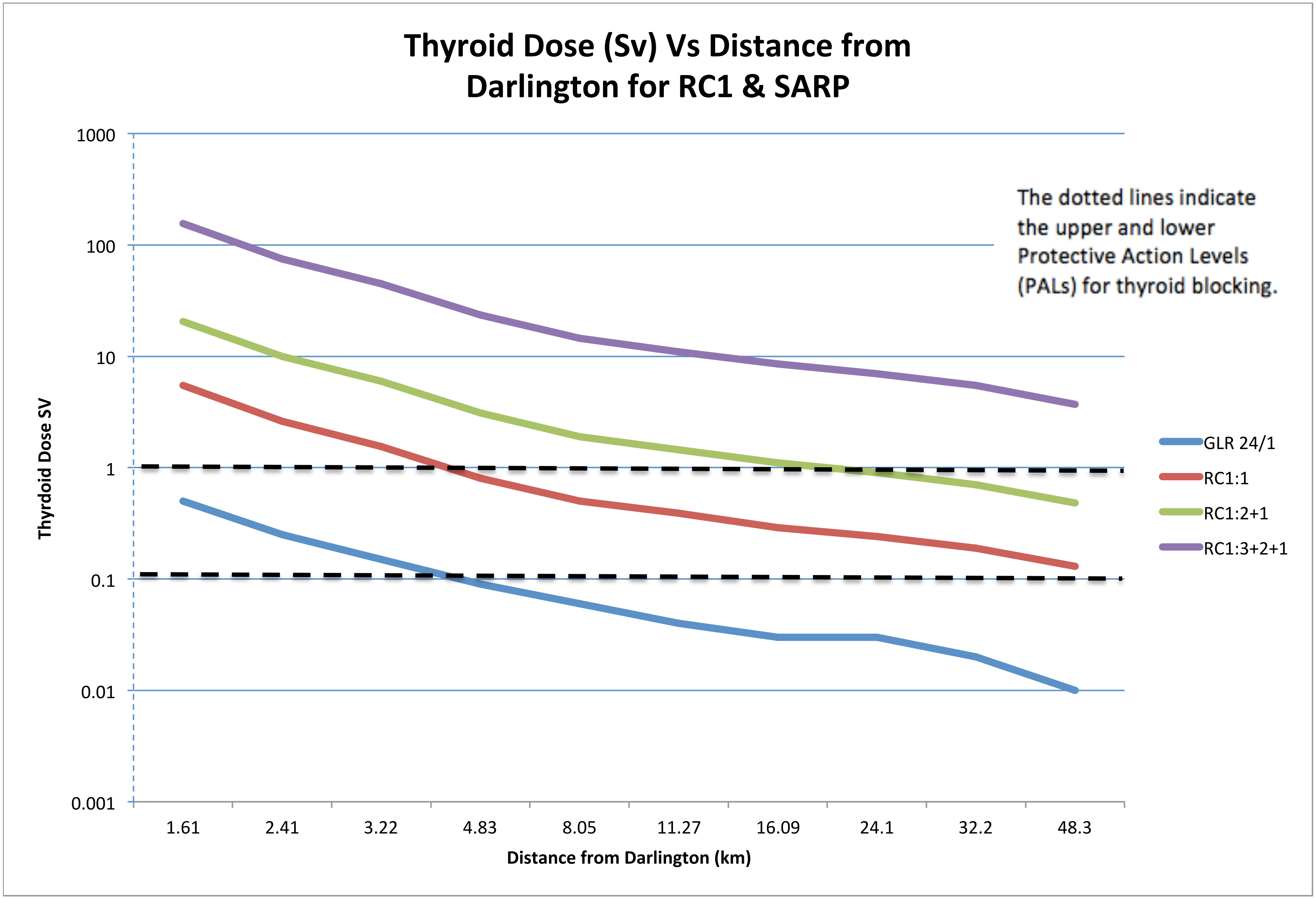
The dotted lines indicate the upper and lower Protective Action Levels (PALs) for evacuation.
100
10
1
0.1
0.01
0.001
Effective Whiole Body Dose (SV)
1.61
2.41
3.22
4.83
8.05
11.27
16.09
24.1
32.2
48.3
Distance from Darlington in Kilometres
GLR 24/1
RC1:1
RC1:2+1
RC1:3+2+1

Effective/WB (Sv) with 0.5 dose reduction

km	1.61	2.41	3.22	4.83	8.05	11.27	16.09	24.1	32.2	48.3
GLR 24/1	0.04	0.02	0.01	0	0	0	0	0	0	0
RC1:1	0.39	0.19	0.12	0.06	0.04	0.03	0.02	0.02	0.01	0.01
RC1:2+1	1.4	0.67	0.4	0.21	0.13	0.1	0.07	0.06	0.05	0.03
RC1:3+2+1	10.36	4.88	2.95	1.5	0.93	0.75	0.56	0.43	0.35	0.23


Thyroid Dose (Sv) Vs Distance from Darlington for RC1 & SARP
The dotted lines indicate the upper and lower Protective Action Levels (PALs) for thyroid blocking.
Thyrdoid Dose SV
1000
100
10
1
0.1
0.01
0.001
1.61
2.41
3.22
4.83
8.05
11.27
16.09
24.1
32.2
48.3
Distance from Darlington (km)
GLR 24/1
RC1:1
RC1:2+1
RC1:3+2+1

Thyroid Committed Equivalent (SV) with 0.5 dose reduction

km	1.61	2.41	3.22	4.83	8.05	11.27	16.09	24.1	32.2	48.3
GLR 24/1	0.5	0.25	0.15	0.09	0.06	0.04	0.03	0.03	0.02	0.01
RC1:1	5.5	2.6	1.55	0.8	0.5	0.39	0.29	0.24	0.19	0.13
RC1:2+1	20.5	10	6	3.1	1.9	1.45	1.1	0.9	0.7	0.48
RC1:3+2+1	155	75	45	23.5	14.5	11	8.5	7	5.5	3.7

PROTECTIVE MEASURE	LOWER LEVEL		UPPER LEVEL	
Dose	Effective Dose	Thyroid Dose	Effective Dose	Thyroid Dose
Sheltering	1 mSv (0.1 rem)	10 mSv (1 rem)	10 mSv (1 rem)	100 mSv (10 rem)
Evacuation	10 mSv (1 rem)	100 mSv (10 rem)	100 mSv (10 rem)	1 Sv (100 rem)
Thyroid Blocking	-	100 mSv (10 rem)	-	1 Sv (100 rem)

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OPMEH Meeting 15Apr/2016

- ~~reg changes~~
- July - October consultation
- posted on environmental register
- at least 45 days, could be longer
- OIC / Cabinet Approval Jan 2017
- recommending general public consultation on env reg (plain language) with links to planning basis document and PNERP for NGOs
- will also invite intervenors to present to a disposition committee (independent, supported by technical panel (academics); CNSC to participate)
- disposition committee will prepare a report (not sure if will be a public doc or not).
- * PAIRD: consultation aspects
- * Nichols meeting with President
- TJ suggests some form of Commission "concurrence" ✓

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

UNPROTECTED/NON PROTÉGÉ

ORIGINAL/ORIGINAL

Supplemental CMD: 16-M30.A

Date signed/Signé le: 28 JULY 2016

Commission Request for Information

Demande d'information de la Commission

Regulatory Oversight Report for Nuclear Power Plants in Canada: 2015 Supplemental

Rapport de surveillance réglementaire des centrales nucléaires au Canada: 2015 supplémentaire

Public Meeting

Réunion publique

Scheduled for :

18 August 2016

Prévue pour :

18 août 2016

Submitted by:

CNSC Staff

Soumise par :

Le personnel de la CCSN

This is Exhibit..........................referred to in the affidavit of...Shawn-Patrick Stensil...............
affirmed before me, this...fifteenth.................
day of......August...............................2016....

....
A COMMISSIONER FOR TAKING AFFIDAVITS

e-Doc: 5018476 (WORD)
e-Doc: 5050439 (PDF)

Canada

Summary

The purpose of this supplemental Commission Member Document (CMD) is to update the Commission and request closure on Commission action items generated from previous Commission proceedings. Specifically, this CMD provides updates to the Commission on Exercise *Unified Response* (ExUR) and to introduce the radio interoperability issue in the Region of Durham.

In addition, this CMD contains an Annex to provide the Commission with a cross reference to all related Commission action items.

There are no actions requested of the Commission. This CMD is for information only.

Résumé

L'objectif de ce CMD supplémentaire est d'apporter des mises à jour aux membres de la Commission et pour demander fermeture aux actions de la Commission soulevés durant les audiences publiques antécédentes. Également, ce CMD apporte des mises à jour sur l'exercice d'urgence « *Unified Response* » et soulève une discussion sur l'interopérabilité des radios pour la région de Durham.

Ce CMD contient en annexe une référence croisée pour toutes les actions de la Commission.

Aucune mesure n'est requise de la Commission. Ce CMD est fourni à titre d'information seulement.

- Participated on Provincial Transportation Working Group to examine evacuation plans.
- Participated in OFMEM discussions relative to revisions to the Planning Basis and PNERP.
- Jointly briefed Regional Committee of Council on coming changes to PNERP Planning Basis, with OFMEM in October 2015.
- Briefed the Durham Nuclear Health Committee on the 2016 emergency management program on January 15, 2016.
- Conducted an Emergency Worker Centre field exercise at the Whitby Iroquois Park complex on June 2, 2016.
- Continue to deliver training for Regional staff on the implementation of Incident Management System in the Emergency Operations Centre.

CNSC staff are of the opinion that since ExUR, the Region of Durham has demonstrated good initiative in implementing recommendations as per their Action Plan. However, there is a need to continue to work closely together to ensure the nuclear emergency response network is well coordinated and harmonized in the Region of Durham.

2.3 Update on Office of Fire Marshal and Emergency Management (OFMEM) Actions

(**Commission Action # M2015-15 and # M2015-17**)

The following corrective actions have now been implemented as a result of ExUR and will be included and tested in Exercise Huron Resolve during first week of October 2016 and for future exercise planning:

- Full participation of stakeholders throughout the exercise design process and during exercise conduct
- Pre-exercise training to address how players should participate in an exercise
- Scenarios to be more inclusive of post release coordination and response efforts

Provincial Nuclear Emergency Response Plan (PNERP)

Work is well underway on updating the 2009 PNERP Master Plan:

- Consultations with select stakeholders regarding specific areas of concern include:
    - Roles and Responsibilities
    - Legislative Basis and Processes
    - Emergency Public Information
    - Severe Accidents
- Review of the current Planning Basis and considerations for revision continues – the first stakeholder consultation was completed early in 2016.

Public consultation on the PNERP Master Plan and the Planning Basis is scheduled for Fall 2016.

Dose control/dosimetry

- OFMEM continues to participate in the OPG sponsored Working Group examining Emergency Worker Dose Control

Nuclear Compensation

- OFMEM actively participates in a Ministry of Municipal Affairs and Housing (MMAH) Working Group examining compensation processes
- These processes are being developed by Industry and will serve to better define PNERP compensation details

Provincial EOC Functionality

- PEOC functionality issues have been addressed with the current state of the art facility

2.4 Update on Health Canada (HC) Actions
(**Commission Action # M2015-17**)

The Commission requested an update on ExUR from Health Canada as the custodian of the Federal Nuclear Emergency Plan. As the lead federal organization, the Radiation Protection Bureau and its federal partners have made significant progress in addressing the 45 recommendations in the Federal Interdepartmental After Action Report from Exercise Unified Response.

Thirty-five of these recommendations have been fully addressed and closed. Key accomplishments include:

- Strengthened arrangements for rapidly notifying federal partners of a nuclear emergency;
- Enhanced capabilities to conduct technical assessments and share the results of these assessments with partners;
- Improvements to strategic planning and dissemination of information to decision-makers;
- Strengthened arrangements for protecting the health and safety of federal emergency workers; and
- Improved procedures for communicating technical information to the public and/or senior officials.

Of the 10 recommendations still to be completed, 5 are being addressed by Public Safety Canada through broader revisions of its all-hazards emergency response plan and procedures; 4 are in progress and require ongoing consultations with partners (one led by Health Canada, one by Ontario Power Generation and two by the province of Ontario) and one is deferred pending completion of the federal government-wide email transition.

2.5 Update on CNSC Staff Actions (Commission Action # M2015-16)

At a Commission meeting held in November 2014, Commission Members were presented with key findings and overall results of the exercise for CNSC staff (reference CMD 14-M72). At the December 2015 Commission meeting, CNSC staff provided the Commission with an update on progress regarding a CNSC staff action plan (reference CMD 15-M48).

Independent evaluations of ExUR were performed by external consultants. Ms. Purdy and Mr. Harlick, the consultants, identified 35 recommendations listed in the CNSC Action Plan. All the action items listed in this plan have been addressed. Thirty-two recommendations of the 35 recommendations have been closed. Three action items remain open as these projects are complex and require more time to complete. These projects are:

1) the CNSC EOC renovations, Phase I is completed, Phase II is ongoing;
2) the NPP plant data transmission; and
3) the recovery and restoration regulatory guidance.

Phase I of the CNSC EOC renovations is completed. Phase II will begin in October and it is expected to be finished by March 31, 2017.

The EOC, NPP data and software projects are under way and are included in the CNSC systems for oversight and project management and will be tracked until anticipated completion in 2017.

CNSC staff has already assembling a Working Group to address the project on the recovery and restoration phases following a nuclear emergency. A kickoff meeting took place in April 2016 and a discussion paper is being developed.

2.6 Update on Ontario Emergency Plan (Commission Action # M2016-09)

The OFMEM has undertaken updating the Provincial Nuclear Emergency Response Plan. The OFMEM is ensuring that all of their key stakeholders are involved. CNSC staff are working in close collaboration with OFMEM and their stakeholders. During the April 2016 Commission meeting, the Commission requested that they be updated on an April 2016 meeting between CNSC and OFMEM (action M2016-09). CNSC staff will provide this update, as well as the latest update from a meeting scheduled on August 11th, during the staff presentation (CMD 16-M30.C).

It should be noted that at the time of writing this CMD, the meeting held in April 2016 with the OFMEM was not conclusive. Both parties agreed for an additional meeting in August to further discuss the PNERP review. CNSC staff recommend that this action item remain open as additional information will be forthcoming. The Commission will be updated accordingly in the fall of 2016.

3 INFORMATION ON RADIO INTEROPERABILITY IN THE REGION OF DURHAM

3.1 Background

In 2014, Durham launched a new radio system called NextGen which is being used by its police and fire services as well as many other municipal services. The NextGen system runs off of the 700 MHz band and provides a seven-channel system to its more than 2,800 users. The system has allowed Durham to consolidate many of its users into a single system that allows seamless two-way communications at all times. Note, the 700 MHz band has been reserved for use by emergency response organizations in Canada. As part of the project, OPG worked with Durham to assist in preparing the specifications for the new system as OPG would be one of the key partners who would have to interface with the new system once implemented.

3.2 Current Status

OPG currently operates a Telus IDEN radio system that will reach its end of life at the end of 2016 since Telus will no longer be supporting this system. Thus, OPG is in the process of specifying its own system for procurement and installation. OPG is evaluating its own internal business requirements as well as examining how its new system will interface with Durham's NextGen system. This is very important as Durham provides off-site police and fire response to OPG's Darlington and Pickering Nuclear Generating Stations.

Presently, when Durham police and fire responders come onto an OPG site and require access to the protected area, they are either provided with OPG hand-held de-powered intrinsically-safe radio handsets or are escorted by OPG staff in order to communicate with OPG responders. This agreed-upon practice has been in place for many years supported by protocols, joint drills and exercises and documented through Memoranda of Understanding (MOU) between OPG Security and Durham Police and between OPG Fire Protection and municipal fire services in Clarington and Pickering. Additionally, OPG has direct phone links in its Security Monitoring Rooms (for Darlington and Pickering) to the Durham Regional Police Service Communications Centre, which operates as the 911 call centre for Police, Fire and EMS. Nonetheless, swapping of radios is considered to be low on the radio interoperability scale as it requires a responder to handle two radios and would not be considered a best practice. With the growing sophistication of technology, it is expected that radio interoperability can be better accomplished more seamlessly through electronic solutions that lead to a responder only needing a single radio handset that can communicate with all responders involved in the emergency.

Actions arising from Commission meetings	Action	CNSC staff response
	Commission Secretariat when the reports are posted on the NB Power website.	specific-seismic-hazard/). CNSC staff request that the Commission close Action # M2016-02.
#M2016-09 (2016-04-06)	The Commission expects that CNSC staff prepare detailed information on the outcome of the meeting with the OFMEM regarding post-event provincial protocols, considering international learnings from Fukushima, scheduled in April 2016.	CNSC staff does not request closure at this time. The Commission will be updated again following the province's public consultation on the PNERP in fall 2016.

Table A.2: Status of actions arising from Commission hearings

Actions arising from Commission hearings	Action	CNSC staff response
#H2015-02 (2015-04-13)	The Commission requested annual updates from staff regarding Bruce A Unit 1 and 2 fuel defects, Bruce B endplate cracking and analysis of pressure relief valve sizing.	CNSC staff have reported on this request from the Commission at section 3.1.1.5 of the 2015 ROR (CMD 16-M30). CNSC staff will update the Commission again following receipt and review of remaining Bruce Power submissions, and no later than 2016 NPP ROR planned in August 2017. Please note that a portion of Action # H2015-02, that concerns analysis of pressure relief valve sizing, is addressed in Action # H2015-03 and Action # H2015-15.
#H2015-03 (2015-04-13)	Concerns raised by an intervenor during a Commission hearing. At the Bruce Power renewal, the Commission requested updates on the progress of and conclusions resulting from a working group between Bruce Power, COG and Dr. Nijhawan in regards to CANDU safety issues (inlcuding PARs and pressure relief valve sizing).	The Commission will be presented with a detailed report during Fiscal Year 2016-17. Please note that Action # H2015-03 is the same as Action # H2015-15, and both of these Actions include analysis of pressure relief valve sizing (Action # H2015-02).
#H2015-04 (2015-04-13)	The Commission requested annual updates on the process for DFO authorization for Bruce Power under Section 35 of the Fisheries Act.	Recognizing the importance to local stakeholders of the issue of fish mortality resulting from the operations at the Bruce sites, the

Regulatory Oversight Report for Nuclear Power Plants in Canada: 2015 Supplementary

Exercise Unified Response Action Plan Updates

Commission Meeting
August 18, 2016
CMD 16-M30.C

CNSC Staff Presentation

This is Exhibit.............................referred to in the affidavit of...Shawn-Patrick Stensil..................... affirmed before me, this...fifteenth................... day of......August..................................2016....

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A COMMISSIONER FOR TAKING AFFIDAVITS

Purpose

- Update and request closure on Commission actions relating to Exercise Unified Response (ExUR)
  - CNSC, Ontario Power Generation (OPG), Region of Durham (RD), Office of Fire Marshal and Emergency Management (OFMEM), Health Canada (HC)
- Update the Commission on the Ontario planning basis for Provincial Nuclear Emergency Response Plan (PNERP)
- Provide information to the Commission on radio interoperability in the Region of Durham

Commission Meeting, August 18, 2016
CMD 16-M30.C

Background

Exercise Unified Response (ExUR)

- Full-scale nuclear exercise, simulated a severe accident at Darlington Nuclear Generating Station - May 26 to 28, 2014

EXERCISE UNIFIED RESPONSE

Breaking News

Nuclear power plant hit by tornado
File photo of the Darlington Nuclear Generating Station in the municipality of Clarington.

THIS IS AN EXERCISE SIMULATION

After Action Reports And Findings

Findings

- November 2014 Commission Meeting, staff and stakeholders provided “Staff Update on Exercise Unified Response” (CMD 14-M72.A)

Progress

- December 2015 Commission Meeting, staff and stakeholders presented their “Action Plan for Exercise Unified Response” (CMD 15-M48)

Commission Meeting, August 18, 2016
CMD 16-M30.C

CNSC ACTION PLAN

Commission Meeting, August 18, 2016
CMD 16-M30.C

CNSC Action Plan Update

Three action items remain open

1. **Emergency Operations Centre (EOC) renovations project (part I - completed; part II - to be completed by March 31, 2017)**
2. **NPP plant data transfer to the CNSC's EOC during nuclear emergencies**
   - Working Group produced report in April 2016
   - OPG, Bruce Power and NB Power have provided their plans to the CNSC
     - CNSC staff will review these plans

Commission Meeting, August 18, 2016
CMD 16-M30.C

CNSC Action Plan Update

Three action items remain open

3. Recovery and restoration following a nuclear emergency

- Working Group consists of staff from the CNSC, HC and other organizations at all levels of government
- A discussion paper is being prepared and will be shared with our Federal and Provincial partners in Sept. 2016
- The discussion paper will be released for public comment in Nov. 2016
- It is expected that a regulatory document will be published in Jan. 2018

ONTARIO POWER GENERATION

Commission Meeting, August 18, 2016
CMD 16-M30.C

ONTARIO POWER GENERATION (OPG) ACTION PLAN

Commission Meeting, August 18, 2016
CMD 16-M30.C

OPG Action Plan Update

CNSC staff have been informed of the following:

- OPG Staff Rotation Guide has been prepared to facilitate movement of staff during an emergency
- Concept of Operations for Radiation Surveys has been prepared
  - Available to OFMEM for inclusion to the PNERP update
- Dose Control Guidance on management of dose for emergency workers is in final draft
  - Working Group consists of staff from OPG, Bruce Power, HC, Ministry of Health and Long Term Care, Ministry of Labour, Durham Region and CNSC
- Updates to Emergency Response Program software is ongoing, it is expected to be completed by June 2017

Commission Meeting, August 18, 2016
CMD 16-M30.C

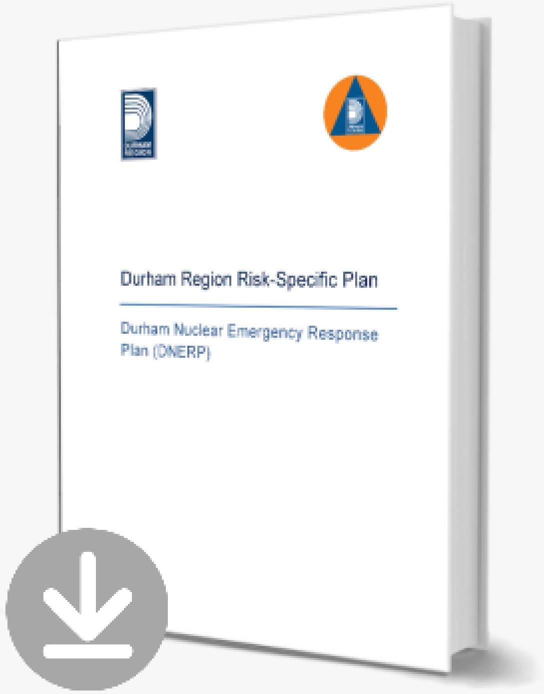
REGION OF DURHAM ACTION PLAN

Commission Meeting, August 18, 2016
CMD 16-M30.C

Region of Durham Action Plan Update

CNSC staff have been informed of the following:

- Reviewed, restructured, revised and completed a new Durham Nuclear Emergency Response Plan
  - Copies made available to CNSC
  - Posted to their web page
- Exploring use of web-based tools to enhance information management in the Emergency Operations Centre
- Updated sector data (demographics, facilities, etc.)



Download DRNERP.pdf

Commission Meeting, August 18, 2016
CMD 16-M30.C

Region of Durham Action Plan Update (cont'd)

- In October 2015, briefed Regional Committee of Council on coming changes to the PNERP Planning Basis
- Briefed the Durham Nuclear Health Committee on the 2016 emergency management program on January 15, 2016
- Continue to deliver training for Regional staff on Incident Management System and in Emergency Operations Centre

Commission Meeting, August 18, 2016
CMD 16-M30.C

ONTARIO OFFICE OF THE FIRE MARSHAL EMERGENCY MANAGEMENT (OFMEM) ACTION PLAN

Ontario Office of the Fire Marshal Emergency Management (OFMEM) Action Plan Update

CNSC staff have been informed of the following :

- Initial consultations with select stakeholders regarding specific areas of concern in the PNERP have been completed
- Review of the current Planning Basis continues – the first stakeholder consultation was completed early in 2016
- Stakeholder consultation on the PNERP Master Plan and the Planning Basis is scheduled for late summer/early fall 2016, followed by a full public consultation on both documents late fall 2016

Commission Meeting, August 18, 2016
CMD 16-M30.C

Ontario Office of the Fire Marshal Emergency Management (OFMEM) Action Plan Update (cont'd)

- PEOC functionality issues have been addressed with the current state of the art facility
- OFMEM continues to participate in the OPG sponsored Working Group examining Emergency Worker Dose Control
- OFMEM actively participates in a Ministry of Municipal Affairs and Housing (MMAH) Working Group examining compensation processes

CNSC Staff Support to OFMEM

Ontario Planning Basis for Provincial Nuclear Emergency Response Plan (PNERP)

- Meetings took place between CNSC and OFMEM staff in Dec. 2015 and Apr. 2016
  - More meetings are planned
- OFMEM provided an update at their Nuclear Emergency Management Coordinating Committee (NEMCC) in Dec. 2015
  - Major revision of PNERP will include input from different sources (CSA N1600; United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR); CNSC- REGDOC 2.10.1 and Ministry of Environment
  - Stressed importance of this revision and obtained feedback from members

Health Canada
Santé Canada

Commission Meeting, August 18, 2016
CMD 16-M30.C

HEALTH CANADA ACTION PLAN

Commission Meeting, August 18, 2016
CMD 16-M30.C

Health Canada Action Plan Updates

Health Canada, in consultation with federal partners, led the development of the Federal Interdepartmental After Action Report (AAR).

Commission Meeting, August 18, 2016
CMD 16-M30.C

Health Canada Action Plan Update

CNSC staff have been informed of the following:

- The majority of the ExUR recommendations have been addressed and closed. Ten actions remain open:
  - 5 are being addressed by Public Safety Canada through broader revisions of its all-hazards emergency response plan and procedures
  - 4 are in progress and require ongoing consultations with partners
  - 1 is deferred pending completion of the federal government-wide email transition

Commission Meeting, August 18, 2016

CMD 16-M30.C

ACTION PLAN UPDATE - SUMMARY

Action Plan Update - Summary

- This concludes the update on ExUR actions
- Four action items listed in Annex “A” of supplemental CMD 16-M30.A
  - Request closure of M2015-15 – Durham emergency planning documentation
  - Request closure of M2015-16 – ExUR CNSC updates
  - Request closure of M2015-17 – ExUR stakeholders updates
  - Request keep open M2016-09 – Ontario PNERP

NEXTGEN
DURHAM REGIONAL INTEROPERABILITY

Commission Meeting, August 18, 2016

CMD 16-M30.C

RADIO INTEROPERABILITY IN THE REGION OF DURHAM

Radio Interoperability in the Region of Durham

Region of Durham (Durham) launched NextGen system in 2014

- NextGen operates on 700 MHz – supports 2,800 users
- 700 MHz band reserved for emergency response in Canada

OPG Telus IDEN system to be retired at end of 2016

- OPG examining 800 MHz Tetra system
- Tetra system would operate on existing OPG infrastructure

Durham has raised concerns regarding unproven interoperability between the NextGen and Tetra systems

- OPG has committed to re-examining, by September 1, 2016 the option of putting its emergency responders on the NextGen system

Commission Meeting, August 18, 2016
CMD 16-M30.C

Radio Interoperability in the Region of Durham (cont'd)

Current state

- Durham responders supplied with OPG handsets on OPG sites
- Arrangement supported by protocols, drills and exercises
- Arrangement considered to be low on interoperability scale (i.e., not a best practice)

Durham's expectations

- Durham responders use their own handsets on OPG sites
- Robust interoperability with OPG (i.e., no single points of failure)
- Encryption

Addressing the needs of Durham public safety

Photo by: Kaptured by Kelly

Commission Meeting, August 18, 2016
CMD 16-M30.C

Radio Interoperability in the Region of Durham (cont'd)

Regulatory Requirements

- *Nuclear Security Regulations* – "to ensure that there is capability at all times for immediate communication among the security monitoring room, the on-site response force and off-site response force"
- CSA N293, *Fire Protection for Nuclear Power Plants* – "the industrial fire brigade shall be equipped with an intelligible two-way radio system. Off-site firefighters shall have access to this communication system in order to communicate with the industrial fire brigade while on site"

Performance-based requirements

Radio Interoperability in the Region of Durham (cont'd)

OPG's commitments

- Full NextGen coverage on its Darlington and Pickering sites
- Seamless interoperability between its system and Durham's NextGen system
- With NextGen able to operate on both 700 MHz and 800 MHz, re-examination of putting OPG's emergency responders on the NextGen system by September 1, 2016

Recommendations

CNSC staff recommend the following:

- Request closure of M2015-15 – Region of Durham emergency planning documentation
- Request closure of M2015-16 – ExUR CNSC updates
- Request closure of M2015-17 – ExUR stakeholders updates
- Request keep open M2016-09 – Ontario PNERP
- CNSC staff will continue to update the Commission on radio interoperability

Commission Meeting, August 18, 2016

CMD 16-M30.C

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Updated emergency planning zones in Germany and the importance of release source term

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affidavit of...Shawn-Patrick Stensil...............
affirmed before me, this...fifteenth...................
day of......August.......................................2016....

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A COMMISSIONER FOR TAKING AFFIDAVITS

Florian Gering
Emergency management division
Federal Office for Radiation Protection (BfS)

Nuclear Power Plants in Germany – after Fukushima

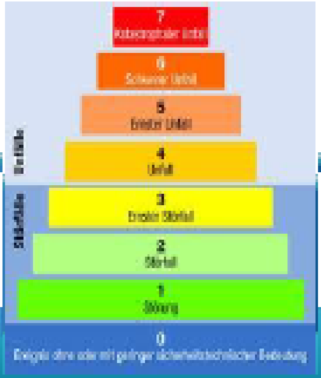
- in operation
- decommissioned

German lessons learned from the Fukushima accident

Lesson learned from Fukushima:

Nuclear accidents even those of the INES Level 7 happen.

Despite high safety requirements and the low calculated probability for such cases we can never be sure, that severe nuclear accidents do not happen.



Consequence:

Detailed Planning of emergency response is necessary even for Level 7 Accidents!

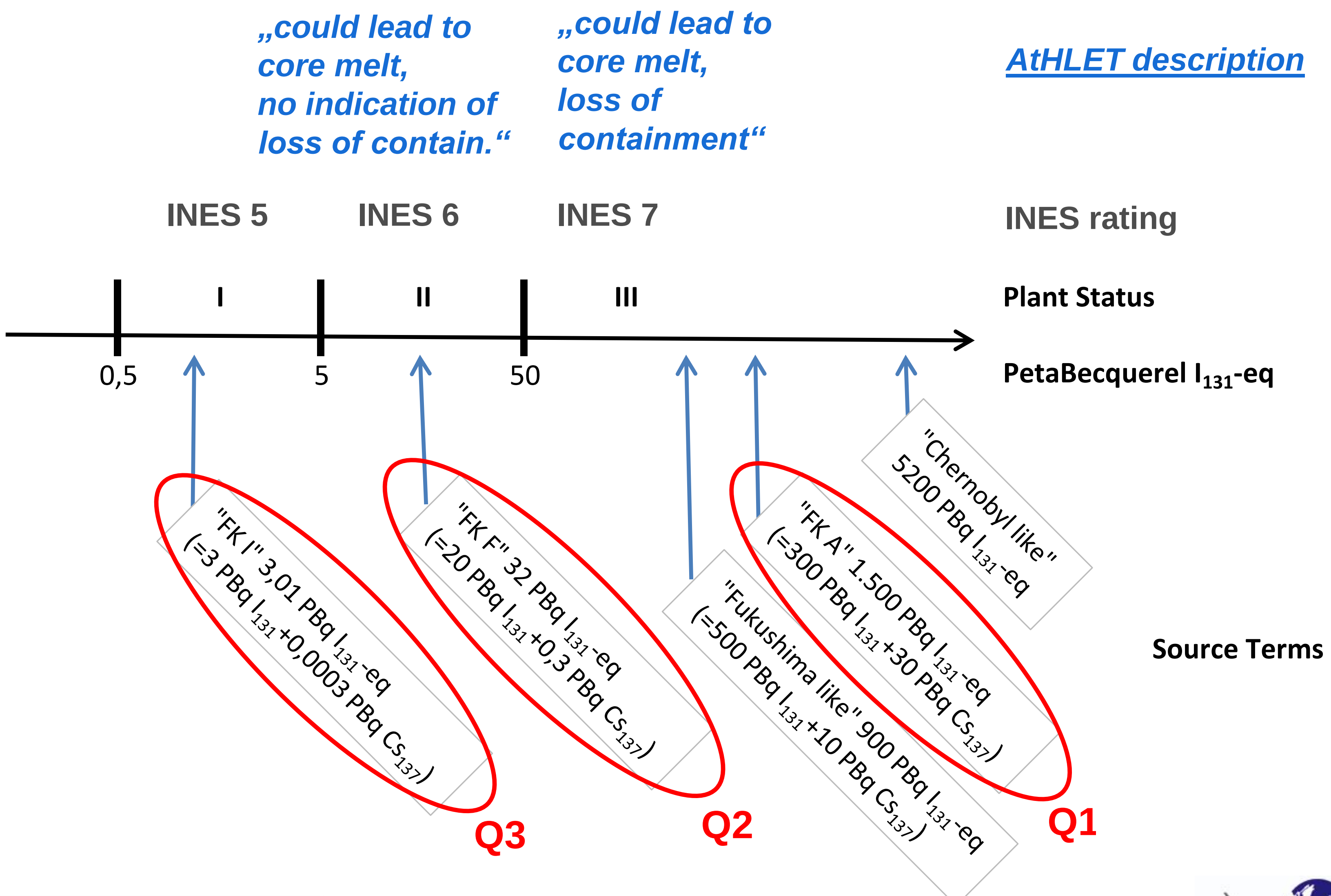
German lessons learned from the Fukushima accident

Recommendation of the German Commission on Radiological Protection:

Reference source terms are required as a basis for detailed planning.

Name	Release of Iod-131 Bq	Release of Cs-137 Bq	Assumed Start of major releases (only for planning purposes) Hours [h] after shutdown of the reactor	Duration of releases	Release via	
Q1	3.0 x 10^{17}	3.0 x 10^{16}	6	48 Hours	Building Roof	INES 7
Q1L	3.0 x 10^{17}	3.0 x 10^{16}	6	14 Days	Building Roof	INES 7 long
Q2	2.0 x 10^{16}	3.0 x 10^{14}	12	48 Hours	Building Roof	INES 6
Q2L	2.0 x 10^{16}	3.0 x 10^{14}	12	14 Days	Building Roof	INES 6 long
Q3[6]	3.0 x 10^{15}	3.0 x 10^{11}	12	48 Hours	Stack	INES 5
Q3L[6]	3.0 x 10^{15}	3.0 x 10^{11}	12	14 Days	Stack	INES 5 long

Source terms used as basis for NPP emergency planning



Assessment of potential consequences of an emergency

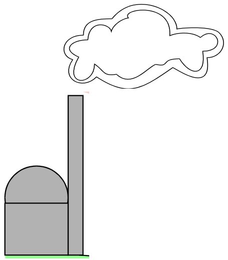
Scenario list

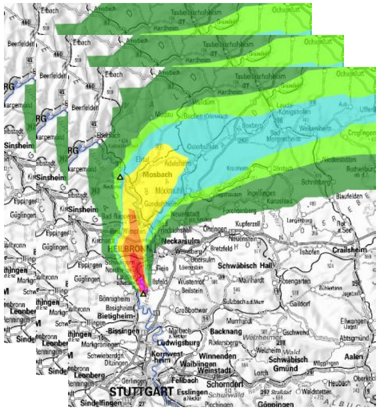
Source terms (for planning)

Radiological consequences

Emergency response plans

1. NPP accident in Germany

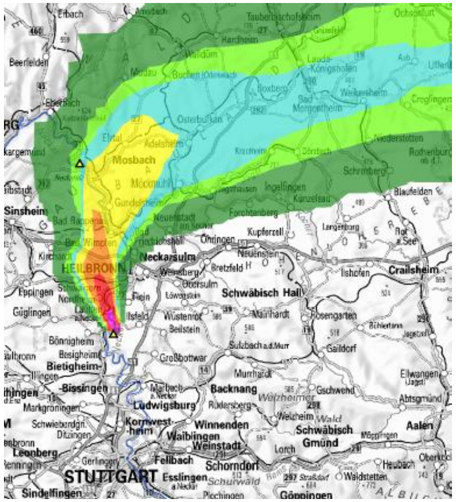




Optimised strategy (including EPZ)

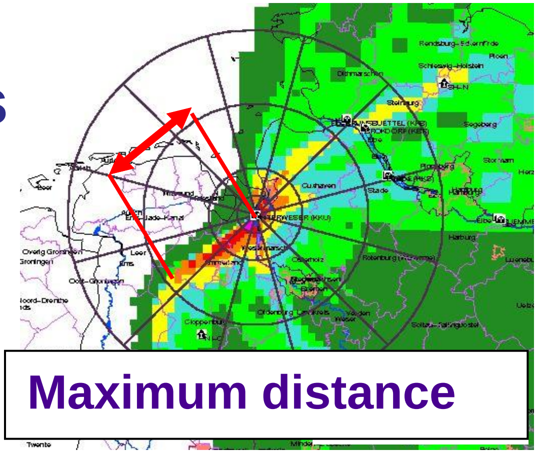
Assessment of potential consequences

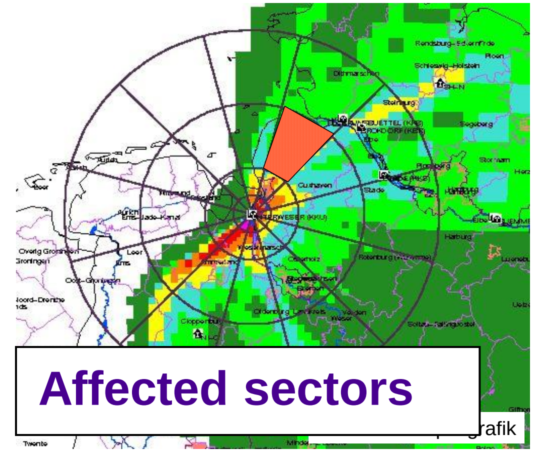
- **Selection of „reference source terms“ for each accident/release category**
- **Selection of representative NPP sites (Unterweser, Grohnde, Philippsburg)**
- **Simulations performed with RODOS based on numerical weather prediction data (Nov. 2011 - Oct. 2012; releases for each day)**

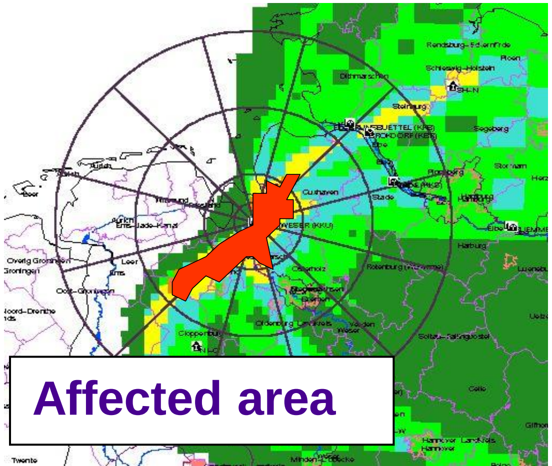


Assessment of potential consequences

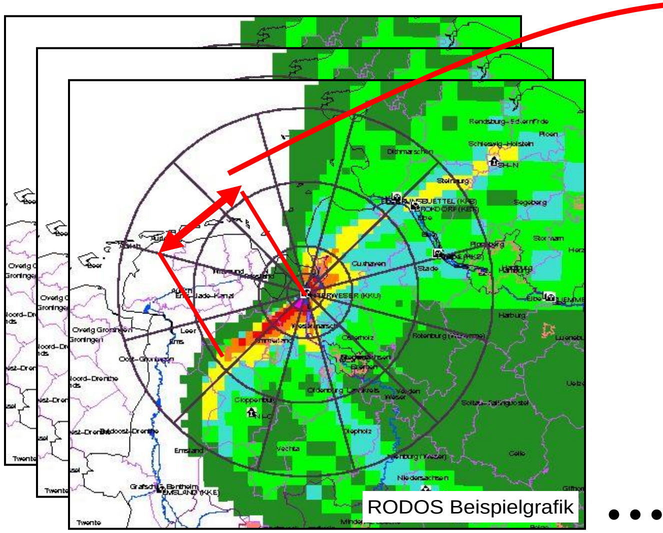
- **Selection of „reference source terms“ for each accident/release category**
- **Selection of representative NPP sites** **(Unterweser, Grohnde, Philippsburg)**
- **Simulations performed with RODOS based on numerical weather prediction data**
  (Nov. 2011 - Oct. 2012; releases for each day)
- **More than 5000 separate simulations**
- **Definition of analysis procedures**
  (Statistical analysis based on national and generic dose intervention limits)

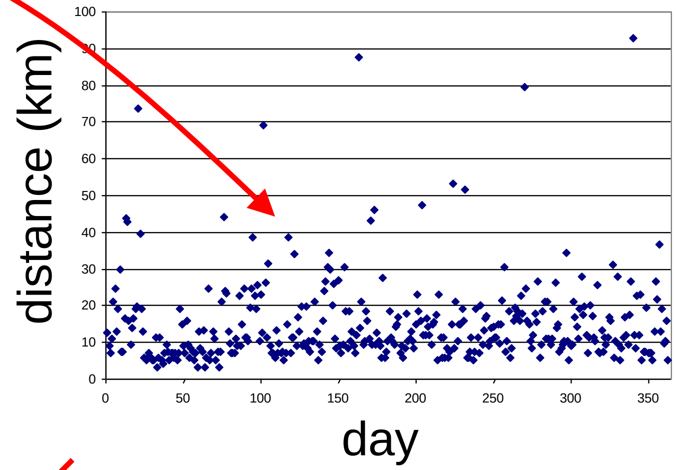




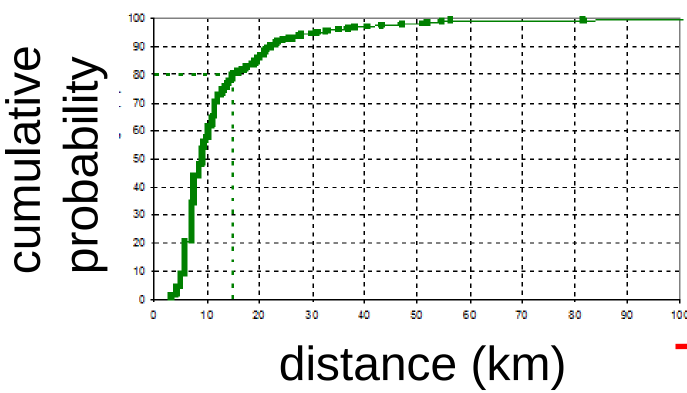


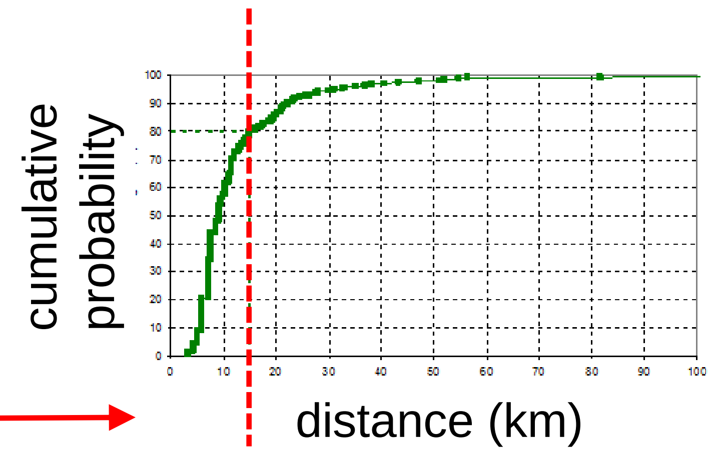
Assessment of potential consequences





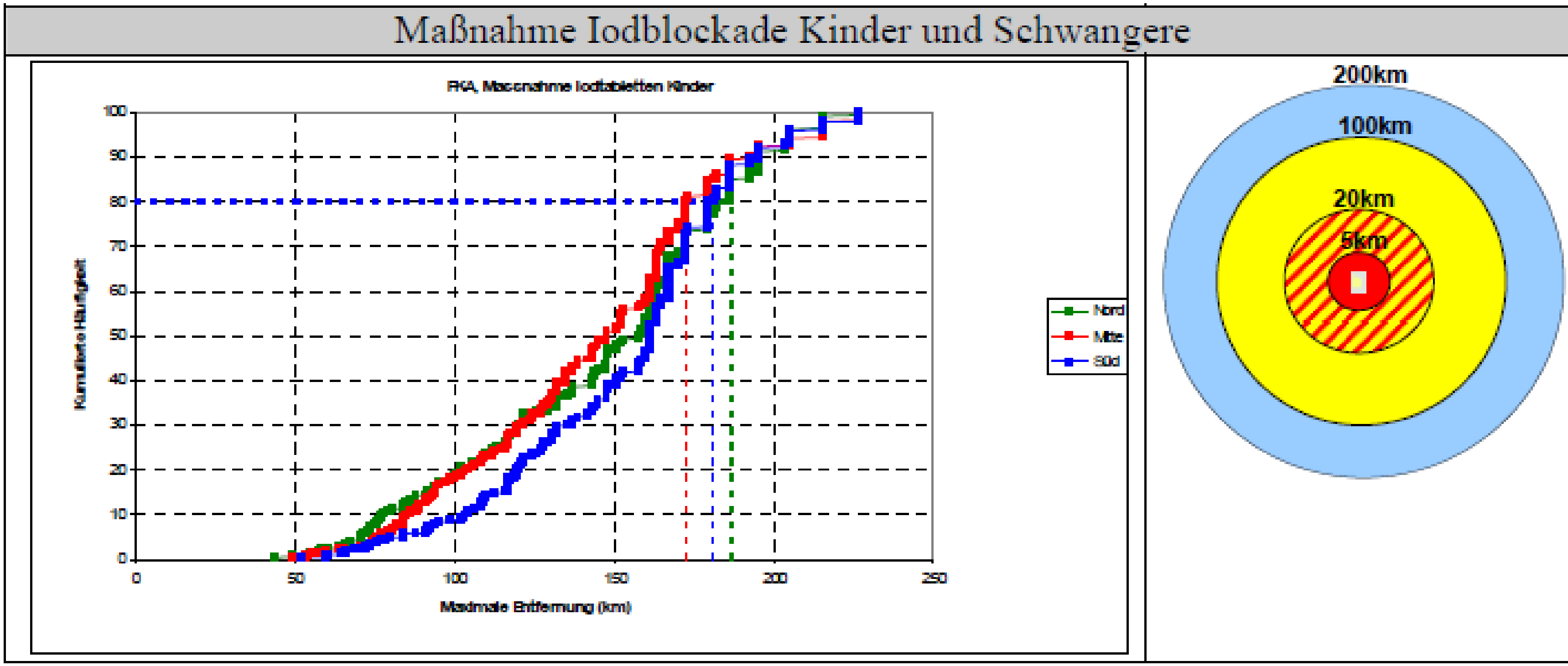
Maximum distance





Results of the assessment of potential consequences

E.g., maximum distances in which ITB for children is required („FKA source term / Q1“)



Results of the RODOS simulation

Maximum distance for evacuation, source term FKA / Q1

Adult	Maximum distance (km) in which intervention level for **evacuation** is exceeded		
	50%-Percentile	**80%-Percentile**	**90%-Percentile**
North (Unterweser)	9	**15**	22
Central (Grohnde)	11	**20**	26
South (Philippsburg)	18	**25**	31
Central (Grohnde) - FKF	0	0	0
Central (Grohnde) - FKI	0	0	0

Results of RODOS simulations

RODOS-based simulation
of potential accident scenarios for
emergency response
management in the vicinity of
nuclear power plants

Schriften

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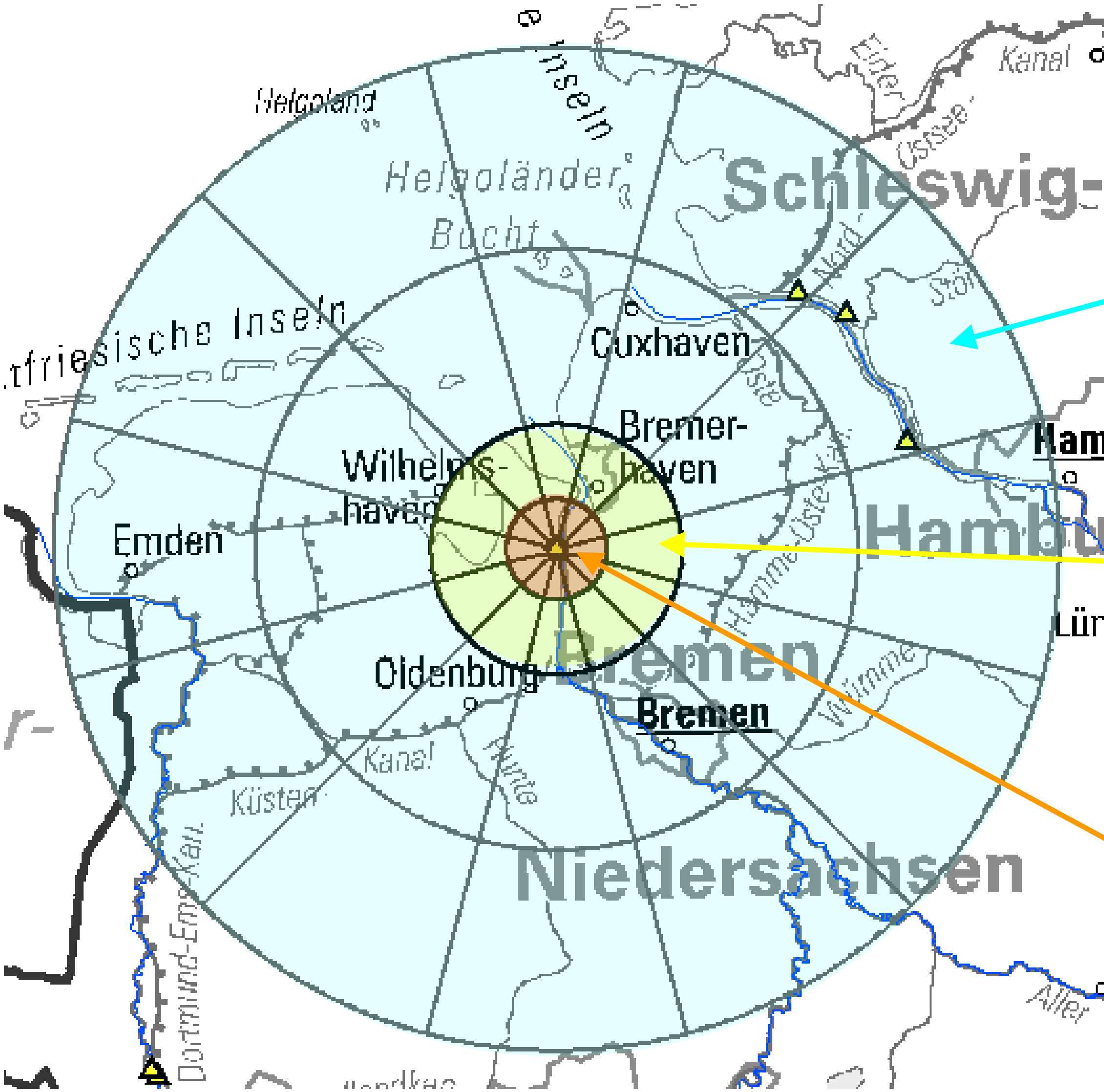
Will be published on BfS website soon

Changes in emergency planning zones in Germany

Recommendation by the German Commission on Radiological Protection:
Planning areas for emergency response in the vicinity of nuclear power plants (www.ssk.de)

Previous	New
Central zone with a radius of **2 km** Sheltering, evacuation (6h), ITB (6h)	Central zone extends up to about **5 km** around NPPs
Middle zone with a radius of **10 km** Sheltering, evacuation (24h), ITB (12h)	Middle zone extends up to about **20 km** around NPPs
Outer zone with a radius of **25 km** Sheltering, ITB	Outer zone extends up to about **100 km** around NPPs
Remote zone with a radius of 100 km ITB only for children and pregnant women	Entire Territory of Germany

Emergency planning zones for NPPs (before 2014)



Emergency planning zones:

<100 km:
ITB for children and pregnant women

<25 km:
ITB for all persons < 45 years

<10 km:
Evacuation, Sheltering

Emergency planning zones for NPPs (since 2014)

Emergency planning zones:

<100 km:
ITB for all persons < 45 years,
sheltering

<20 km:
Evacuation,
Sheltering

<5 km:
Evacuation (priority),
Sheltering

German lessons learned from the Fukushima accident

Lesson learned from Fukushima:

Consequences of severe accidents are always international!

Lessons learned from Fukushima (in Germany!):

Regulations and plans for measures to be taken in case of accidents outside of Europe are not available!

Consequence:

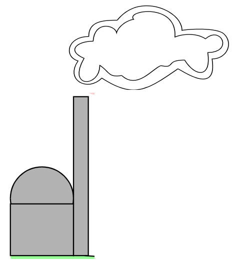
Definition of Szenarios which have to be covered up by regulations

Development of enhanced list of planning scenarios

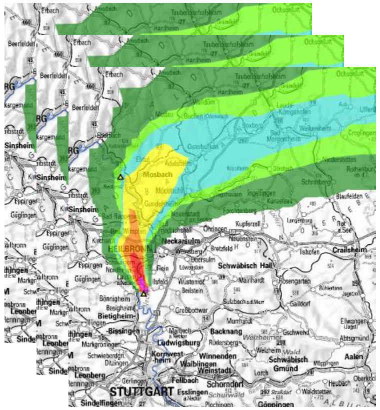
Scenario list

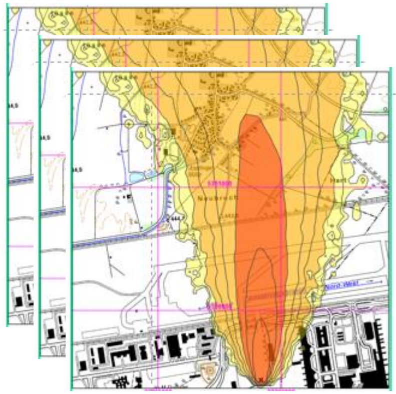
0. Unclear situation
1. NPP accident in Germany
2. NPP accident in neighbouring countries
3. NPP accident within Europe
4. NPP accident outside Europe
5. Accident in a nuclear facility
6. Terroristic attack
7. Transport accident
8. Radiological emergency situations
9. Satellite crash

Source terms (for planning)



Radiological consequences





...

...

Emergency response plans

Optimised strategy

Optimised strategy

...

...

German lessons learned from the Fukushima accident

Lesson learned from Fukushima:
Planning is necessary for all phases of an accident.

In particular, the planning for the Post-accident-phase must be improved so that the lives of people affected can be normalized as quickly as possible!

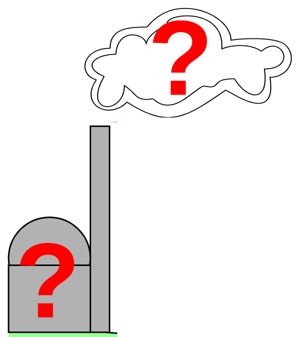
Consequence:
Enlargement of planning to all phases of accidents!

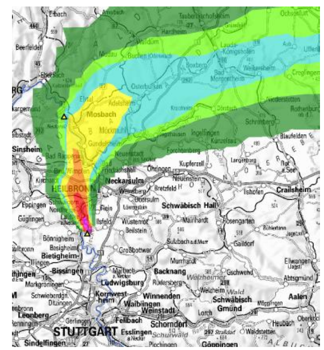
Thank you for your attention!

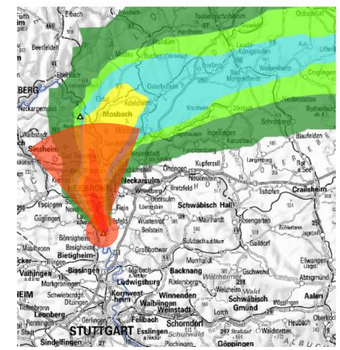
Decision about protective actions

Source term assessment → Dispersion modelling → Intervention limits: protective actions

„Standard approach“:

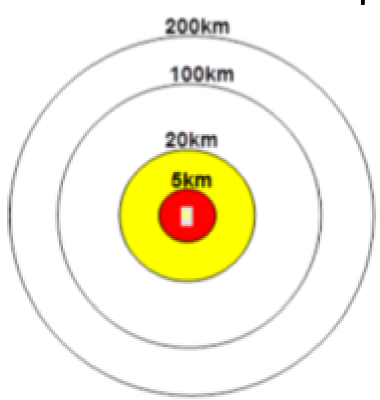


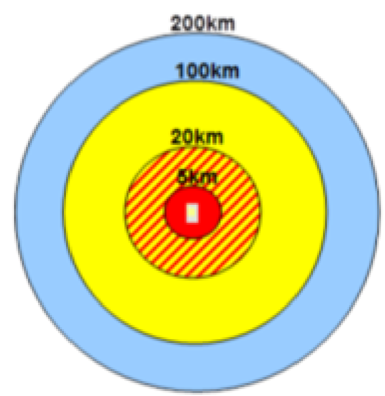




Protective actions to be recommended to the decision makers be decided on the basis of the plant status and weather conditions:

Supplementary NERDA approach:





Identifying actions (graded approach)

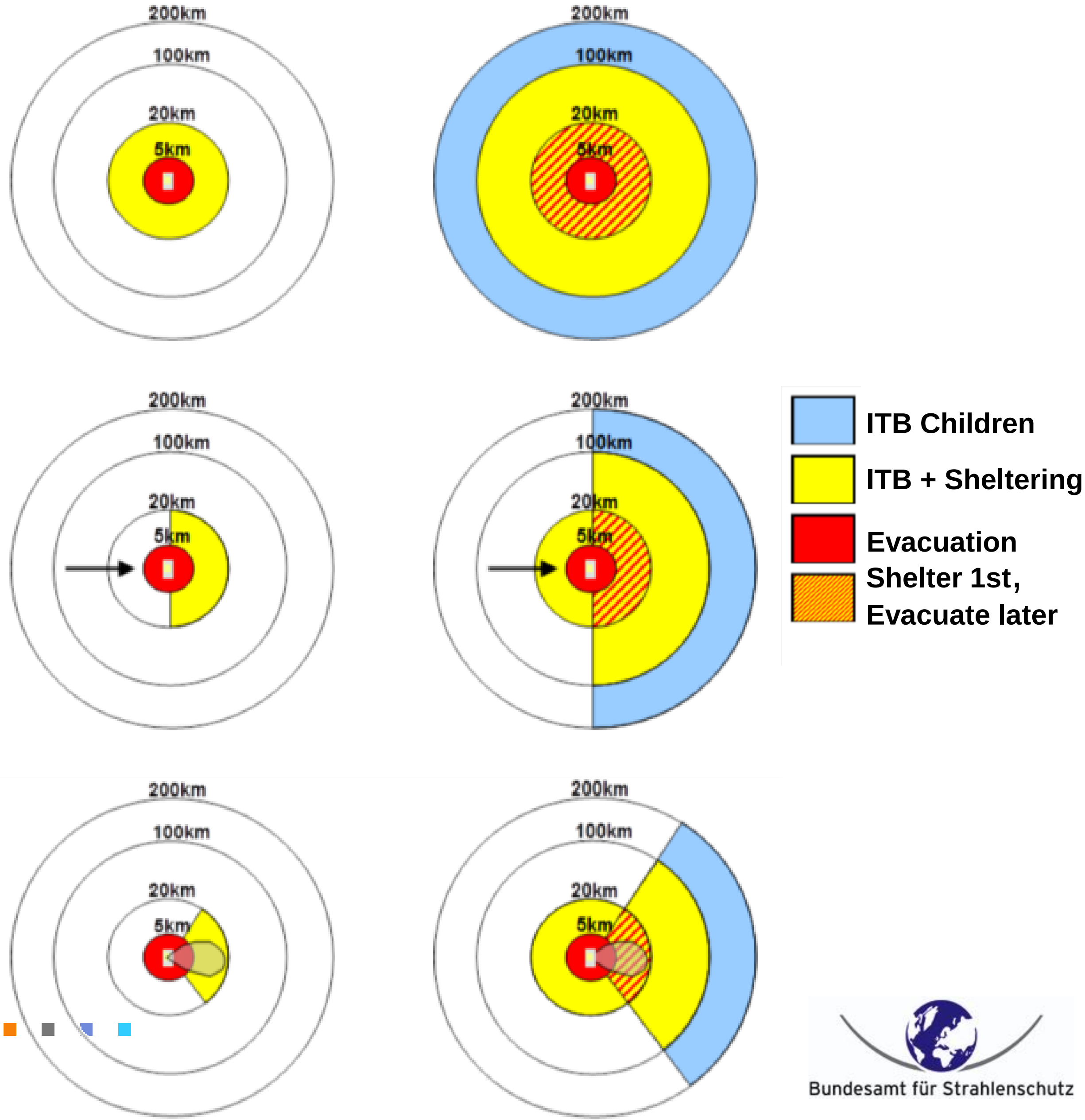
For an immediate threat

Class I, II | Class III

Weather conditions unknown or unstable

Wind direction stable

Dispersion calculation available and wind direction stable



New published or reviewed publications by SSK 1

- Kriterien für die Alarmierung der Katastrophenschutzbehörde durch die Betreiber kerntechnischer Einrichtungen (Empfehlung, 2013, together with RSK)
  Criteria for the alert of emergency response authorities by the operators of nuclear plants
- Rahmenempfehlungen für die Planung von Notfallschutzmaßnahmen durch Betreiber von Kernkraftwerken (Empfehlung, 2014, together with RSK)
  Guidelines for planning of emergency measures by operators of NPPs *(only in German)*
- Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei Ereignissen mit Freisetzungen von Radionukliden (Empfehlung, 2014)
  Basic radiological principles for decisions on measures for the protection of the population against incidents involving releases of radionuclides
- Planungsgebiete für den Notfallschutz in der Umgebung von Kernkraftwerken (Empfehlung, 2014)
  Planning areas for emergency response near nuclear power plants
- Fragestellungen zum Aufbau und Betrieb von Notfallstationen (Stellungnahme, 2014)
  Questions regarding set-up and operation of emergency care centres *(only in German)*

New published or reviewed publications by SSK 2

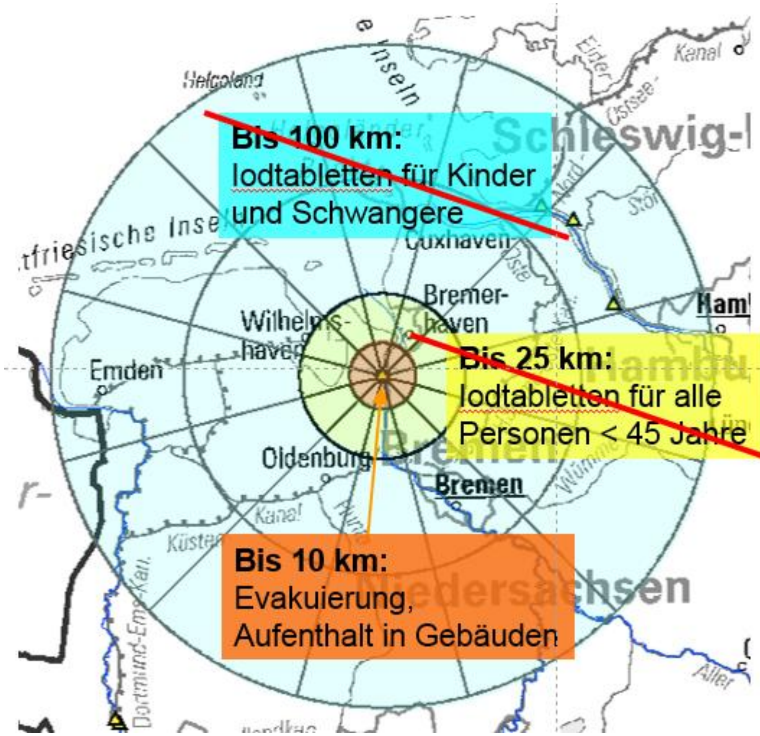
- Kriterien für die Alarmierung der Katastrophenschutzbehörde durch die Betreiber kerntechnischer Planung der Jodblockade in der Umgebung stillgelegter Kernkraftwerke (Empfehlung, 2014)
  Planning iodine thyroid blocking in the vicinity of decommissioned nuclear power plants
- Prognose und Abschätzung von Quelltermen bei Kernkraftwerksunfällen (Empfehlung, 2014)
  Prognosis and estimation of source terms at accidents of NPPs (only in German)
- Planungsgebiete für den Notfallschutz in der Umgebung stillgelegter Kernkraftwerke (Empfehlung, 2014)
  Planning areas for emergency response in the vicinity of decommissioned NPPs (only in German)
- Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen (Empfehlung, 2015)
  Guidelines for disaster control in the vicinity of nuclear plants (only in German)
- Weiterentwicklung des Notfallschutzes durch Umsetzen der Erfahrungen aus Fukushima (Empfehlung, 2015)
  Enhancements of emergency preparedness and response through implementation of lessons learned after Fukushima (only in German)

Planungsgebiete für den Notfallschutz in der Umgebung bereits stillgelegter Kernkraftwerke

Die Planungsgebiete, die in der Umgebung der in 2011 stillgelegten Kernkraftwerke entsprechend **BMU 2008** ausgewiesen sind, können beibehalten werden.

Die **Fernzone** kann aufgehoben werden.

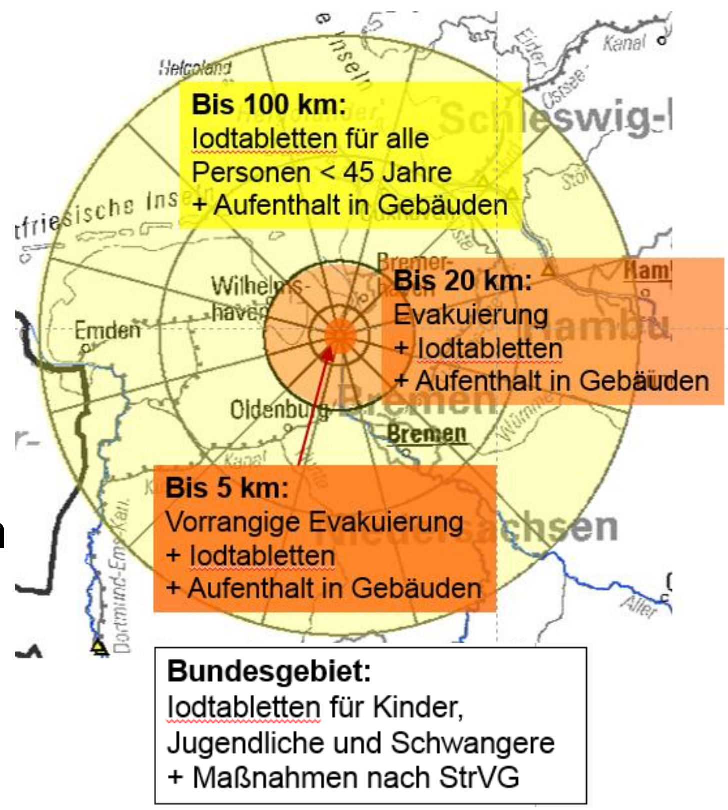
Die Planung der **Iodblockade** für die Umgebung der in 2011 endgültig stillgelegten Kernkraftwerke muss nicht mehr aufrechterhalten werden.



Planungsgebiete für den Notfallschutz in der Umgebung zukünftig stillzulegender Kernkraftwerke

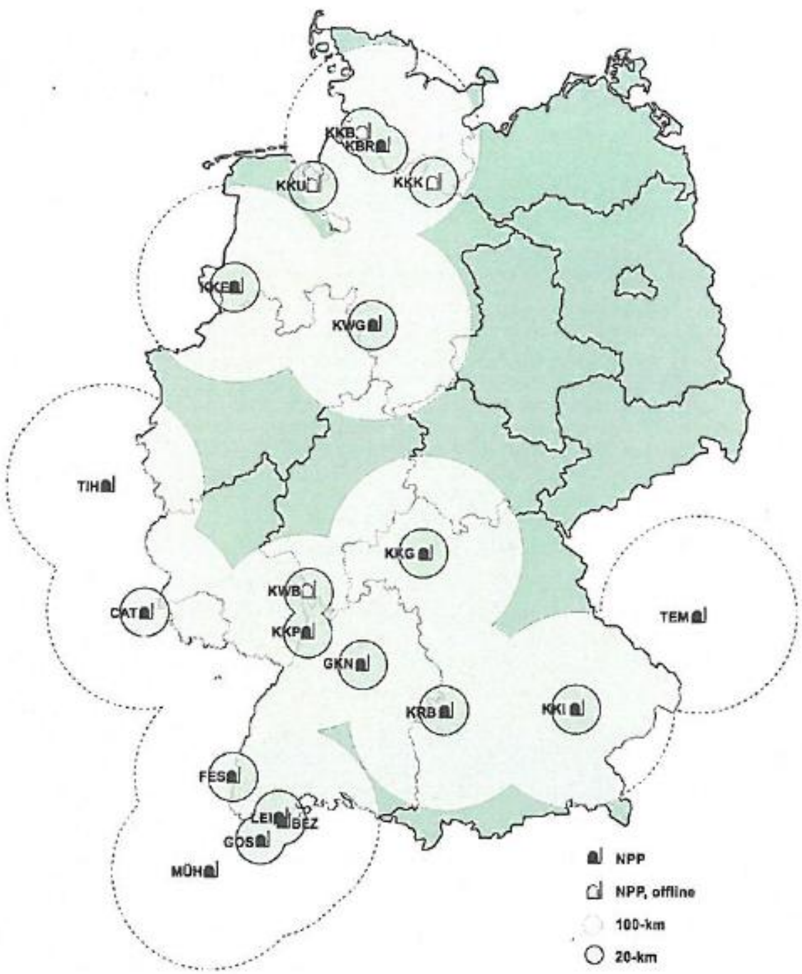
Für die Umgebung der künftig in Deutschland endgültig stillgelegten Kernkraftwerke empfiehlt die SSK, dass die **Planungsgebiete entsprechend SSK 2014-2** solange aufrechterhalten werden, solange Brennstoff in der Anlage verwahrt wird jedoch **längstens für die Dauer von drei Jahren** ab dem Tag der letzten Abschaltung.

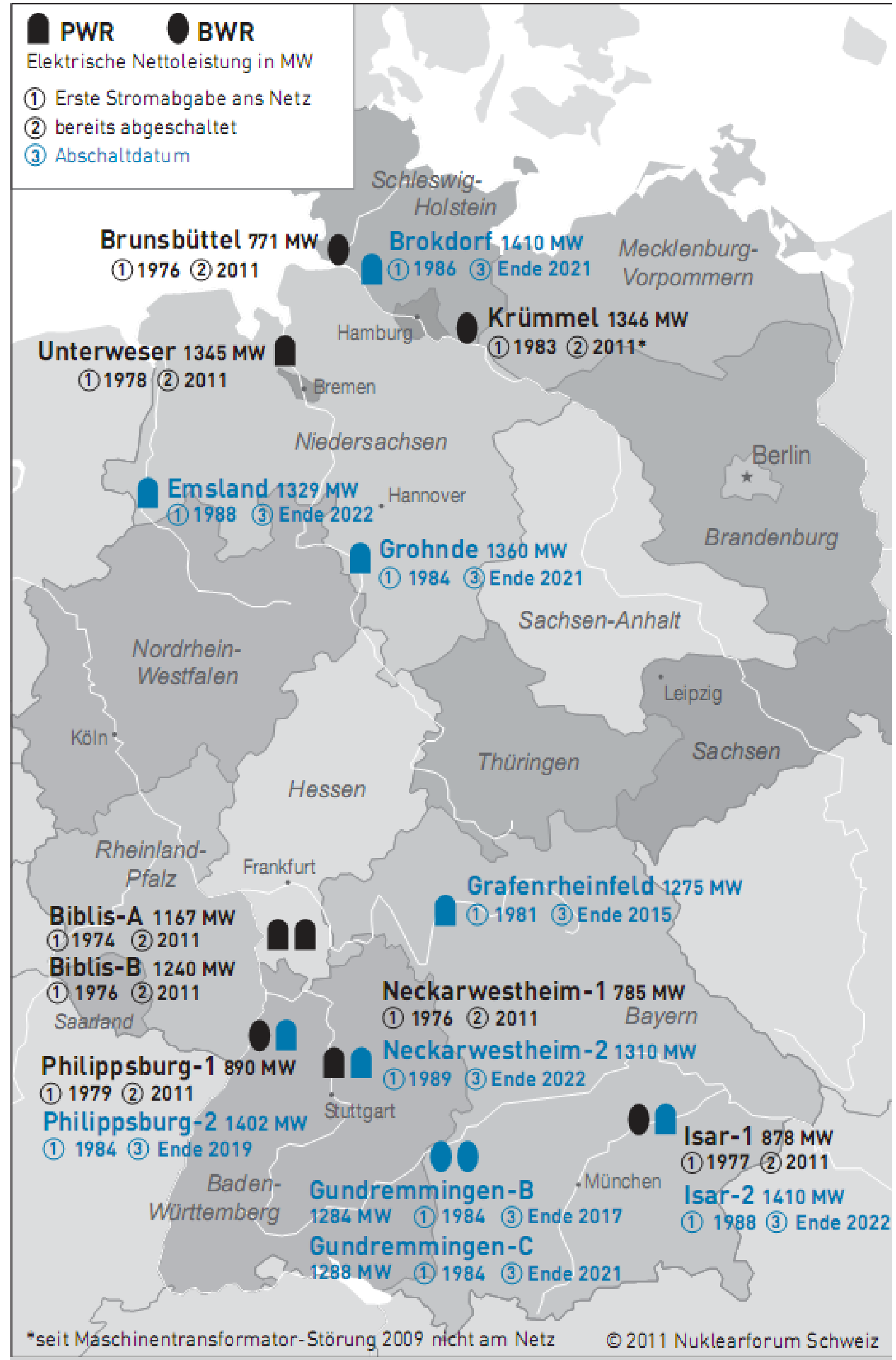
Für den Fall, dass **nach Ablauf von drei Jahren noch Brennstoff** in der Anlage vorhanden ist, können die Planungsgebiete entsprechend den o.g. **Regelungen für heute bereits stillgelegte Kernkraftwerke** festgelegt werden.



Für die Umgebung aller künftig in Deutschland endgültig stillgelegten Kernkraftwerke empfiehlt die SSK, dass die **Planung der Iodblockade für die Dauer eines Jahres** entsprechend 12 Monaten ab dem Tag der letzten Abschaltung beibehalten werden muss.

Nuclear Power in Germany and Neighboring States





RODOS-based simulation of potential accident scenarios for emergency response management in the vicinity of nuclear power plants

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Salzgitter, June 2015

RODOS-based simulation of potential accident scenarios for emergency response management in the vicinity of nuclear power plants

Summary

In the wake of the Fukushima disaster in March 2011, the German Federal Office for Radiation Protection (BfS) started to investigate the potential radiological consequences of a "Fukushima-like" accident in a German nuclear power plant and conducted appropriate simulations in 2012. Between the end of 2012 and the end of 2013, the first study was followed by a much more detailed and comprehensive investigation comprising more than 5,000 case studies for three nuclear power plant (NPP) sites in Germany. Based on these results the German Commission on Radiological Protection (SSK) released a new recommendation in March 2014 including an expansion of the current emergency planning zones for nuclear power plants in Germany.

The key results of this study with respect to the maximum dimensions of the affected areas where dose criteria may be exceeded are described below. The following results are based on the largest nuclear release scenario "FKA" (INES scale 7):

- Threshold levels for deterministic effects and high doses (effective doses higher than 1,000 mSv) can be reached or exceeded within a distance of about 3 km on average.
- The emergency reference level for the intervention "Evacuation" can be reached or exceeded within a distance of up to 9 to 18 km (adults) and/or up to 14 to 24 km (infants) on average (the indicated interval describes the minimum and maximum levels of the median value at all three NPP sites).
- The emergency reference level for the intervention "Sheltering" can be reached or exceeded within a distance of up to 62 to 80 km (adults) and/or up to 91 to 114 km (infants) on average.
- The emergency reference level for the intervention "Stable iodine prophylaxis" can be exceeded within a distance of up to 24 to 34 km (adults) and/or up to 148 to 161 km (infants and pregnant women) on average.

Key words: Fukushima accident, RODOS, emergency preparedness, emergency response,planning zones, dispersion models.

1. INTRODUCTION

1.1. Background

In the wake of the Fukushima reactor accident a number of interested parties called for appropriate consequences with respect to disaster control and emergency response management. Questions were raised about the technical, scientific and legal foundations.

Following the Fukushima disaster in March 2011, the German Federal Office for Radiation Protection (BfS) started to investigate the potential radiological consequences of a “Fukushima-like” accident in a German nuclear power plant and conducted the relevant calculations (Gering 2012). One question was of particular interest: Is emergency preparedness in Germany fit for a similar accident or does it require conceptual improvements. The results showed that the existing planning did not take into account all potential scenarios of events.

The first BfS investigation was followed by a more detailed and more comprehensive study conducted between autumn 2012 and autumn 2013. The present report describes the approach and results of the second BfS study.

At the same time when the first BfS investigations were performed, the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) requested support from the Commission on Radiological Protection (SSK). The Commission was supposed to verify – against the background of the experience made in Fukushima – whether the boundary conditions, requirements and criteria contained in the relevant rules and regulations on nuclear emergency response management correspond to the state-of-the-art of research, science and technology.

In order to use the knowledge gained from the Japanese reactor accident in Germany and to incorporate this knowledge into German rules and regulations, adapted to the local boundary conditions, it was necessary to examine closely the potential radiological consequences of this type of accidents. Simply transferring the radiological consequences observed in Japan to German sites could only be a first rough, yet insufficient approach. The consequences observed in Japan are a unique case, resulting from the amount of radioactive substances released and the course of the release, the local orography and the meteorological conditions prevailing during the release. Even in Japan, an accident involving the same course of events but under different meteorological conditions might have had a large number of potential consequences.

This is all the more true for Germany since the orography and climatic conditions differ dramatically from those at the Japanese site. It was therefore decided to use model calculations in order to investigate the potential radiological consequences of such accidents for three German NPP sites that are typical with respect to their orography and regional climate. In order to take into account the meteorological conditions it was decided to superimpose a particular year's realistic meteorological data registered at the three sites upon the accidental release of radioactive substances assumed for the purposes of this study.

The methodology and boundary conditions for the model calculations to be performed by the SSK working group were established on the basis of the findings from the first BfS study and refined in cooperation with BfS. The results were assessed in a number of joint discussions.

The results of the new BfS calculations formed the basis for a new recommendation issued by the Commission on Radiological Protection, entitled "Planning areas for emergency response management in the vicinity of nuclear power plants" (SSK 2014b), that was adopted in February 2014. These results will also be the basis for the further development of off-site emergency response measures that will be derived from the implementation of the experience gained in the reactor accident.

1.2. Overview

The target of this study is to analyse the radiation exposure to the population in the event of an accident involving a meltdown in a German NPP and to identify the areas where protective measures for the population would have to be taken. The analysis is based on different release scenarios (chapter 4) and boundary conditions (chapter 3) according to the state-of-the-art of science and technology, always bearing in mind the occurrences in Fukushima (chapter 2). On the basis of these assumptions the authors evaluated the protective measures that would be required in the event of such massive releases according to the existing and advanced emergency response management concepts (chapter 3). To this end those areas were identified where high doses and serious deterministic effects might occur (in case of the assumed release and the considered meteorological situation) and where the emergency reference levels for protective measures might be exceeded.

The radiological consequences of these releases were assessed taking three NPP sites as examples (Unterweser, Grohnde and Philippsburg; see chapter 5). The radiological consequences were determined with the help of the decision support system RODOS (chapter 6). Numerical weather forecasts issued by Germany's National Meteorological Service DWD for the period November 2011 to October 2012 were used for the dispersion calculations. For every day within the above mentioned period a separate RODOS calculation was performed and the radiological consequences were analysed at each site and for each source term (chapter 7). The results of these calculations were evaluated with the help of different criteria, in particular with respect to the size, expansion and position of the areas where dose criteria would be exceeded and protective measures for the population would have to be taken (chapter 8). This report ends with a summary of the most important results (chapter 9).

2. RELEVANT DATA ON THE COURSE OF EVENTS IN FUKUSHIMA

2.1. Description of the accident

On 11 March 2011 the Northern part of Japan was hit by a magnitude 9.0 earthquake. The epicentre was located around 130 km off the Eastern coast of the Northern part of Japan's main island Honshu. The earthquake triggered a tsunami that ravaged the coastal areas one hour later by producing several flood waves with a height of up to 15 metres.

This natural disaster triggered a severe nuclear accident at the Fukushima Dai-ichi site where six nuclear generating units comprising light water reactors were operated. The Japanese government classified this accident subsequently as a level 7 event on the International Nuclear and Radiological Event Scale (INES 7).

The accident struck the generating units 1 to 4 of the Fukushima Dai-ichi site. The reactor cores in blocks 1, 2 and 3 were destroyed because the external power supply, the internal emergency power supply and the heat removal failed. Furthermore, the cooling water supply in the wet storage facilities was interrupted so that the integrity of the fuel elements was at risk. This was in particular true for unit 4 where the complete reactor core was intermediately stored at the time of the accident due to maintenance work.

The damage that had occurred in units 1 to 3 led to significant releases of radioactive substances into the environment that lasted more than a week. Although the meteorological conditions prevailing during the main release phase contributed to a dissipation of the radioactive substances in the direction of the sea, large-scale measures for the protection of the population were required (see also GRS 2013, BfS 2012).

2.2. Areas where protective measures were implemented in Fukushima

In the first days after the accident large areas within up to 20 km from the power plant site were evacuated. In an area with a distance of up to 30 km from the plant people were urged to remain indoors. Later on, people living even further away were requested to leave their homes in an area in north-western direction with a distance of up to 47 km from the power plant site (see Fig. 2.2 below). This decision was based on local dose rate measurements.

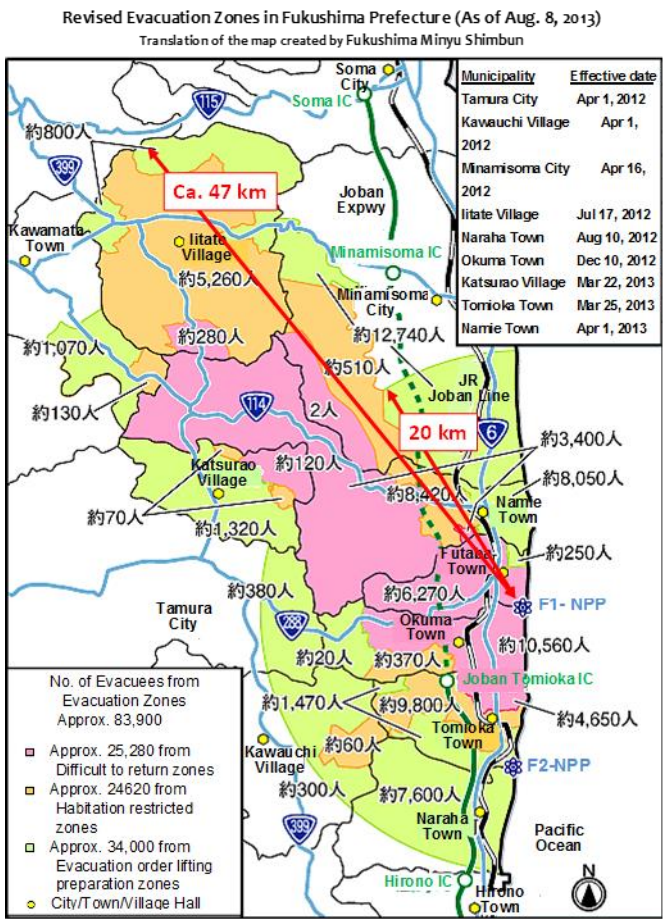


Fig. 2.2: Evacuation zones and number of people affected after the Fukushima Dai-ichi accident; this map shows the current classification of evacuation zones with respect to the future lifting of evacuation orders (Source: Fukushima Minyun Shimbun, revised by Kenji Nanba, Univ. of Fukushima).

The area where protection measures were implemented immediately after the accident is significantly larger than the corresponding evacuation zones previously envisaged both in Japan and in Germany.

3. CONCEPT FOR THE DETERMINATION OF POTENTIALLY AFFECTED AREAS

3.1. Radiological Foundations and Protection Concepts (revised in 2014)

The present study is fundamentally based on the concept previously valid for German emergency management with respect to the planning and implementation of protective measures in the case of an event involving significant releases of radioactive substances. This protection concept is described in "Radiologische Grundlagen für Entscheidungen über Maßnahmen zum Schutz der Bevölkerung bei Ereignissen mit Freisetzungen von Radionukliden" (*Radiological Foundations for decisions on measures to protect the population in case of events involving radionuclide releases*) (SSK 2014). The Radiological Foundations are based on radiobiological and radioepidemiological knowledge, in particular with respect to dose-risk and dose-effect relationships for stochastic and deterministic effects. Refinements of the protection concept could also be included in the study thanks to the cooperation of BfS and SSK.

In 2014 the Commission on Radiological Protection (SSK) concluded its revision of the Radiological Foundations (SSK 2014). In the course of this revision it was possible to include the conceptual enhancements and precisions on radiological emergency management that were made on an international level in recent years.

They are essentially based on the recommendations issued in 2007 by the International Commission on Radiological Protection ICRP 103 (ICRP 2007). The concepts for exposure situations that might result from a radiological emergency, newly introduced in the ICRP 103 publication, are more closely explained in the following publications ICRP 109 (ICRP 2009a) and ICRP 111 (ICRP 2009b), where the implementation is discussed in more detail.

ICRP recommendation 103 introduces a reference value for the residual dose that includes in particular the effective dose and takes into account dose contributions via all exposure paths (inhalation, external radiation, ingestion). In the case of serious radiological events the reference value for the effective dose within a year following the event can be fixed at a maximum of 100 mSv. The ICRP suggests that the residual dose to be stipulated for emergency planning purposes be typically between 20 mSv and 100 mSv within the first year following the event (ICRP 103). However, the reference value to be determined must take into account the gravity of the radiological consequences that has to be expected.

In the framework of the present study BfS also analysed the question if the new ICRP concept of a reference value for the residual dose in the first year following the incident matches the existing German emergency reference levels (section 8.6).

The study also includes analyses with respect to the protective measures “Temporary relocation” and “Permanent relocation” as defined by the protection concept valid up to 2014. However, the introduction of reference values according to the IRCP reduces the practical relevance of these measures.

3.2. Radiological protection goals in emergency management

BfS based its investigations presented here on the radiological protection goals set out in the Radiological Foundations (SSK 2014) and the associated assessment criteria. The Commission on Radiological Protection refined its radiological protection goals in emergency planning when revising its Radiological Foundations. All measures implemented as part of the emergency management are aimed at reducing the radiation exposure to the population, as per (SSK 2014). The objective is to avoid serious deterministic effects by taking measures to reduce individual radiation doses so that they remain below the threshold doses for these effects. According to (SSK 2014), the ICRP defines serious deterministic effects as irreversible damage that is directly attributable to the radiation exposure and leads to a significant deterioration in the quality of life.

Apart from avoiding deterministic effects, appropriate measures are envisaged in order to reduce and adequately limit the risk of individuals incurring stochastic effects.

3.3. Concept for determining potentially affected areas and the associated radiological criteria

The target of this study is to analyse the radiation exposure to the population in the event of an accident involving a meltdown in a German NPP and to identify the areas where protection measures for the population would have to be taken. The concept for determining the areas affected by protection measures is described in the SSK Recommendation "Planungsgebiete für den Notfallschutz in der Umgebung von Kernkraftwerken" (*Planning areas for emergency management in the vicinity of nuclear power plants*) (SSK 2014b). The area affected by a presumed accident is segmented according to the established goals and to the requirements for an effective and efficient implementation of protective measures. The concept for determining potentially affected areas uses a dose-related approach, based on the selection of an adequate reference accident with the associated reference source term. However, additional requirements and boundary conditions such as ensuring the implementation of protective measures in line with the priorities are also considered as weighting factors in the analysis of the calculated dose distribution.

Potentially affected areas were determined with the help of dispersion calculations based on a reference source term (chapter 4). One of the objectives of these calculations was to determine up to which distance from the source protective measures would be required in the assumed event. The emergency reference levels for the different protective measures were used as criteria to determine the areas where protective measures for the population would have to be taken.

According to (SSK 2014), emergency reference levels are dose levels that individuals will or might receive assuming certain exposure conditions. They function as radiological trigger criteria for the relevant protective measures. Emergency reference levels are planning values. The emergency reference levels for protective measures relate to the effective dose or the organ dose (in the case of the thyroid). The different emergency reference levels are dose levels that are far below the threshold doses for deterministic effects. Emergency reference levels for the protective measures listed in Table 3.3.1 are indicated in the Radiological Foundations (SSK 2014). The emergency reference levels help to determine areas where it is necessary from a radiation protection perspective to implement protective measures.

Table 3.3.1: Emergency reference levels for the interventions "Sheltering", "Stable iodine prophylaxis" and "Evacuation".

Type of intervention	**Emergency reference levels**		
	Organ dose (thyroid)	**Effective dose**	**Integration times and exposure paths**
Sheltering		10 mSv	External exposure within 7 days and committed effective dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside
Stable iodine prophylaxis	50 mSv Children and teenagers under the age of 18 and pregnant women; 250 mSv Individuals aged 18 to 45		Committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside
Evacuation		100 mSv	External exposure within 7 days and committed effective dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside

Three planning areas can be determined based on the emergency reference levels stated above:

1. An area immediately connected to the NPP premises where the population should be evacuated because the “100 mSv criterion” might be exceeded.
2. An area connected to the previous one where all individuals who are scheduled for a thyroid prophylaxis should take iodine tablets because the relevant emergency reference level (thyroid dose) might be exceeded; and
3. An area connected to the previous one where children and teenagers under the age of 18 should take iodine tablets because the thyroid dose might exceed 50 mSv under the given boundary conditions.

The potential radiation exposure principally decreases with an increasing distance from the NPP premises. Thus people in the immediate vicinity of the plant would be more severely affected by the radiological consequences of an assumed accident than people further away from the plant. In order to optimise the protection of the population in line with the extent of the potential effects, the planning area for an evacuation must be further subdivided.

It must be noted that in the event of a presumed INES level 7 accident serious deterministic effects and a high risk of stochastic effects are possible in an area directly connected to the NPP premises if no protective measures are taken. It is therefore necessary to prepare protective measures for this area that can be implemented and completed very quickly with top priority and, if possible, before the release caused by the accident starts. Thus when determining the top priority planning area two aspects are of primary importance: a) avoiding serious deterministic effects and b) ensuring that the implementation of protective measures is optimised, i.e. performed in line with priorities.

In order to determine the top priority planning area the distance from the plant was analysed up to where the occurrence of serious deterministic effects would be probable if people were to remain outside permanently for 7 days. The criterion used for the potential occurrence of such effects was the threshold dose for the relevant deterministic effects. In (SSK 2014) a variety of deterministic effects and their dose thresholds are examined in detail. The threshold doses quoted there, however, are generally levels that will not provoke any effects at all in 99% of the exposed individuals.

With respect to serious deterministic effects it can be deduced from the analysis in (SSK 2014) that a short-time radiation exposure of the red bone marrow can severely impair blood cell formation. A dose threshold of 1,000 mGy is quoted for this effect. Compared with the other serious deterministic effects discussed in (SSK 2014), a short-time exposure of the haematopoietic red bone marrow at a threshold dose of 1,000 mGy is the most restrictive condition for adults and children. According to (SSK 2014), the increased radiation sensitivity during prenatal development calls for special threshold doses for particularly radiation-sensitive stages in the development of tissue and organs. The most restrictive conditions with respect to serious deterministic effects and the associated threshold doses result in a threshold dose of 100 mGy for short-time whole-body exposure during the foetal development stage between the 2nd and 7th week and a threshold dose of 300 mGy for the brain during the particularly radiation-sensitive stage of development between the 8th and 15th week of pregnancy.

The following table summarizes the threshold doses for the occurrence of serious deterministic effects that were taken into consideration when determining the top priority planning area. All threshold levels are cited from the Radiological Foundations (SSK 2014).

Table 3.3.2: Threshold levels for the occurrence of serious deterministic effects

Dose criterion	**Group of individuals**	**Threshold level**	**Integration times and exposure paths**
Dose to the red bone marrow	Adults, infants	1,000 mGy	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside
Effective dose or uterus dose* (see below)	Foetus 2nd to 7th week	100 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled by the mother in this time if she were to remain permanently outside
Dose to the brain	Foetus 8th to 15th week	300 mGy	External exposure within 7 days and committed dose due to the radionuclides inhaled by the mother in this time if she were to remain permanently outside

*Since it is not possible to calculate organ doses to the foetus for the organogenesis, the inhalation dose to the mother is used as the effective dose to the foetus and the uterus dose to the mother is used for the external exposure (ICRP 2001).

Apart from the threshold levels for serious deterministic effects the SSK introduced another criterion for determining the top priority planning area with a level of 1,000 mSv for the effective dose. The groups of individuals, integration times and exposure paths correspond to the boundary conditions for the emergency management levels stated in (SSK 2014). This criterion helps to determine areas where measures need to be taken with top priority and where protective measures are particularly effective. As with the threshold levels for the occurrence of serious deterministic effects this criterion is only a planning factor which helps to determine the area where protective measures must be implemented.

3.4. Other relevant criteria for the present study

The present investigations exceed the scope necessary for determining planning areas. On the basis of the previous protection concept investigations were performed to define the areas where temporary or permanent relocations might be necessary according to the assumed boundary conditions. The radiological criteria relevant for these investigations are summarized in the following Table 3.4:

Table 3.4: Emergency reference levels for the interventions Permanent relocation and Temporary relocation (as per SSK 2008)

Type of intervention	Emergency reference levels		
	Organ dose (thyroid)	Effective dose	Integration times and exposure paths
Permanent relocation		100 mSv	External exposure within 1 year due to deposited radionuclides
Temporary relocation		30 mSv	External exposure within 1 month

3.5. Methods for determining potentially affected areas

An analytical method was selected to determine the potentially affected areas. Different release scenarios were considered (see chapter 4), including a reference source term chosen by SSK for determining the planning areas. The RODOS system (Real-time Online Decision Support System) (Raskob and Gering 2010; see also http://www.rodos.fzk.de) was used to determine those areas where high doses and serious deterministic effects might occur considering the established boundary conditions and where emergency reference levels for protective measures might be exceeded. Other factors of influence for emergency management were also considered when selecting the reference source term and establishing the boundary conditions for the calculation and assessment. The method consisted of the following steps:

- Establish parameters for the assumed release of radioactive substances;
- Select reference source terms including of scenarios comparable to the Fukushima accident;
- Select representative NPP sites in Germany;
- Establish boundary conditions for the RODOS calculations;
- Establish evaluation procedures to determine potentially affected areas where protective measures are required from a radiological point of view;
- Perform RODOS calculations to determine those areas where protective measures would be necessary according to the emergency reference levels as per (SSK 2014), where the 1,000 mSv criterion is reached or where serious deterministic effects might occur.

The previous planning areas are outlined in the following paragraphs for a clear presentation of the baseline situation.

The planning areas for emergency management in the vicinity of nuclear power plants are set out in the framework recommendations for disaster control in the vicinity of nuclear installations (BMU 2008), as can be seen in the table below. In 2008, the framework recommendations were last aligned with the state-of-the-art of science and technology. They apply to German nuclear installations and installations in other countries close to the German borders that require planning on German territory.

Table 3.5: Planning areas according to the framework recommendations for emergency management in the vicinity of nuclear installations (valid through February 2014; BMU 2008).

Central zone	In the central zone all alert measures type 2 must be prepared (alert measures type 2 are designed to prevent imminent risks to the lives and health of the population and include in particular interventions such as Sheltering, Stable iodine prophylaxis and Evacuation). In the case of NPP the central zone is a radius of 2 km around the plant. Measures to be taken in the central zone are particularly urgent due to the proximity to the affected plant and are generally performed independently of the direction of dispersion.
Intermediate zone	The intermediate zone is a circular planning zone where all alert measures type 2 must be prepared. In the case of NPP the intermediate zone stretches from a radius of 2 km from the plant to a radius of roughly 10 km from the plant. Measures to be taken in the intermediate zone are generally performed depending on the direction of dispersion (determined by sectors).
Exterior zone	The exterior zone is a circular planning zone where the distribution of iodine tablets to all individuals under the age of 45 must be prepared and the population must be warned not to eat freshly harvested food. In addition, measurements will be performed in the exterior zone to assess the radiological situation. In the case of NPP the intermediate zone stretches from a radius of 10 km from the plant to a radius of roughly 25 km from the plant. Measures to be taken in the exterior zone are generally performed depending on the direction of dispersion (determined by sectors).
Distant zone	The distant zone is a circular planning zone where the distribution of iodine tablets to children and teenagers under the age of 18 and to pregnant women must be prepared and the population must be warned not to eat freshly harvested food. In the case of NPP the distant zone stretches from a radius of 25 km from the plant to a radius of roughly 100 km from the plant. This zone may be divided in subsections with respect to organizing the distribution of iodine tablets. Measures to be taken in the distant zone are performed depending on the direction of dispersion (determined by sectors).

Planning areas are regions in the vicinity of the nuclear installation where particular protective measures must be prepared. In the framework recommendations these regions are called "planning zones" and are divided into central zone, intermediate zone, exterior zone and distant zone.

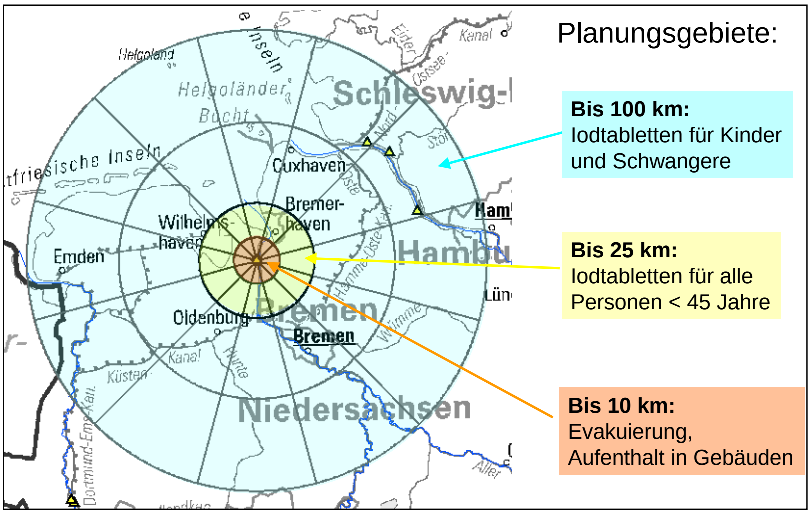


Fig. 3.1: Planning areas for disaster control (valid through February 2014), illustrated at the example of the Unterweser nuclear power plant

4. RELEASE SCENARIOS

The present study considers various release scenarios (source terms) in order to estimate the resulting radiation exposure experienced by the population and to determine the necessary protective measures.

The German Association for Plant and Reactor Safety (GRS) established representative event sequences for pressurised-water reactors and boiling-water reactors within a research project at the end of 2010. The associated source terms were added to the RODOS source term library (Löffler et al. 2010). The following table shows the developed scenarios for pressurised-water reactors.

Table 4.1: Release categories in the RODOS source term library as per (Löffler et al. 2010); for reasons of comparison the established source term for the Fukushima accident as per (GRS 2013) is indicated in italics

Name	Type	Release of iodine-131 [Bq]	Release of caesium-137 [Bq]	Beginning of main release Hours [h] after reactor shutdown	Calculated frequency [10^{-7}/year]
FKA	Uncovered steam generator tube leak	$3.1 \cdot 10^{17}$	$2.9 \cdot 10^{16}$	≈ 21	2.1
Fukushima	*Cooling failure in several reactors*	*1 to* $2 \cdot 10^{17}$	$1\text{-}2 \cdot 10^{16}$	*≈ 13*	-
FKI	Filtered pressure discharge via the chimney	$2.8 \cdot 10^{15}$	$2.8 \cdot 10^{11}$	≈ 57	8.8
FKH	Filtered pressure discharge via the roof	$2.8 \cdot 10^{15}$	$2.8 \cdot 10^{11}$	≈ 57	2.6
FKF	Unfiltered pressure discharge via the roof	$2.3 \cdot 10^{16}$	$2.8 \cdot 10^{14}$	≈ 57	2.1
FKE	Failure of the sump suction pipe	$1.8 \cdot 10^{17}$	$9.4 \cdot 10^{14}$	≈ 33	1.4

The release scenarios FKA, FKF and FKI were taken into consideration for the present study (highlighted in bold letters in the table above). These releases correspond to the highest categories, i.e. level 5 (FKI), level 6 (FKF) and level 7 (FKA) on the commonly accepted International Nuclear Event Scale (INES) used for assessing nuclear and radiological events.

A source term is characterised by the amount of radioactive substances released (release quantity), length of release and place of release. For disaster control purposes the length of the pre-release period is also of key importance (i.e. the length of time between the moment when it is recognized that a larger release of radionuclides from the plant is possible and the beginning of the release; corresponding to the "beginning of main release" in the above table).

The following figures show the development of release rates for the three considered source terms FKA, FKF and FKI.

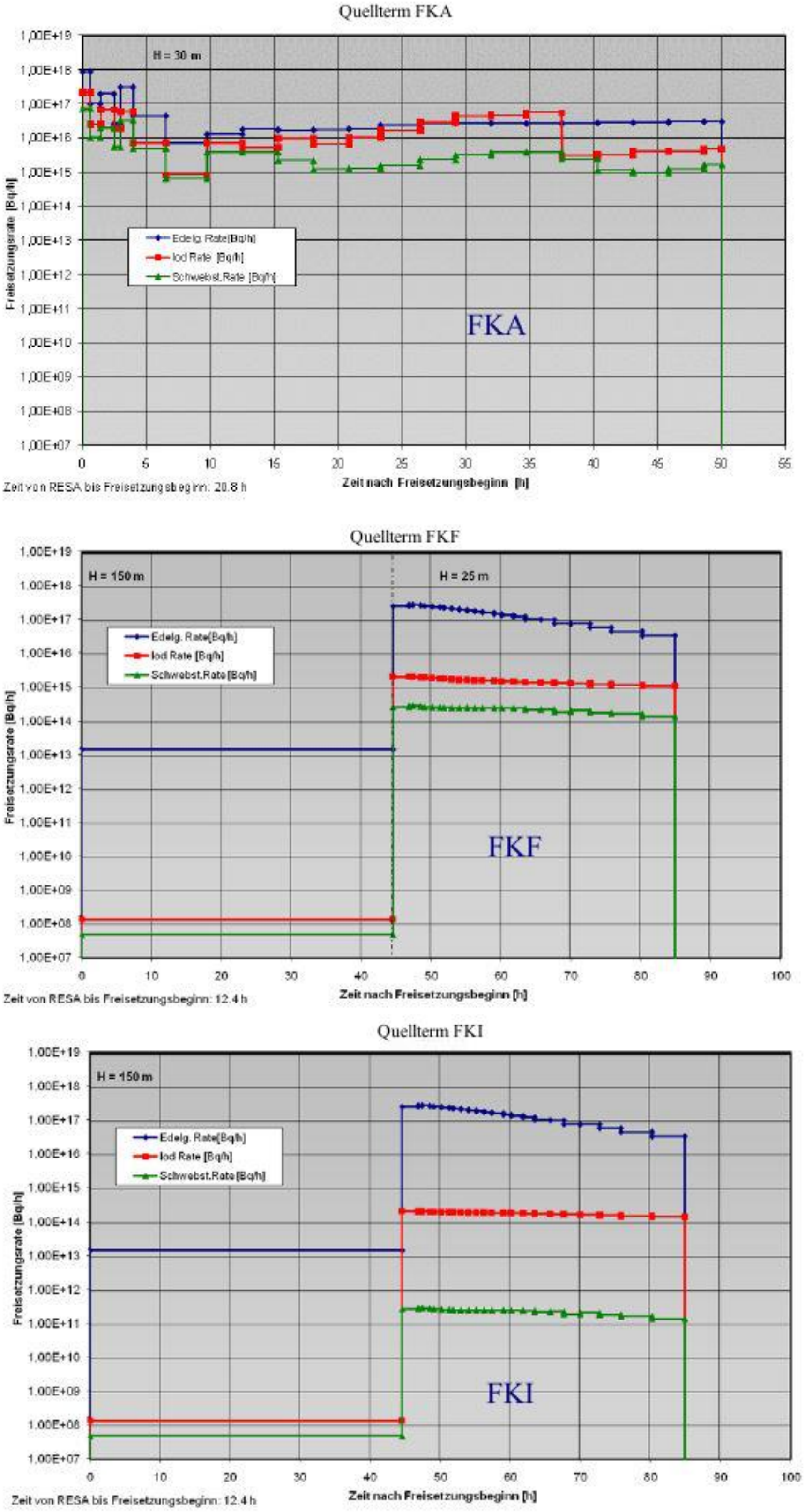


Fig. 4.1: Development of release rates over time (summed up via nuclide groups) for the considered source terms FKA, FKF and FKI. The relevant height of release (above ground) is stated in each figure in the upper left-hand corner.

5. SELECTION OF INVESTIGATED NPP SITES

5.1. Selection of investigated sites

The three areas selected for the present investigation were supposed to represent as far as possible the different climatological conditions in Germany. The selected areas are characterized by:

- Shallow orography, high wind velocity on average;
- Moderately structured orography, positioned in a valley, moderate wind velocity on average; and
- Distinctive deep valley, moderate orography, low wind velocity on average, frequent occurrence of inversions.

NPP sites within these areas were selected (Unterweser, Grohnde and Philippsburg) and the radiological consequences for accidents at these sites were calculated.

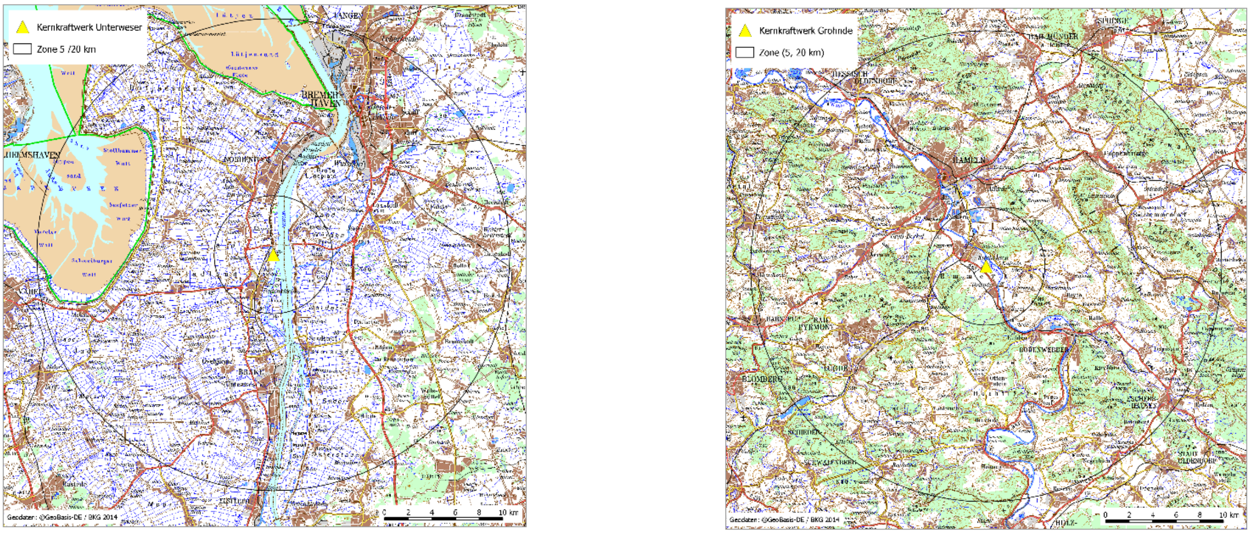


Fig. 5.1 a, b: Representation of the surroundings of Unterweser NPP (left) and Grohnde NPP (right) on a topographic map with the scale indicated in the bottom right-hand corner and circles at a distance of 5 km and 20 km from the site

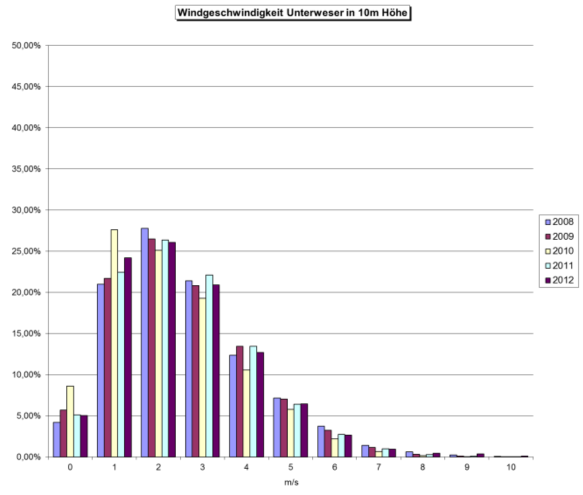
Fig. 5.1 c: Representation of the surroundings of Philippsburg NPP on a topographic map with the scale indicated in the bottom right-hand corner and circles at a distance of 5 km and 20 km from the site

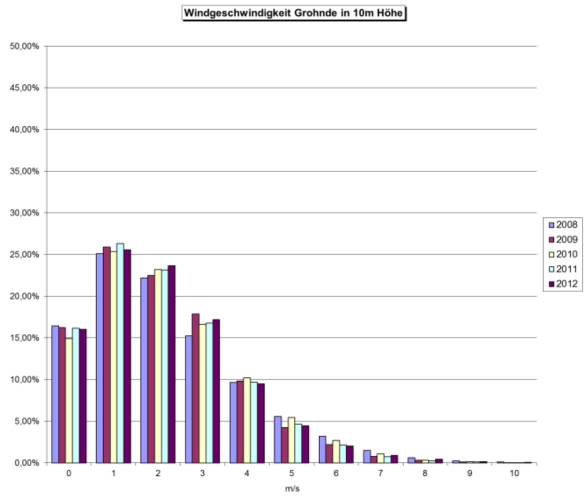
5.2. Meteorological comparison of individual sites

Long-term time series of meteorological measurements, established through the Remote Monitoring of Nuclear Power Plants (KFÜ), are available for the Unterweser, Grohnde and Philippsburg sites. BfS has made a statistical analysis of the monthly average of these data over several years. This analysis has shown that the period of time for which the calculations were performed, i.e. 1 November 2011 to 31 October 2012, can be considered representative for a longer period (2008 - 2012). Extraordinary meteorological conditions would have limited the validity of the results.

5.2.1. Wind velocity at the individual sites

Wind velocity is an essential parameter for dispersion. The following diagrams show the statistical distribution of wind velocity for individual wind velocity classes and different years (2008 – 2012) at the individual sites (Unterweser, Grohnde and Philippsburg).





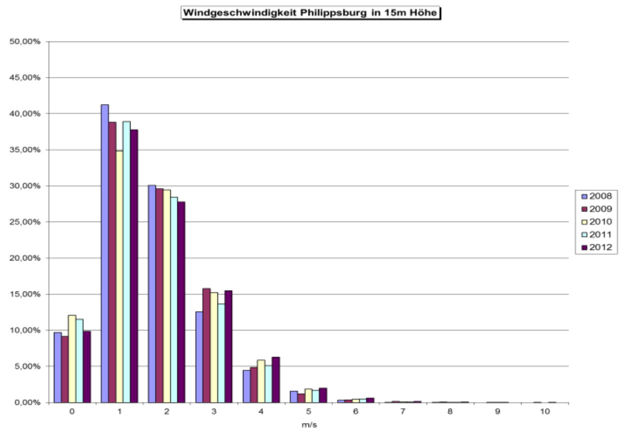


Fig. 5.2.1 a, b, c: Diagrams showing the frequency distribution of wind velocity at the Unterweser, Grohnde and Philippsburg sites in the years 2008 to 2012

The frequency distributions of wind velocity are typical representations of the different climatic regions in Germany with

- relatively high wind velocities in the north German lowlands (Unterweser),
- slightly lower wind velocities in the area of moderately structured orography (Grohnde with a distinguishable increase in frequency for lower wind velocities due to its position in a valley) and
- the shift to the area of lower wind velocities due to its position in a deep valley and frequent occurrence of inversions in the Upper Rhine Rift (Philippsburg).

The differently coloured bars each represent one year. It can be clearly seen that there are no great differences between the individual years for the set of data available (2008 – 2012). There is a slight increase in frequency for lower wind velocities (0 and 1 m/s) at Unterweser in 2010. However, this is due to statistical variations and is not relevant for the further assessments.

5.2.2. Wind direction

The wind direction is represented in the form of a frequency distribution of the wind direction as a function of time. A greater distance from the centre means that this wind direction is more frequent in the year under consideration (differently coloured lines).

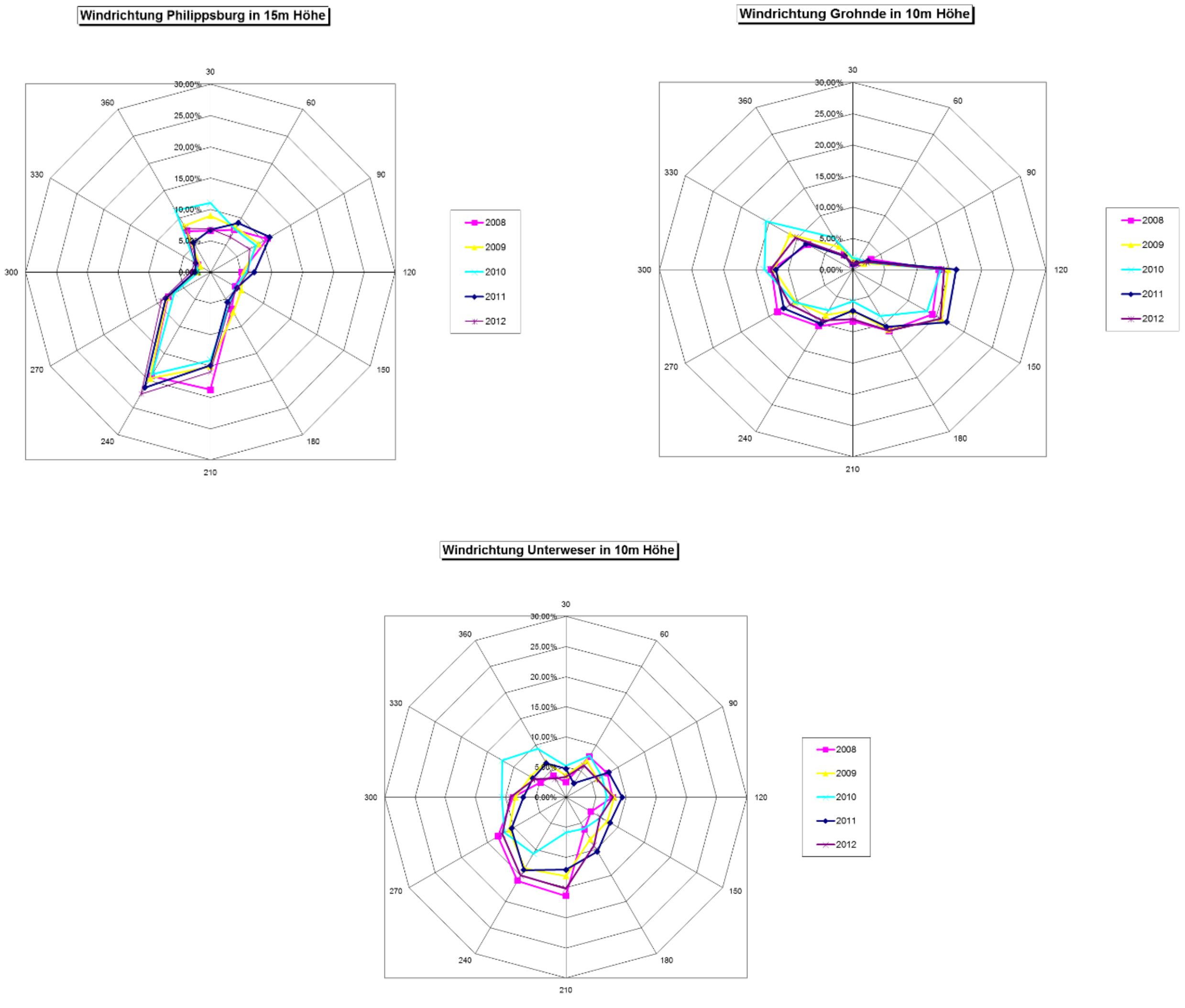


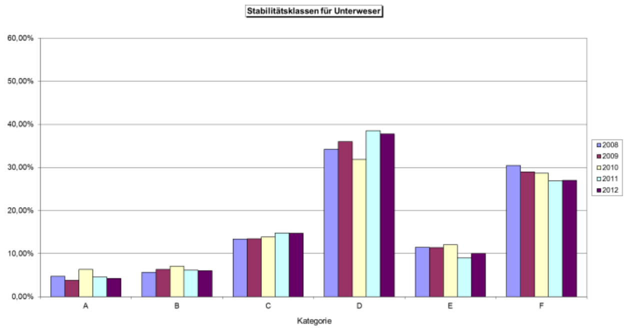
Fig. 5.2.2 a, b, c: Frequency distribution of the wind velocity at the Philippsburg, Grohnde and Unterweser sites in the years 2008 to 2012. The wind direction is combined in sectors of 30° each.

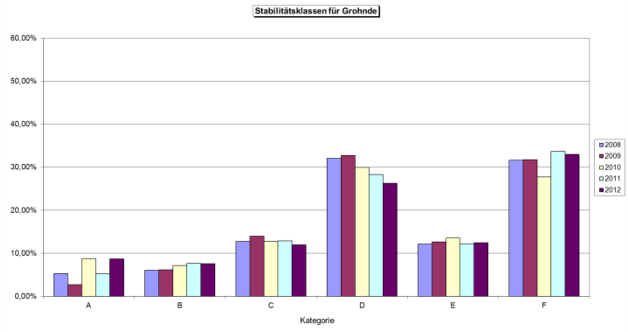
For the northern part of Germany, a broad distribution of south-western wind directions can be seen, which is typical for this region (prevailing wind direction). A dominance of certain wind directions can also be seen in the charts for Grohnde and Philippsburg. These frequent occurrences are due to the fact that the airstream is guided because of the site's position in a valley and/or the valley's orientation.

So the period of time for which the calculations were performed (1 November 2011 to 31 October 2012) can be considered representative for the meteorologically analysed years 2008 to 2012 with respect to the wind direction as well.

5.2.3. Atmospheric stability

The atmospheric stability is also of considerable relevance to the dispersion in the atmosphere. It is therefore another essential parameter for dispersion and is thus investigated in the study. The stability is represented according to the Pasquill stability classes. As per Pasquill, A means very unstable, B unstable to slightly unstable, C slightly unstable to neutral, D neutral to slightly stable, E stable and F very stable.





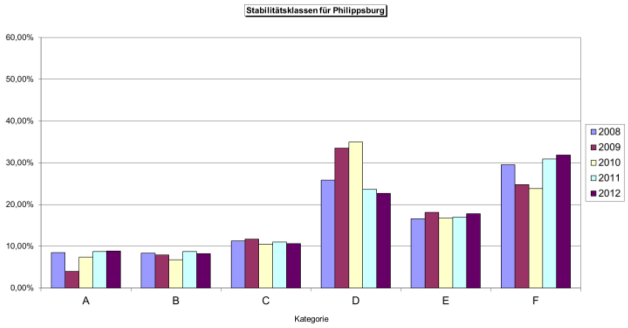


Fig. 5.2.3 a, b, c: Frequency distribution of stability (as per Pasquill) at the Unterweser, Grohnde and Philippsburg sites in the years 2008 to 2012

The frequency distribution of the stability classes is very similar at the different sites. Neutral to slightly stable cases (class D) and very stable cases (class F) are the most frequent occurrences. Neutral to slightly stable cases are most frequent at the Unterweser site near the German coast, while they are less often observed further away from the coast. The unstable cases (A to C) are less frequent near the German coast, while they are more often observed at the sites located in a valley (Grohnde und Philippsburg).

The frequency distribution does not present significant differences over the individual years. There are some fluctuations in class D at all sites and even less significant fluctuations in class F. Since these differences amount to less than 10% in the individual years they are not significant for the overall calculations.

5.2.4. Precipitation

Precipitation influences the dispersion of radionuclides in the atmosphere in particular due to wet deposition. This should therefore be regarded as another essential parameter for dispersion with respect to the statistical distribution in the individual years.

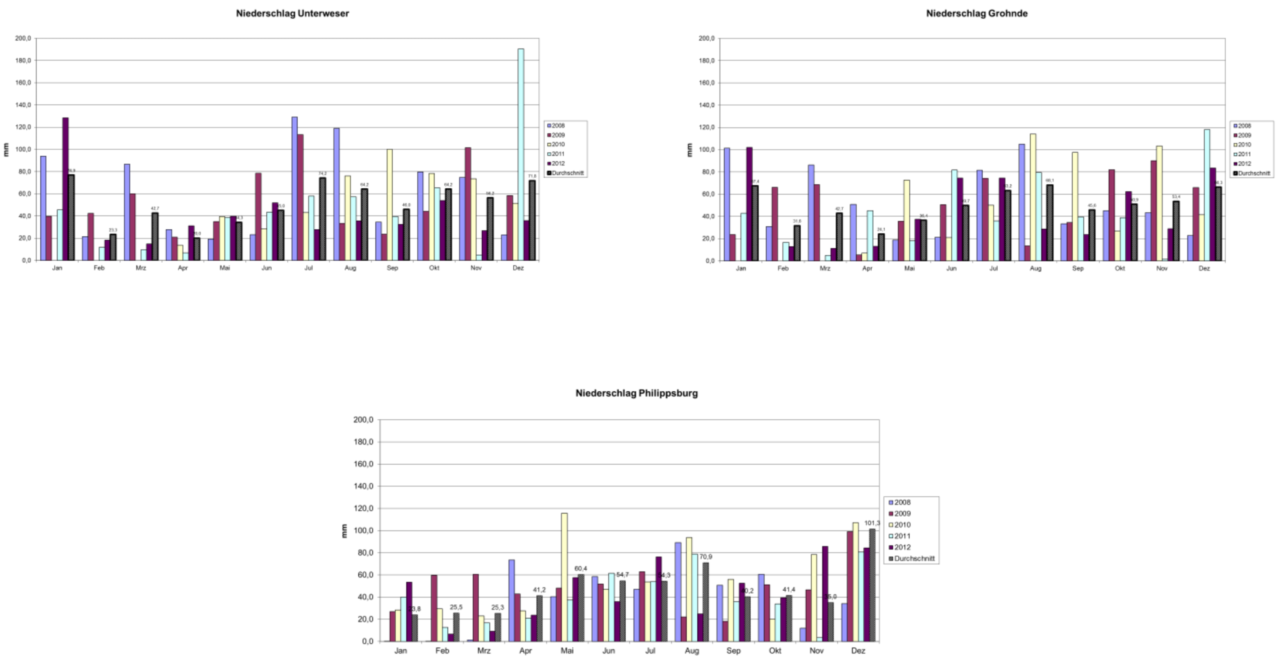


Fig. 5.2.4 a, b, c: Frequency distribution of precipitation at the Unterweser, Grohnde and Philippsburg sites in the years 2008 to 2012

Precipitation does indeed differ at the individual sites and especially over the different years. Precipitation seems to present greater differences in particular in several months of the year 2010. However, these differences are equalized by the frequency in the preceding and/or following months so that it can be assumed that these are ordinary and typical fluctuations for precipitation. It is not to be expected that these fluctuations have an impact on the wet deposition considered in RODOS calculations.

Summarizing the meteorological measurements of these essential parameters for dispersion it can be stated that the period of time chosen for the study (1 November 2011 to 31 October 2012) can be considered representative for a longer period of time (2008 – 2013).

6. THE DECISION SUPPORT SYSTEM (RODOS)

The investigations presented here and conducted by BfS on the subject of potential consequences of severe NPP accidents in Germany were performed with the help of the RODOS computer programme (Raskob und Gering 2010; http://www.rodos.fzk.de/). The Real-time Online Decision Support System (RODOS) is operated at BfS – as well as in numerous other European countries – in order to perform dispersion and dose calculations in the event of a nuclear accident (or other radionuclide releases into the environment) and to assess the potential consequences.

The Karlsruhe Institute of Technology (KIT) coordinates the development of RODOS, funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the European Commission. The project was conducted in cooperation with a working group constituted of federal government representatives and federal state representatives. For more than 10 years now the Federal Office for Radiation Protection (BfS) operates an emergency operations centre where the German RODOS is implemented and ready for operation. One of the system's special features is that the following data can be transmitted online and integrated in the calculations: real-time measuring data from the Remote Monitoring System for of Nuclear Power Plants (KFÜ) in the Federal States, meteorological forecast data from Germany's National Meteorological Service (DWD) and country-wide data from the Integrated Measurement and Information System (IMIS) used for monitoring environmental radioactivity.

RODOS comprises numerous models, e.g.

- for processing meteorological input data;
- for calculating the dispersion in the atmosphere;
- for simulating the transfer of radionuclides within the human food chain;
- for estimating the radiation exposure experienced by the population; and
- for simulating the impact of a variety of countermeasures.

6.1. Dispersion models in RODOS

A variety of dispersion models is integrated in RODOS. Due to different boundary conditions (e.g. calculation time, spatial and temporal resolution) mainly two models can be used for the extensive calculations performed with RODOS in the framework of this study. These two models will be outlined in the following paragraphs. Both models were used in the study. Since the RIMPUFF model offers a higher physical potential and the possibility to calculate consequences for greater distances from the place of release, all results presented in this study are based on calculations performed with RIMPUFF.

6.1.1. ATSTEP

ATSTEP is based on the algorithm of a Gaussian puff model and is used for distances of up to 50 km from the place of emission [http://www.rodos.fzk.de/Documents/Public/Handbook/Volume3/4_2_5_ATSTEP.pdf]. It was developed in particular for very rapid calculations in the case of a release of airborne, radioactively contaminated substances due to an accident. ATSTEP can calculate a real-time diagnosis of the radiological situation following a release and dispersion for up to 24 hours.

A radiological situation can thus be described via the following results, calculated with ATSTEP:
- Ground-level concentration (short-term or time-integrated);
- Contamination of the soil surface due to dry or wet deposition;
- Gamma radiation (from the soil, from the cloud).

These results are then edited as time-dependent, nuclide-specific fields in the entire computational domain.

The following dispersion-relevant or radiologically-relevant phenomena can be considered with the help of ATSTEP:
- Time-dependent meteorology (mast measurements, SODAR, forecast data, inhomogeneous wind fields);
- Time-dependent and nuclide-specific release rates, significance of thermal buoyancy (effective plume height).

In contrast to traditional puff models (e.g. RIMPUFF), ATSTEP does not use short-term puff releases but time-integrated, elongated puffs. The transport of each expanded puff in the atmosphere is represented by two trajectories that are each coupled to both ends of the puff. This pair of trajectories and thus the expanded puff itself follows an inhomogeneous and variable 2D-wind field so that the corresponding cloud retraces all the required changes in position, dimension and orientation, such as extending, rotating, shrinking or lateral movements.

Due to the expanded puffs the simulation of the cloud can be represented by a significantly smaller amount of puffs. The number of time steps required for simulating release and transport is therefore clearly smaller. This type of approximation thus reduces the programme's computing time so that a complete dispersion and exposure forecast for a release over several hours can be obtained in a ten-minute real-time interval.

Compared with the traditional puff model the approximation via expanded puffs requires a reduction of the spatial and temporal resolution. This higher resolution, however, is only necessary if the dispersion conditions are extremely variable and inhomogeneous.

6.1.2. RIMPUFF

The RIMPUFF model (Risø Mesoscale PUFF Model) is a Lagrangian, mesoscale, atmospheric puff dispersion model that calculates the activity and doses of airborne radioactive substances. The model can handle both non-steady and inhomogeneous meteorological situations that are particularly important with respect to estimating the short-term releases (due to an accident) of airborne radionuclides in the atmosphere.

The model can be used in homogeneous and inhomogeneous terrains with moderate orography for a range of up to several hundred kilometres from the place of emission. Time-variable releases can be represented by a series of Gaussian puffs where each puff represents the amount of release within a certain time interval.

RIMPUFF was optimised for real-time computation of activities, time-integrated activities, the deposition and the dose originating from the gamma radiation of the clouds and the soil. The RIMPUFF computation procedure comprises stability-dependent dispersion parameters, computation procedures for the effective plume height, the possibility to include inversion and reflection at the soil and the possibility to include dry and wet deposition. The model can also be used in moderately structured terrain; a puff-split procedure will be used in this case.

6.2. Dose calculations in RODOS

Dose calculations in RODOS include all relevant human exposure paths in the case of radionuclide releases. These are:

- External radiation exposure due to radionuclides in the air;
- External radiation exposure due to radionuclides deposited on the ground;
- External radiation exposure due to radionuclides deposited on the clothes or skin;
- Internal radiation exposure due to inhalation of airborne radionuclides;
- Internal radiation exposure due to ingestion of radionuclides with the food.

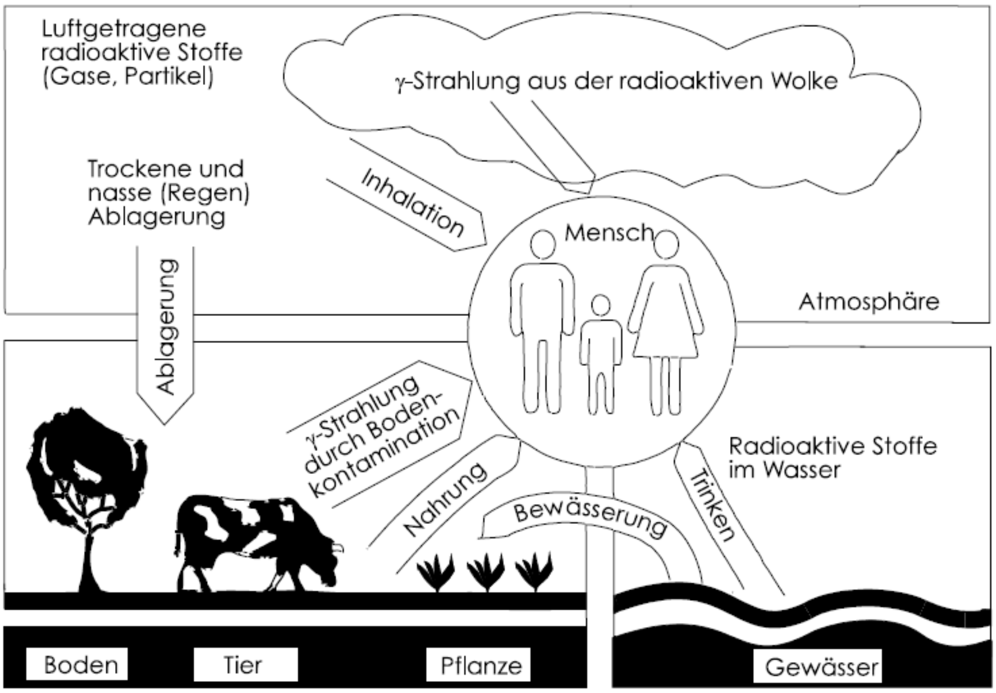


Fig. 6.2: Schematic representation of exposure paths that can lead to human radiation exposure (as per (SSK 2008)).

Dose calculations with the help of RODOS can include different factors, such as:

- Dependency of the dose on the age group considered (adults with a 50-year committed dose in case of incorporation; teenagers, children and infants with a 70-year committed dose in case of incorporation);
- Dependency of the dose on the organ considered (e.g. effective dose, thyroid dose etc.), or on inhalation rates;
- Reduction of the dose due to sheltering in buildings;
- The long-term reduction of the external dose rate due to weather-related effects;
- The influence of plant growth, harvesting, processing and storing foodstuffs and feedstuffs on the internal dose arising from the ingestion of radionuclides with the food;
- The influence of food patterns on the internal dose arising from the ingestion of radionuclides with the food.

The dose coefficients are a central element of the dose calculations – they describe the relationship of radionuclides in different environmental media (e.g. on the soil surface, in the air or in food) and the resulting human radiation exposure. RODOS uses the dose coefficients published by the International Commission on Radiological Protection (ICRP) to calculate the internal exposure (ICRP 2012, BMU 2001). The internal exposure of the foetus is also calculated with the help of dose coefficients established by the ICRP (ICRP 2001). Since no international recommendations for dose rate coefficients are available for the external exposure, RODOS uses data published by the Association for Radiation and Environmental Research (GSF) (Jacob 1990).

7. CALCULATIONS IN RODOS

7.1. Boundary conditions

The objective of this study is to analyse the consequences that an accident in a German NPP might have, including the occurrence of a meltdown. To this end those areas were identified with the help of RODOS where high doses and serious deterministic effects will occur (in case of the assumed release and the considered meteorological situation) and where the emergency reference levels for protection measures will be exceeded. The calculations in RODOS were performed on the example of three NPP sites (Unterweser, Grohnde and Philippsburg; cf. chapter 5).

Based on the releases listed in chapter 4 "Release Scenarios" and on real forecast data published by Germany's National Meteorological Service (DWD) calculations were performed in RODOS for a randomly selected period of time (1 November 2011 to 31 October 2012; 365 days with one calculation per day and a forecast period of 96 h). The large amount of computational results (obtained from more than 5,000 individual calculations) constitutes a secured statistical basis for statements on the potential radiological consequences.

The selected period of time, i.e. a full year, ensures that each season with its individual meteorological conditions is sufficiently taken into consideration. An examination of the meteorological data obtained from the Remote Monitoring System of Nuclear Power Plants (KFÜ) at the individual sites over several years (see section 5.2) has shown that the period under investigation does not differ significantly from other years and can thus be considered a representative year. In order to statistically validate the data for this one-year-interval a dispersion calculation was performed in RODOS for each day and each site on the basis of the three relevant source terms (see chapter 4). Thus more than 3,000 calculations were performed for 365 days and 3 sites. More than 2,000 additional calculations were also performed (e.g. to investigate the impact of the dispersion model, the selected starting time and other assumptions). The individual calculations start at midnight of each day. The weather conditions at night, characterised by a stable layer, reduce the vertical exchange of contaminated air masses. Since the release is at its highest level in the beginning, the choice of midnight as starting point for the calculations generally leads to conservative results.

The data obtained from the COSMO-EM System (Consortium for Small-scale MOdeling – Model for Europe) used by Germany's National Meteorological Service (DWD) can be used as meteorological database for the flow fields. DWD routinely provides these data fields twice a day to BfS. Alternatively the meteorological data obtained from the KFÜ system of each site would have been available. The study's authors had to decide which set of data might be advantageous: more exact site data with meteorological measurements at the point of release or the DWD data that are representative for the entire simulation area. Since it was expected that the dispersion and the relevant exposure, based on the reference source term FKA, would stretch over more than 100 km in the simulation area, the DWD's data fields were considered advantageous.

Within RODOS the operator can choose between the dispersion models ATSTEP and RIMPUFF. ATSTEP is a model that is intended to provide rapidly-available calculation results so that a simple calculation algorithm was implemented. Since computing time was of minor relevance for these investigations, the authors opted for the RIMPUFF model. While RIMPUFF requires more computing time, it offers more detailed modelling (in particular for longer distances from the site of release) and thus better reproduction of the meteorological processes.

In each computation cycle the radiation exposure experienced by the population within the computational area was calculated in the form of the effective dose and the organ dose to the thyroid and bone marrow. The radiation doses were typically (i.e. unless otherwise stated) determined for an integration period of 7 days – this applies to the external doses due to radionuclides deposited on the ground – and with the conservative assumption that people would permanently remain outside without protection (i.e. shielding effects produced by buildings were not taken into consideration). The authors took account of the external exposure paths and the internal exposure due to inhalation. However, they did not take account of the internal exposure due to radionuclides in food (ingestion) since they assumed that the dose contribution caused by ingestion would be minor compared with the other exposure paths if EU maximum values for radionuclides in food were respected and use was restricted.

All calculations were performed for adults and small children (1 to 2 years of age), partly even for the embryo/foetus between the 2nd and 7th week (period during which malformations are induced by ionising radiation; SSK 2014a) and between the 8th and 15th week (main risk period for mental retardation due to ionising radiation; SSK 2014a).

The following figure shows one of the RODOS results on the example of the effective dose to adults due to inhalation, cloud and ground radiation over seven days. The interventions Sheltering and Evacuation are based on this dose value. The figure shows the result for the Grohnde site, the source term FKA and a fictitious release starting on 1 November 2011. Each of the RODOS calculations covers a square with a side length of around 320 km, the considered NPP lying in the centre of the square. This method makes it possible to calculate the radiological impact at least for a distance of 160 km from the NPP site. The red circles illustrate the previous emergency management planning areas around the NPPs (2, 10, 25 km). The circular areas at a distance of 2 to 10 km from the site and at 10 to 25 km from the site are each divided into 12 sectors. In the coloured representation of the result for this dose, the emergency reference level for the intervention Sheltering is exceeded when the colour changes from yellow to orange and the emergency reference level for the intervention Evacuation is exceeded when changing from red to magenta.

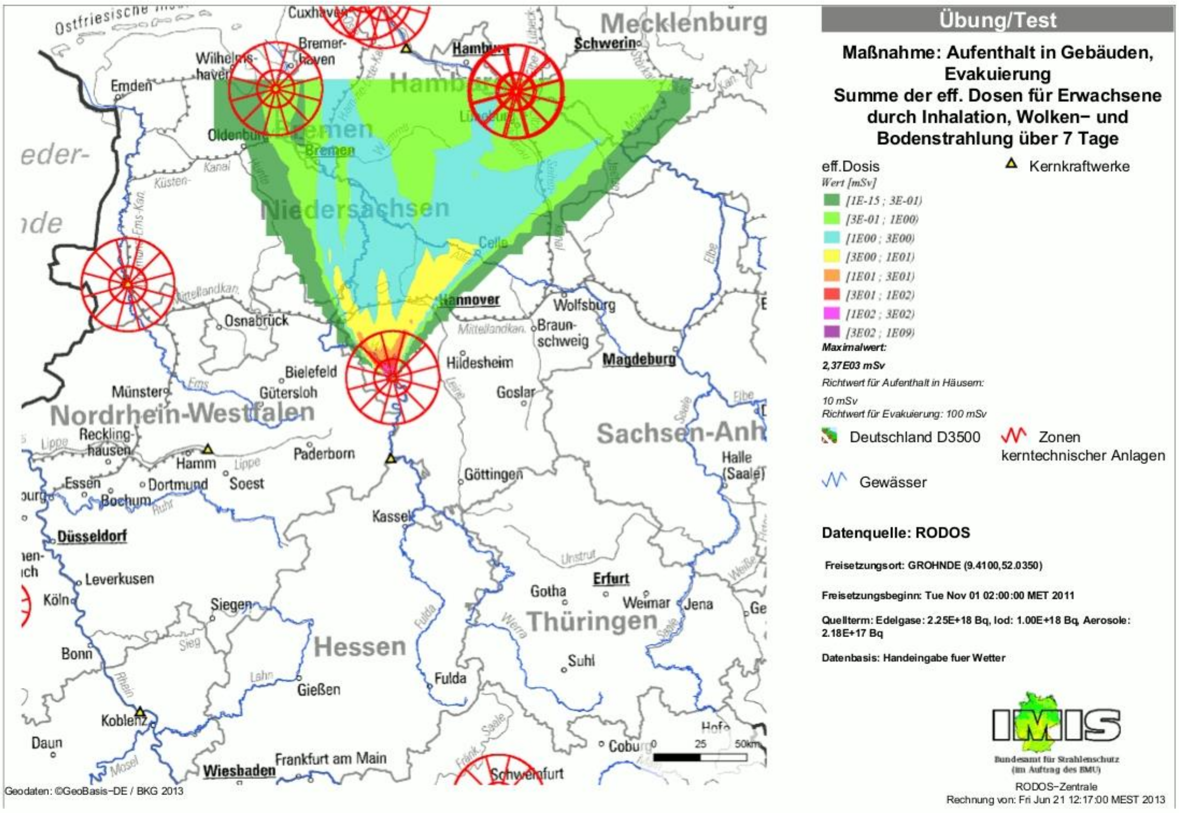


Fig. 7.1: Effective dose to adults due to inhalation, cloud and ground radiation over 7 days for the Grohnde site, the source term FKA and a fictitious release starting on 1st November 2011.

7.2. Analysis of the RODOS calculations

The results obtained from the RODOS calculations for the radiation exposure experienced by the population have been compared with different dose criteria (sections 3.3 and 3.4) and those areas have been determined where specific dose criteria were exceeded. The following dose criteria were taken into account:

1. Emergency reference levels for the interventions
   - Sheltering (effective dose of 10 mSv);
   - Evacuation (effective dose of 100 mSv);
   - Stable iodine prophylaxis (thyroid dose of 50 mSv for children, teenagers and pregnant women; thyroid dose of 250 mSv for individuals aged 18 to 45);
   - Temporary relocation (effective dose of 30 mSv in one month);
   - Permanent relocation (effective dose of 100 mSv in one year);
2. Threshold levels for the occurrence of serious deterministic effects (SSK 2914 a):
   - 1,000 mGy for the dose to the red bone marrow;
   - 300 mGy for the brain dose to a foetus in 8th to 15th week;
   - 100 mSv for the effective dose to a foetus in 2nd to 7th week.
3. Dose criterion: effective dose of 1,000 mSv (SSK 2014a).

The following parameters were defined for those areas where one of the dose criteria is exceeded:

- the surface area (see Fig. 7.2.1 a);
- the number of people affected (for some cases);
- the number of sectors affected at various distance ranges (see Fig. 7.2.1 b);
- the maximum distance from the NPP where each dose criterion is still exceeded (see Fig. 7.2.1 c).

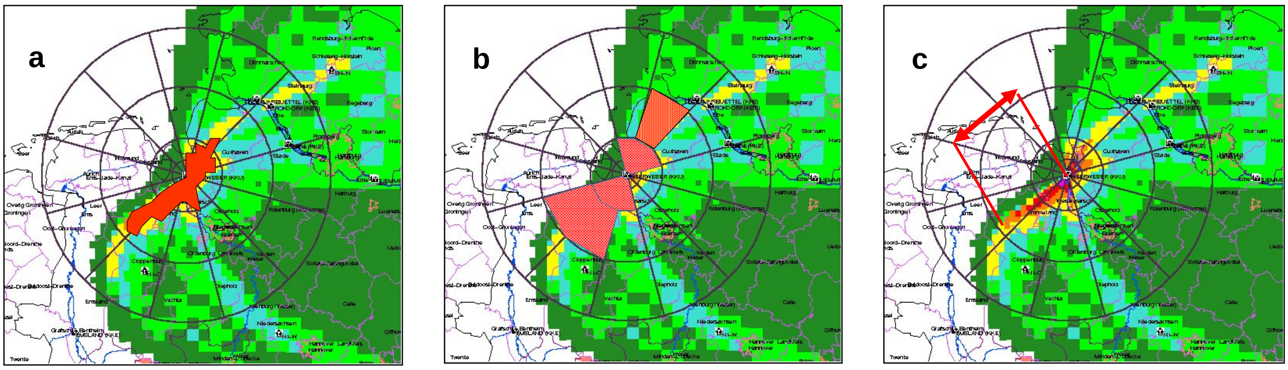


Fig. 7.2.1 a, b, c: Example of the determination of areas where one of the dose criteria is exceeded: (a) surface area, (b) number of sectors affected, (c) maximum distance from the NPP.

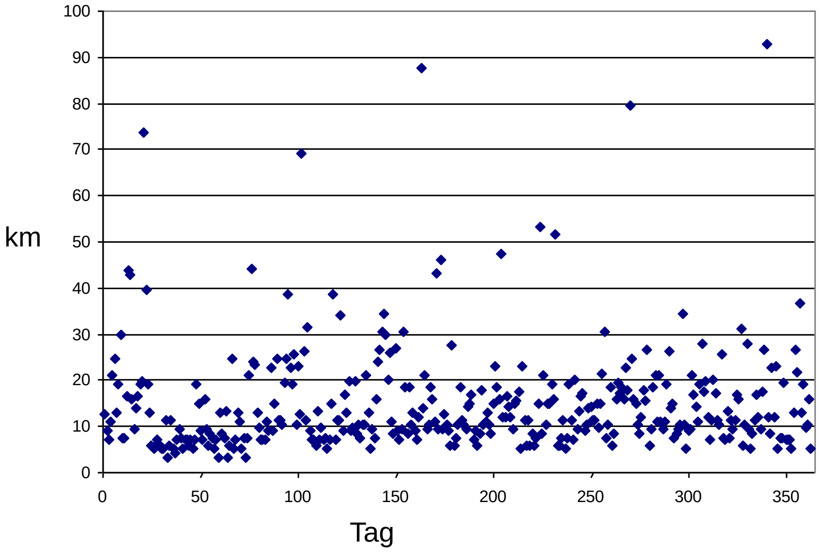
For each site, each release and each dose criterion the large number of calculations (resulting from the different weather scenarios within a year) makes it possible to determine the statistical distribution of the parameters characterising the affected areas. This distribution shows how often certain parameter values, such as a maximum distance within which an intervention needs to be implemented, can occur within one year.

Fig. 7.2.2 a below shows (by way of example) for each day within a particular year the maximum distance within which the emergency reference level for the intervention Evacuation would have been exceeded at the Unterweser site in the case of a release with the source term FKA. It can be seen that the results vary significantly. In most cases the maximum distance is between 5 km and 30 km, but larger values of up to 90 km are also reached in individual cases.

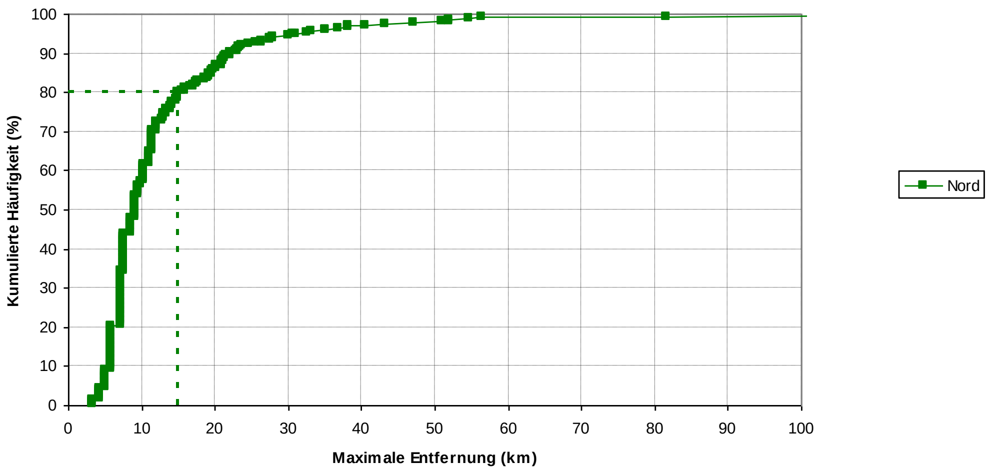
Fig. 7.2.2 b illustrates the cumulative frequency of these results. In this graphic the cumulative frequency represents the proportion of calculated weather conditions in which all areas where the relevant emergency reference value is exceeded are within the indicated distance.

Fig. 7.2.2 c shows the same results, compared for all three sites. It can be seen that the maximum distances for the intervention Evacuation tend to be longer for the "Southern" site (i.e. Philippsburg NPP) than for the other sites ("Northern" = Unterweser NPP, "Central" = Grohnde NPP).

a)



b)



c)

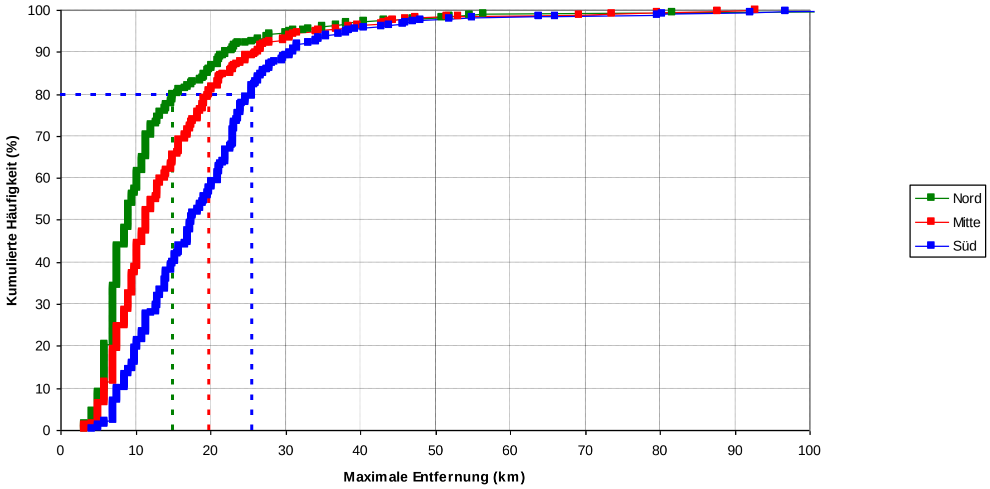


Fig. 7.2.2 a, b, c: Representation of the maximum distance within which the emergency reference level for the intervention Evacuation would have been exceeded in the case of a release with the source term FKA at the Unterweser site (a, b) and at all three sites (c).

8. RESULTS OF THE RODOS CALCULATIONS

The results of the RODOS calculations were assessed with respect to the dose criteria and the resulting protective measures for the population. The assessment focused in particular on the maximum dimensions and the total size of the affected areas, the number of affected people and the number of affected sectors (i.e. the affected angular range around the NPP).

In order to represent the results from the large number of simulations more clearly, the results of all individual calculations were summarized and statistically analysed. The data are represented via the cumulative frequency, e.g. as a function of the distance. The cumulative frequency represents the proportion of calculated weather conditions in which all areas where the relevant emergency reference value is exceeded are within the indicated distance. It can be seen from Fig. 8.1.1 a, for example, that the intervention Sheltering would have to be recommended for a distance of up to 62 km at the "Northern" site in 50% of the cases considered, while it would have to be recommended for a distance of more than 62 km in the other 50% of cases.

The statistical measure "percentile" will be used for the further assessment. "Percentile" is a measure used in statistical analyses of results, referring to the total amount (100% of simulations) of calculations performed in RODOS. The "percentile" is a value on a scale reaching from zero to one hundred, indicating the percentage of simulation calculations for which a result is equal to or lower than a previously defined value. The percentile is frequently used to estimate the extreme values in a distribution. In the context of the RODOS calculations, the 80th percentile can be used, for example, to determine the maximum distance for an intervention. Thus the 80th percentile of a distance (e.g. x km) means that an intervention will be required up to this distance of x km in 80% of the cases. In the remaining 20% of cases the intervention will be required in excess of this distance of x km.

8.1. Maximum dimensions of the affected areas

8.1.1. Intervention: Sheltering

Intervention: Sheltering, adults, source term FKA

Fig. 8.1.1 a: Cumulative frequency distribution of the maximum distance for the intervention Sheltering, adults, source term FKA

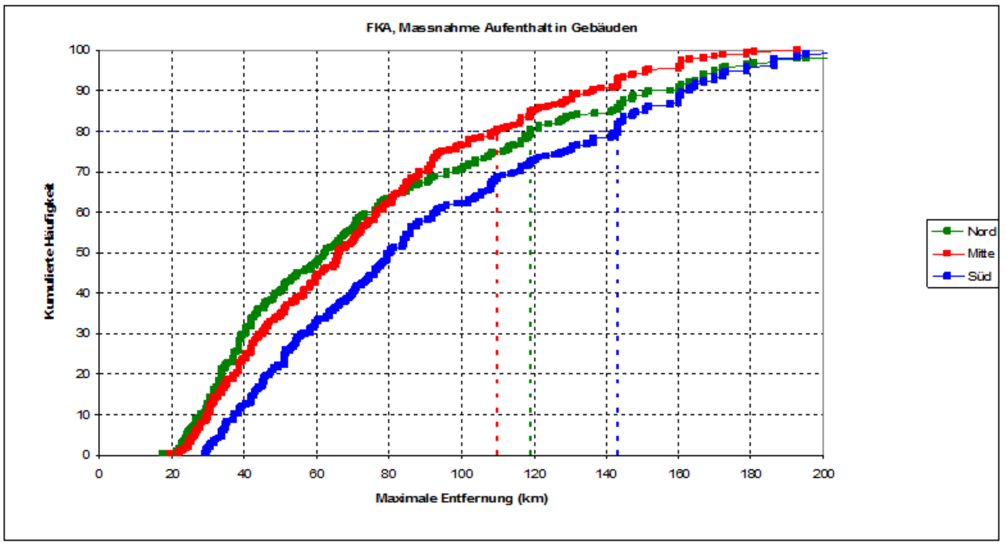


Table 8.1.1 a: Data on the cumulative frequency distribution of the maximum distance for the intervention Sheltering, adults, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Sheltering	Effective dose	Adults	10 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			62	119	152
Central site (Grohnde)			66	110	137
Southern site (Philippsburg)			80	143	163

The figure above shows the cumulative frequency of the intervention Sheltering for adults with an emergency reference level of 10 mSv and the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.
Here the areas were determined where the intervention Sheltering would be necessary because the emergency reference level of 10 mSv is exceeded. The outer limit of these areas is defined as the maximum distance. In 80% of the considered cases this outer limit is at a distance of between 20 km and 110 km.

Similarly the outer limit for the Northern site would be defined as a distance of between 18 km and 119 km, and the outer limit for the Southern site would be defined as a distance of between 30 km and 143 km. Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Intervention: Sheltering, infants, source term FKA

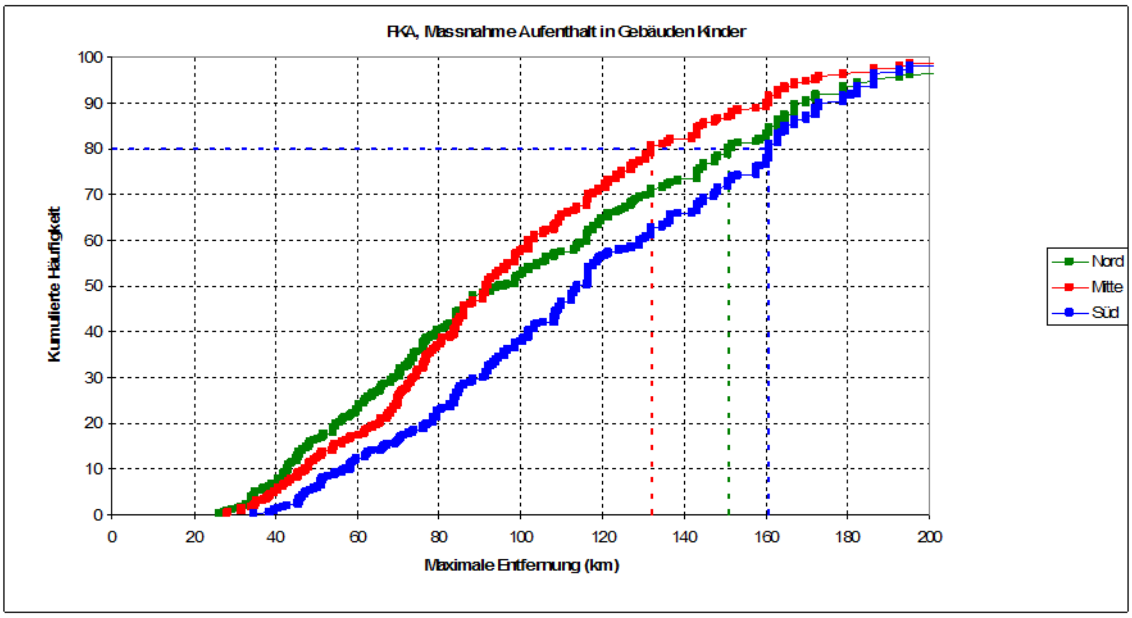


Fig. 8.1.1 b: Cumulative frequency distribution of the maximum distance for the intervention Sheltering, infants, source term FKA

Table 8.1.1 b: Data on the cumulative frequency distribution of the maximum distance for the intervention Sheltering, infants, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Sheltering	Effective dose	Infants	10 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			95	151	170
Central site (Grohnde)			91	132	161
Southern site (Philippsburg)			114	161	173

The figure above shows the cumulative frequency of the intervention Sheltering for infants with an emergency reference level of 10 mSv and the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside

Based on the relevant emergency reference level of 10 mSv the intervention Sheltering should be recommended within an area with an outer limit of between 28 km and 132 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site should be defined as a distance of between 26 km and 151 km, and the outer limit for the Southern site should be defined as a distance of between 35 km and 161 km.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Intervention: Sheltering, adults, source term FKF

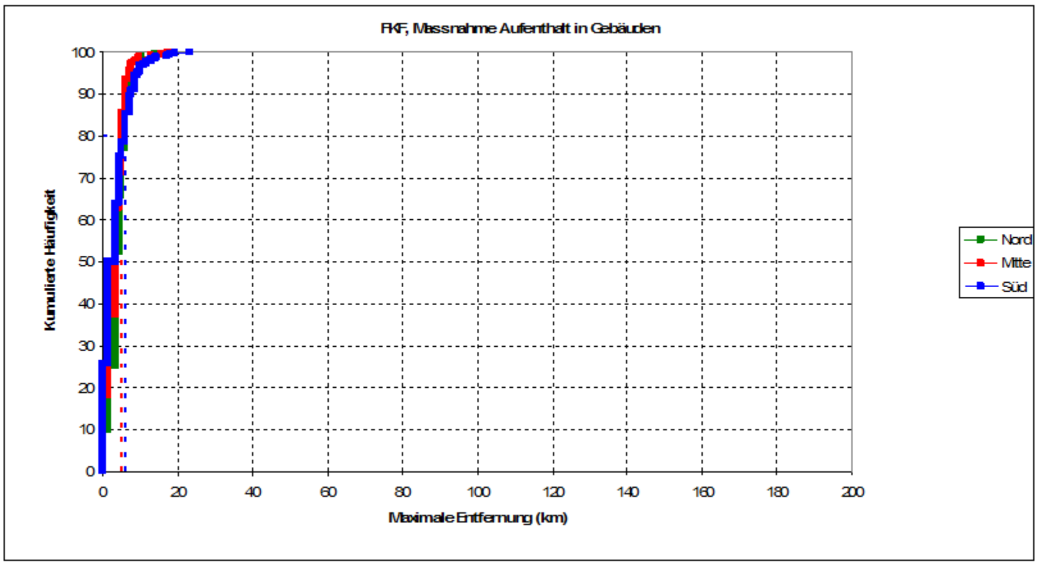


Fig. 8.1.1 c: Cumulative frequency distribution of the maximum distance for the intervention Sheltering, adults, source term FKF

Table 8.1.1 c: Data on the cumulative frequency distribution of the maximum distance for the intervention Sheltering, adults, source term FKF

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Sheltering	Effective dose	Adults	10 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			3	6	7
Central site (Grohnde)			3	5	6
Southern site (Philippsburg)			3	6	8

The figure above shows the cumulative frequency of the intervention Sheltering for adults with an emergency reference level of 10 mSv and the source term FKF. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 10 mSv the intervention Sheltering should be recommended within an area with an outer limit of between 0 km and 5 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of between 0 km and 6 km, and the outer limit for the Southern site would also be defined as a distance of between 0 km and 6 km.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Maximum distance for the intervention Sheltering, infants, source term FKF

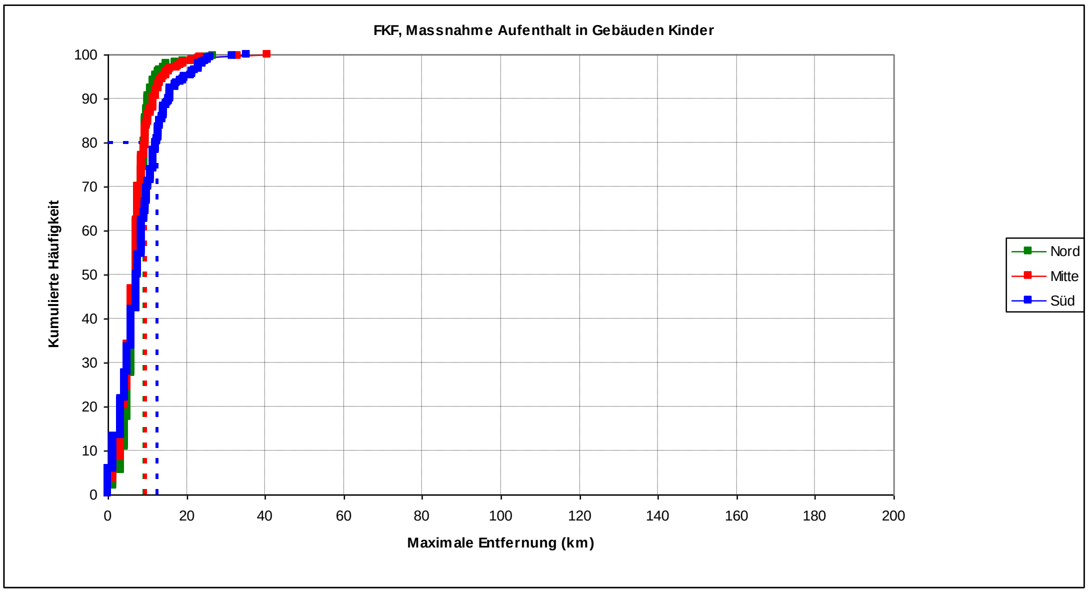


Fig. 8.1.1 d: Cumulative frequency of the maximum distance for the intervention Sheltering, infants, source term FKF

Table 8.1.1 d: Data on the cumulative frequency distribution of the maximum distance for the intervention Sheltering, infants, source term FKF

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Sheltering	Effective dose	Infants	10 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			7	9	10
Central site (Grohnde)			7	10	11
Southern site (Philippsburg)			8	13	16

The figure above shows the cumulative frequency of the intervention Sheltering for adults with an emergency reference level of 10 mSv and the source term FKF. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside

Based on the relevant emergency reference level of 10 mSv the intervention Sheltering should be recommended within an area with an outer limit of between 0 km and 10 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of between 0 km and 9 km, and the outer limit for the Southern site would be defined as a distance of between 0 km and 13 km.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

8.1.2. Intervention: Evacuation

<u>Intervention: Evacuation, adults, source term FKA</u>

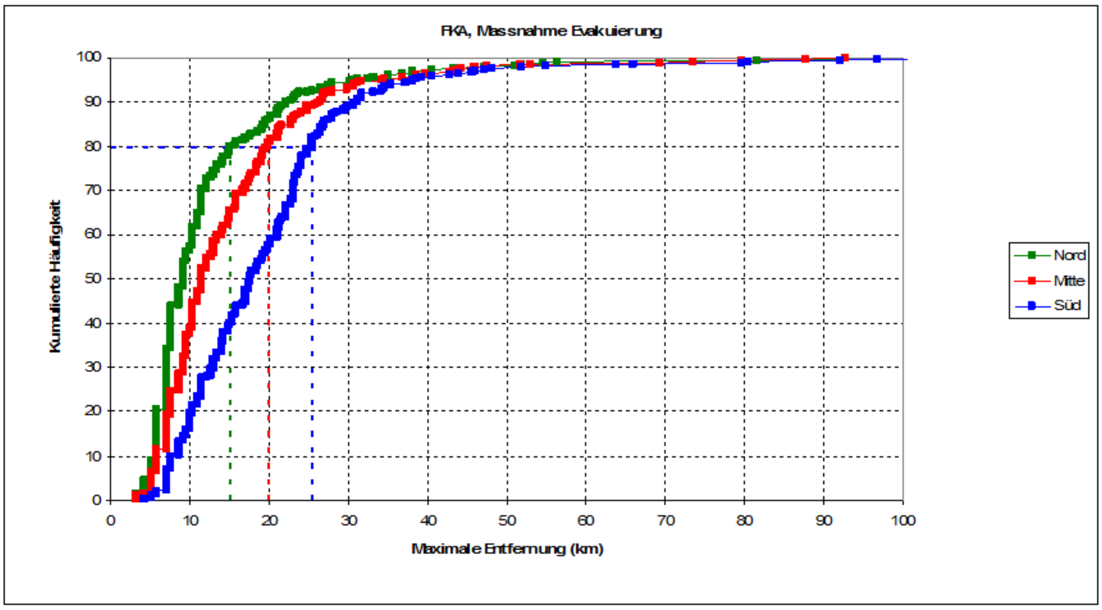


Fig. 8.1.2 a: Cumulative frequency distribution of the maximum distance for the intervention Evacuation, adults, source term FKA

Table 8.1.2 a: Data on the cumulative frequency distribution of the maximum distance for the intervention Evacuation, adults, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Evacuation	Effective dose	Adults	100 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			9	15	22
Central site (Grohnde)			11	20	26
Southern site (Philippsburg)			18	26	31

The figure above shows the cumulative frequency of the intervention Evacuation for adults with an emergency reference level of 100 mSv and the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 100 mSv the intervention Evacuation should be recommended within an area with an outer limit of between 3 km and 20 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of between 3 km and 15 km, and the outer limit for the Southern site would be defined as a distance of between 4 km and 26 km.
Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Intervention: Evacuation, infants, source term FKA

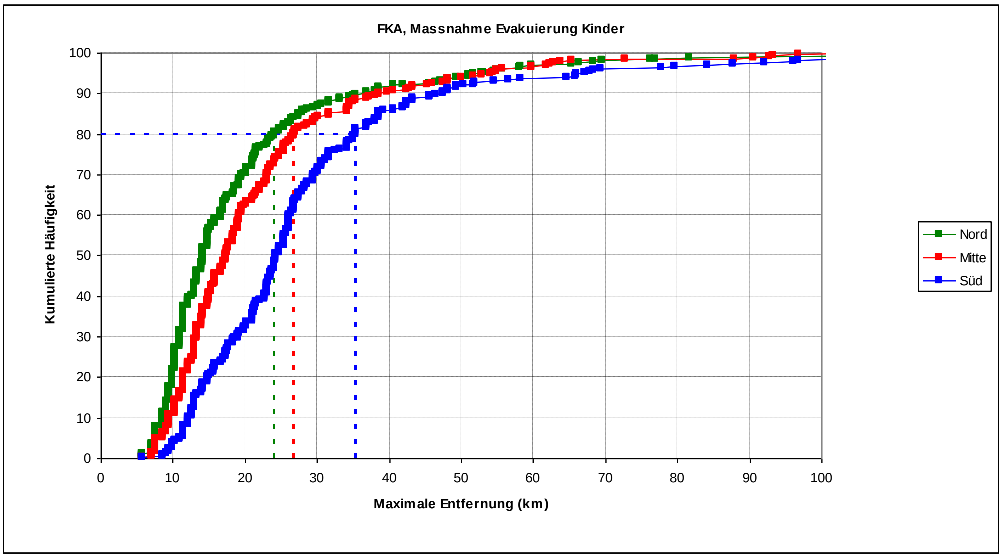


Fig. 8.1.2. b: Cumulative frequency distribution of the maximum distance for the intervention Evacuation, infants, source term FKA

Table 8.1.2. b: Data on the cumulative frequency distribution of the maximum distance for the intervention Evacuation, infants, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Evacuation	Effective dose	Infants	100 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			14	24	35
Central site (Grohnde)			17	27	39
Southern site (Philippsburg)			24	35	47

The figure above shows the cumulative frequency of the intervention Evacuation for infants with an emergency reference level of 100 mSv and the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 100 mSv the intervention Evacuation should be recommended within an area with an outer limit of between 6 km and 27 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of between 6 km and 24 km, and the outer limit for the Southern site would be defined as a distance of between 6 km and 35 km.
Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Intervention: Evacuation, adults, source term FKF

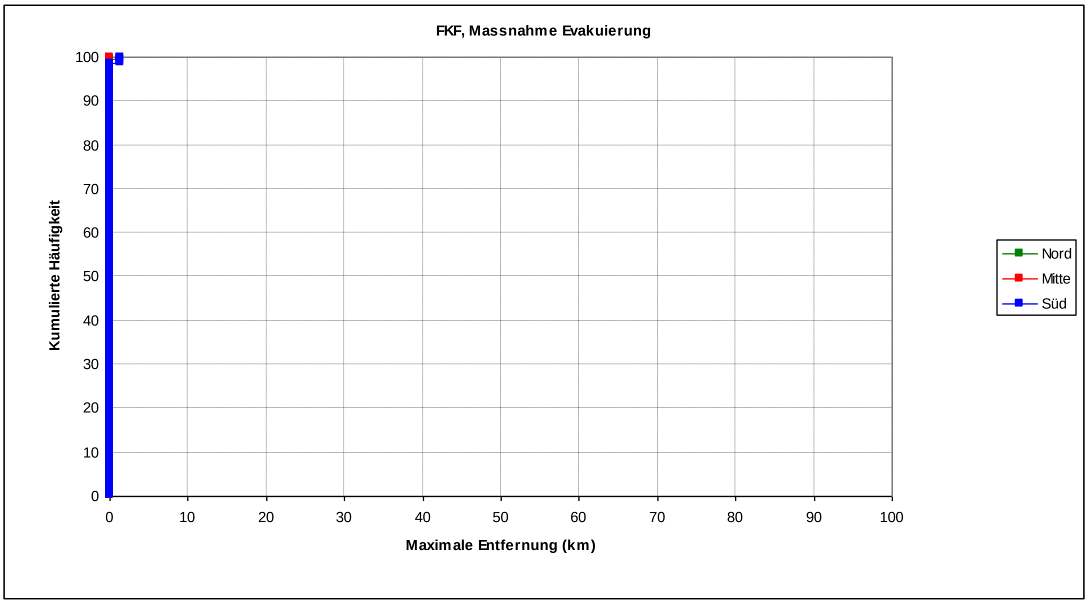


Fig. 8.1.2 c: Cumulative frequency distribution of the maximum distance for the intervention Evacuation, adults, source term FKF

Table 8.1.2 c: Data on the cumulative frequency distribution of the intervention Evacuation, adults, source term FKF

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Evacuation	Effective dose	Adults	100 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			0	0	0
Central site (Grohnde)			0	0	0
Southern site (Philippsburg)			0	0	0

The figure above shows the cumulative frequency of the intervention Evacuation for adults with an emergency reference level of 100 mSv and the source term FKF. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

The emergency reference level of 100 mSv is exceeded once at the Northern site, not at all at the Central site and 5 times at the Southern site; the distance for the outer limit is 1.4 km in each case. The 90th percentile is not reached.

Intervention: Evacuation, infants, source term FKF

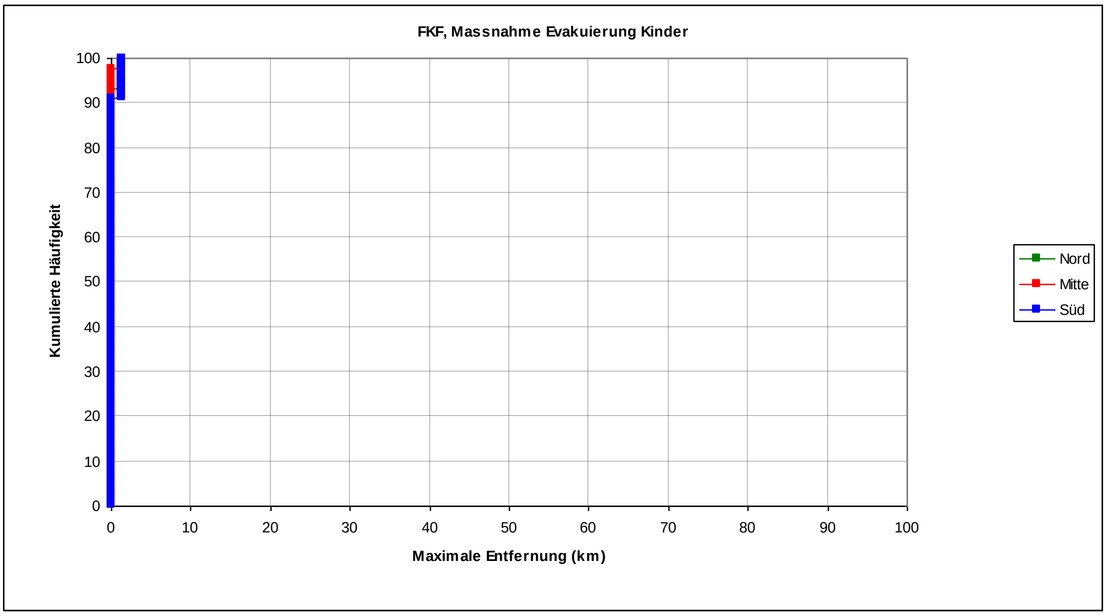


Fig. 8.1.2. d: Cumulative frequency distribution of the maximum distance for the intervention Evacuation, infants, source term FKF

Table 8.1.2 d: Data on the cumulative frequency distribution of the intervention Evacuation, infants, source term FKF

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Evacuation	Effective dose	Infants	100 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			0	0	0
Central site (Grohnde)			0	0	0
Southern site (Philippsburg)			0	0	0

The figure above shows the cumulative frequency of the intervention Evacuation for infants with an emergency reference level of 100 mSv and the source term FKF. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

In 365 individual calculations, the emergency reference level of 100 mSv is exceeded 24 times at the Northern site, 9 times at the Central site and 33 times at the Southern site; the distance for the outer limit is 1.4 km in each case. The 90th percentile is not reached.

8.1.3. Intervention: Temporary relocation

Temporary relocation, adults, source term FKA

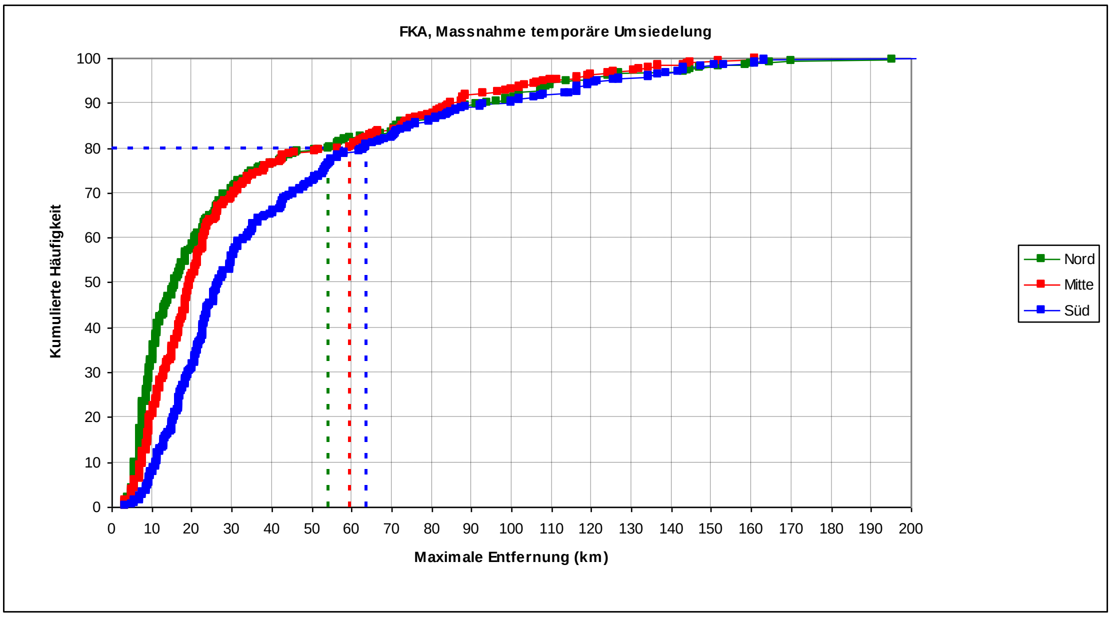


Fig. 8.1.3 a: Cumulative frequency distribution of the maximum distance for the intervention Temporary relocation, source term FKA

Table 8.1.3 a: Data on the cumulative frequency distribution of the intervention Temporary relocation, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Temporary relocation	Effective dose	Adults	30 mSv	Exterior exposure within 1 month	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			16	54	91
Central site (Grohnde)			20	60	85
Southern site (Philippsburg)			27	64	100

The figure above shows the cumulative frequency of the intervention Temporary relocation for adults with an emergency reference level of 30 mSv and the source term FKA. The integration times and exposure paths are external exposure due to radionuclides deposited on the ground within 1 month.

Based on the previous emergency reference level of 30 mSv the intervention Temporary relocation should be recommended within an area with an outer limit of between 3 km and 60 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of between 3 km and 54 km, and the outer limit for the Southern site would be defined as a distance of between 3 km and 64 km.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Temporary relocation, infants, source term FKA

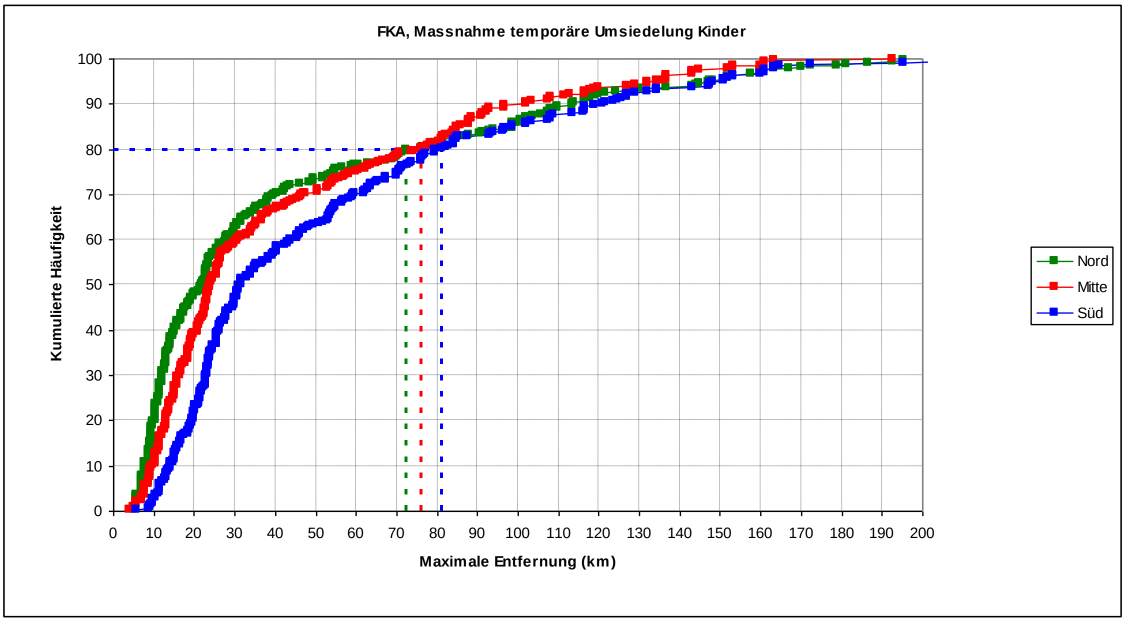


Fig. 8.1.3 b: Cumulative frequency distribution of the maximum distance for the intervention Temporary relocation, infants, source term FKA

Table 8.1.3 b: Data on the cumulative frequency distribution of the intervention Temporary relocation, infants, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Temporary relocation	Effective dose	Infants	30 mSv	Exterior exposure within 1 month	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			22	72	113
Central site (Grohnde)			24	76	102
Southern site (Philippsburg)			32	81	121

The figure above shows the cumulative frequency of the intervention Temporary relocation for infants with an emergency reference level of 30 mSv and the source term FKA. The integration times and exposure paths are external exposure due to radionuclides deposited on the ground within 1 month.

Based on the previous emergency reference level of 30 mSv the intervention Temporary relocation should be recommended within an area with an outer limit of between 5 km and 76 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of between 4 km and 72 km, and the outer limit for the Southern site would be defined as a distance of between 6 km and 81 km.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Temporary relocation, adults, source term FKF

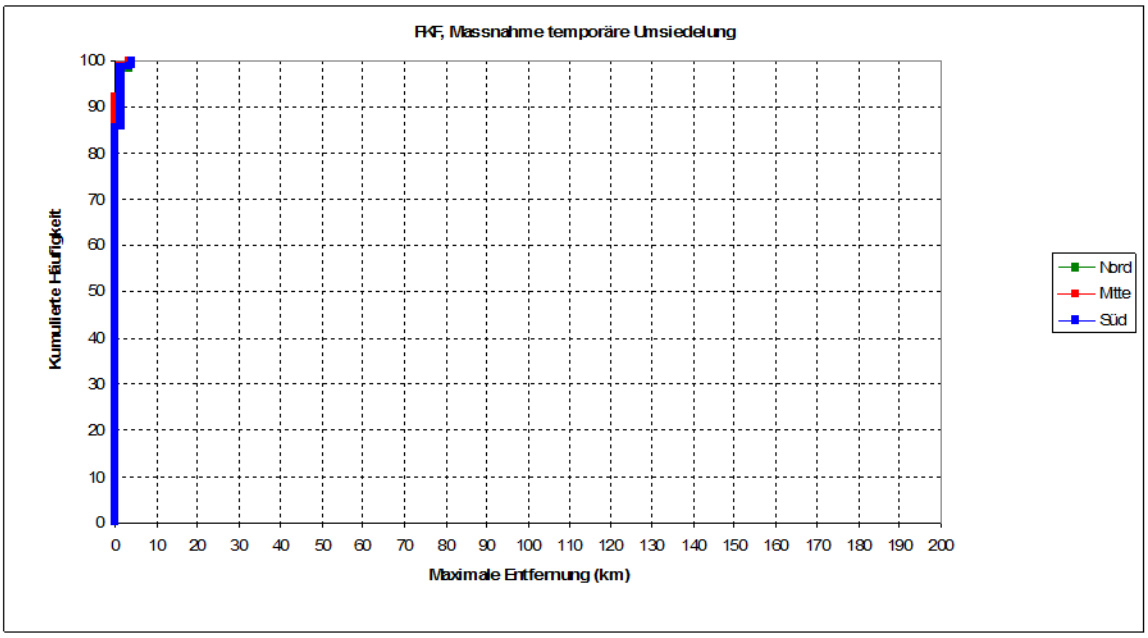


Fig. 8.1.3 c: Cumulative frequency distribution of the maximum distance for the intervention Temporary relocation, source term FKF

Table 8.1.3 c: Data on the cumulative frequency distribution of the intervention Temporary relocation, source term FKF

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Temporary relocation	Effective dose	Adults	30 mSv	Exterior exposure within 1 month	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			0	0	1.4
Central site (Grohnde)			0	0	0
Southern site (Philippsburg)			0	0	1.4

The figure above shows the cumulative frequency of the intervention Temporary relocation for adults with an emergency reference level of 30 mSv and the source term FKF. The integration times and exposure paths are external exposure due to radionuclides deposited on the ground within 1 month.

In 365 individual calculations, the emergency reference level of 30 mSv is exceeded 41 times at the Northern site, 28 times at the Central site and 53 times at the Southern site; the distance for the outer limit is 4.2 km at maximum and 1.4 km in most cases. The 80th percentile is not reached.

Temporary relocation, infants, source term FKF

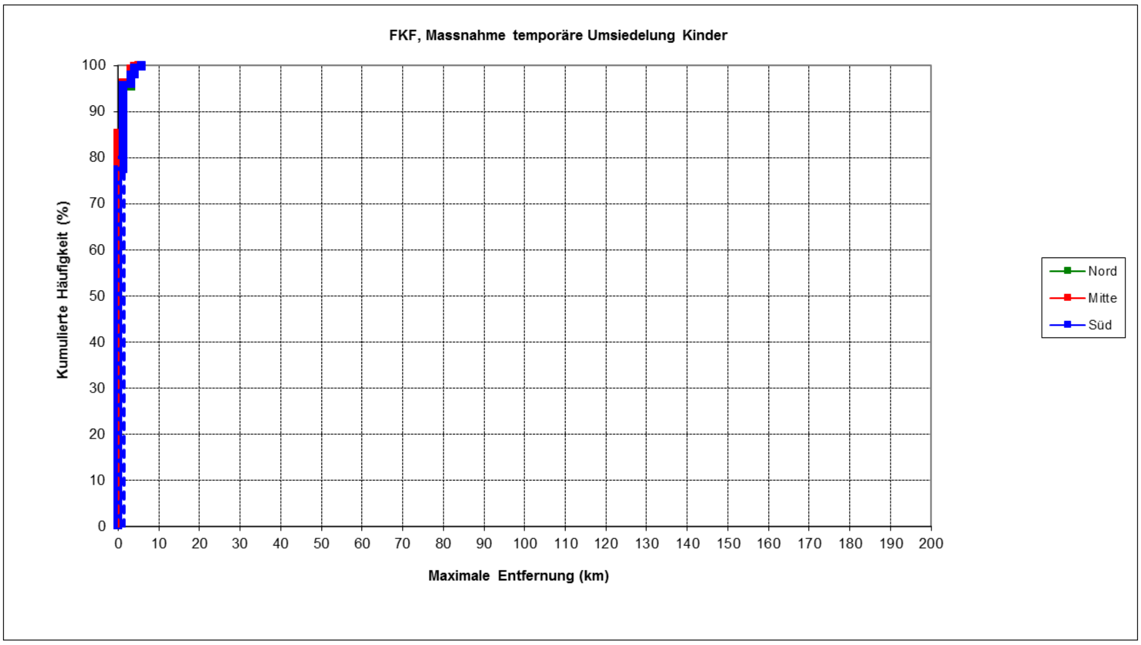


Fig. 8.1.3 d: Cumulative frequency distribution of the maximum distance for the intervention Temporary relocation, infants, source term FKF

Table 8.1.3 d: Data on the cumulative frequency distribution of the intervention Temporary relocation, infants, source term FKF

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Temporary relocation	Effective dose	Infants	30 mSv	Exterior exposure within 1 month	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			0	0	1.4
Central site (Grohnde)			0	0	1.4
Southern site (Philippsburg)			0	1.4	1.4

The figure above shows the cumulative frequency of the intervention Temporary relocation for infants with an emergency reference level of 30 mSv and the source term FKF. The integration times and exposure paths are external exposure due to radionuclides deposited on the ground within 1 month.

In 365 individual calculations, the emergency reference level of 30 mSv is exceeded 68 times at the Northern site, 53 times at the Central site and 82 times at the Southern site; the distance for the outer limit is 5.1 km at maximum at the Northern and Central sites and 5.8 km at maximum at the Southern site. The 50th percentile is not reached in any case.

8.1.4. Intervention: Permanent relocation

Intervention: Permanent relocation, adults, source term FKA

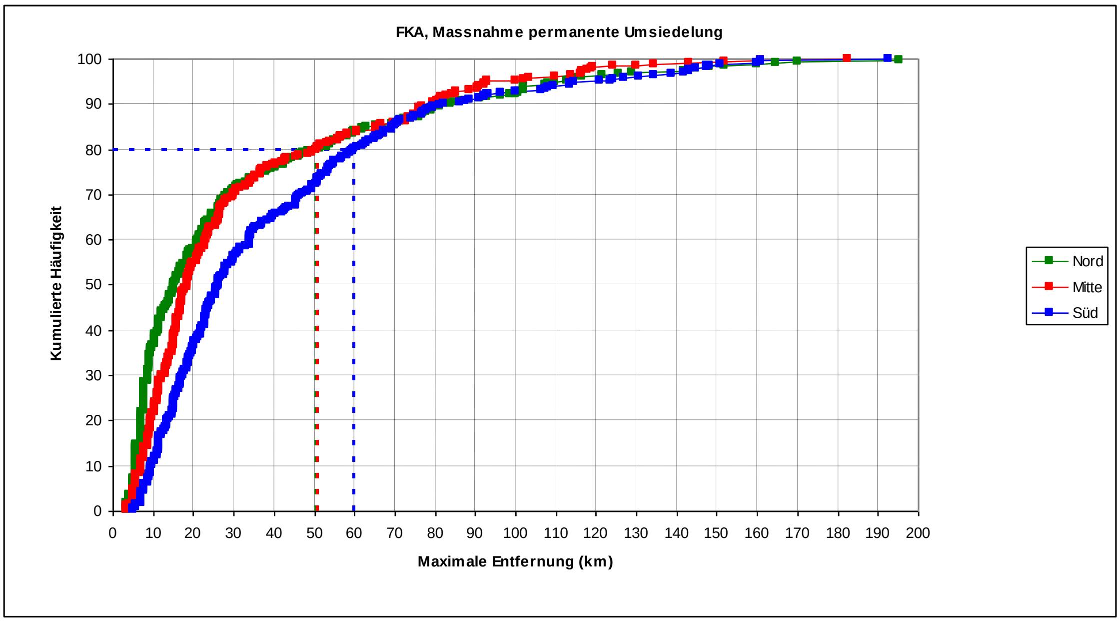


Fig. 8.1.4 a: Cumulative frequency distribution of the maximum distance for the intervention Permanent relocation, adults, source term FKA

Table 8.1.4 a: Data on the cumulative frequency distribution of the intervention Permanent relocation, adults, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Permanent relocation	Effective dose	Adults	100 mSv	Exterior exposure within 1 year due to deposited radionuclides	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			15	50	81
Central site (Grohnde)			18	51	80
Southern site (Philippsburg)			26	60	82

The figure above shows the cumulative frequency of the intervention Permanent relocation for adults with an emergency reference level of 100 mSv and the source term FKA. The integrations times and exposure paths are external exposure due to radionuclides deposited on the ground within 1 year.

Based on the relevant emergency reference level of 100 mSv the intervention Permanent relocation should be recommended within an area with an outer limit of between 3 km and 51 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of between 3 km and 50 km, and the outer limit for the Southern site would be defined as a distance of between 5 km and 60 km.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Intervention: Permanent relocation, infants, source term FKA

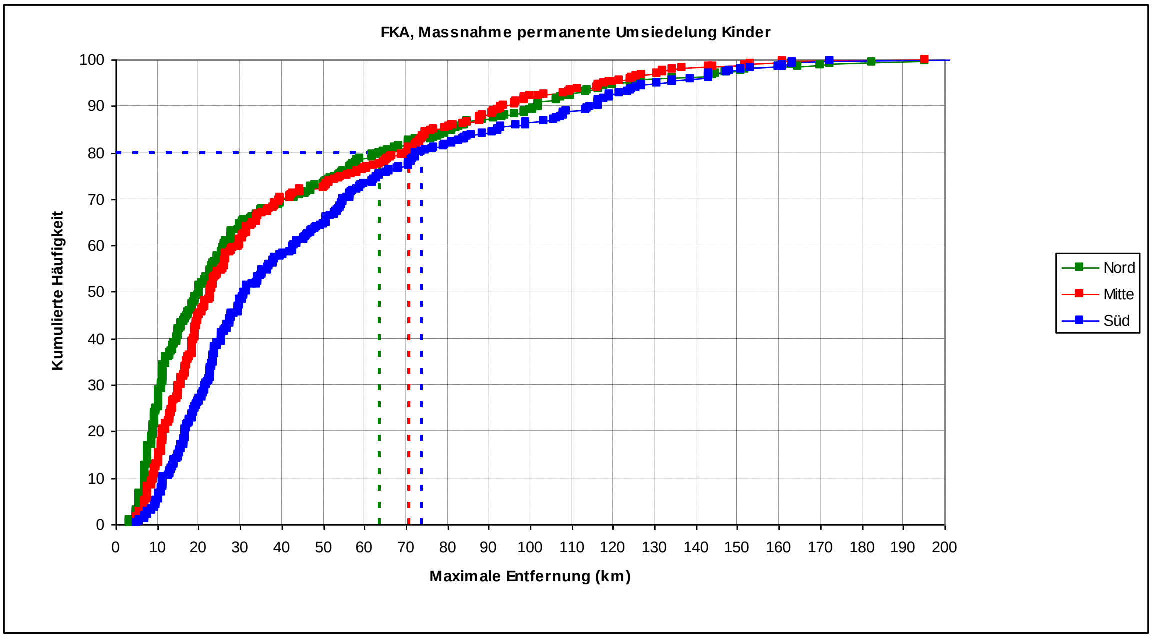


Fig. 8.1.4 b: Cumulative frequency distribution of the maximum distance for the intervention Permanent relocation, infants, source term FKA

Table 8.1.4 b: Data on the cumulative frequency distribution of the intervention Permanent relocation, infants, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Permanent relocation	Effective dose	Infants	100 mSv	Exterior exposure within 1 year due to deposited radionuclides	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			20	64	102
Central site (Grohnde)			23	71	94
Southern site (Philippsburg)			32	74	117

The figure above shows the cumulative frequency of the intervention Permanent relocation for infants with an emergency reference level of 100 mSv and the source term FKA. The integrations times and exposure paths are external exposure due to radionuclides deposited on the ground within 1 year.

Based on the relevant emergency reference level of 100 mSv the intervention Permanent relocation should be recommended within an area with an outer limit of between 5 km and 71 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of between 3 km and 64 km, and the outer limit for the Southern site would be defined as a distance of between 5 km and 74 km.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Intervention: Permanent relocation, adults, source term FKF

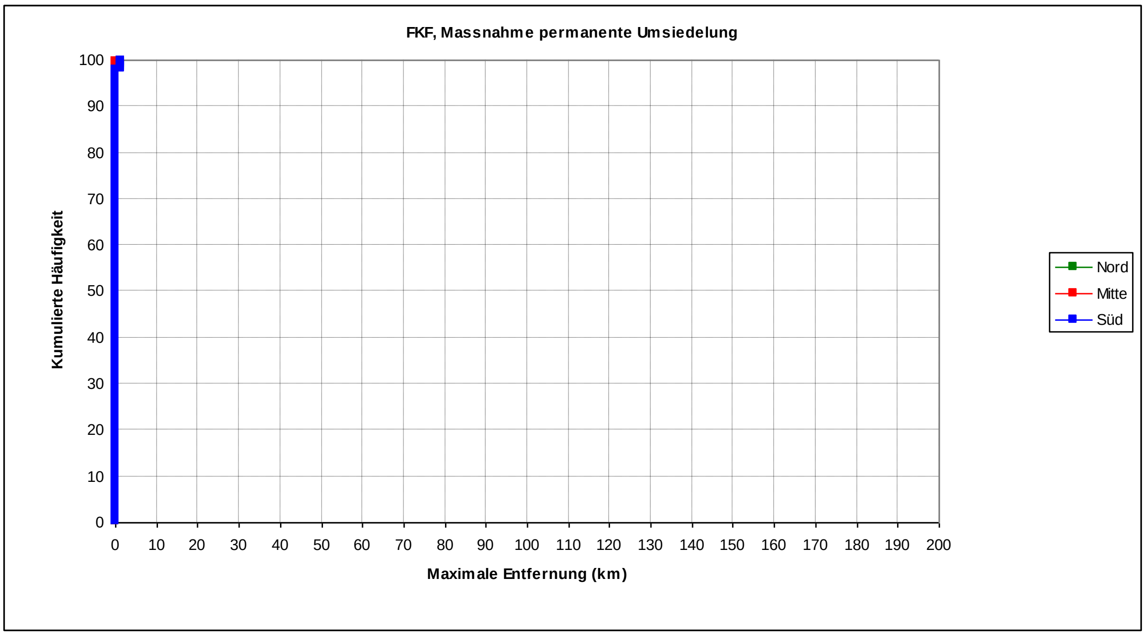


Fig. 8.1.4 c: Cumulative frequency distribution of the maximum distance for the intervention Permanent relocation, source term FKF

Table 8.1.4 c: Data on the cumulative frequency distribution of the intervention Permanent relocation, source term FKF

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Permanent relocation	Effective dose	Adults	100 mSv	Exterior exposure within 1 year due to deposited radionuclides	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			0	0	0
Central site (Grohnde)			0	0	0
Southern site (Philippsburg)			0	0	0

The figure above shows the cumulative frequency of the intervention Permanent relocation for adults with an emergency reference level of 100 mSv and the source term FKF. The integrations times and exposure paths are external exposure due to radionuclides deposited on the ground within 1 year.

In 365 individual calculations, the emergency reference level of 100 mSv is exceeded 3 times at the Northern site, not at all at the Central site and 8 times at the Southern site; the distance for the outer limit is 1.4 km in each case. The 80th percentile is not reached.

Intervention: Permanent relocation, infants, source term FKF

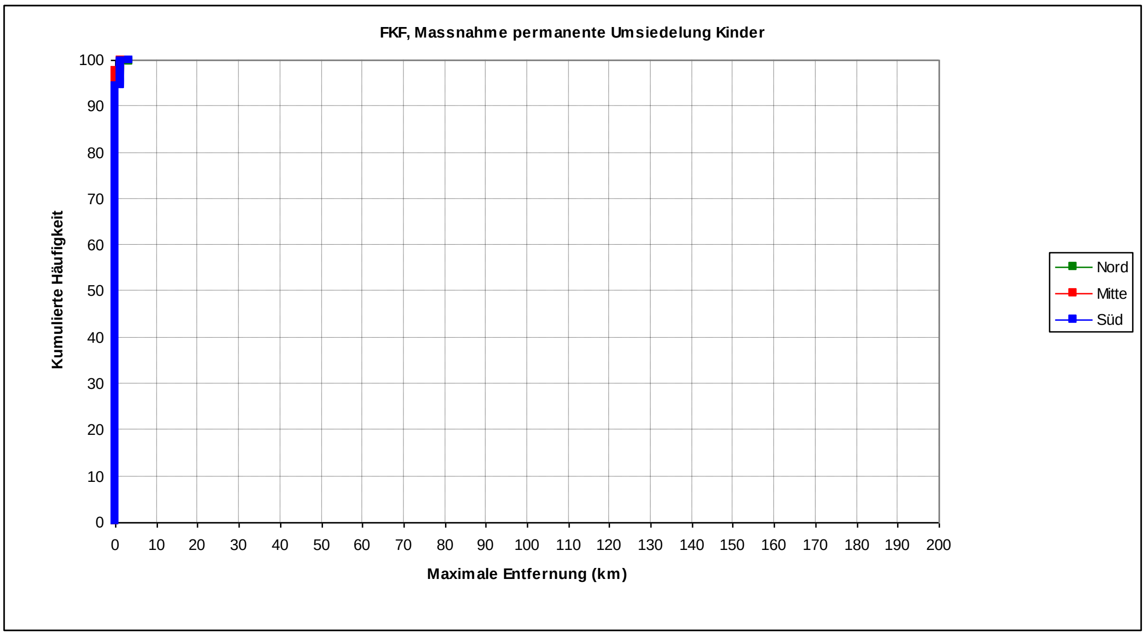


Fig. 8.1.4 d: Cumulative frequency distribution of the maximum distance for the intervention Permanent relocation, infants, source term FKF

Table 8.1.4 d: Data on the cumulative frequency distribution of the intervention Permanent relocation, infants, source term FKF

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Permanent relocation	Effective dose	Infants	100 mSv	Exterior exposure within 1 year due to deposited radionuclides	
			Maximum distance (km) at which the emergency reference level is exceeded.		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			0	0	0
Central site (Grohnde)			0	0	0
Southern site (Philippsburg)			0	0	0

The figure above shows the cumulative frequency of the intervention Permanent relocation for infants with an emergency reference level of 100 mSv and the source term FKF. The integrations times and exposure paths are external exposure due to radionuclides deposited on the ground within 1 year.

In 365 individual calculations, the emergency reference level of 100 mSv is exceeded 10 times at the Northern site, 9 times at the Central site and 21 times at the Southern site; the distance for the outer limit is 3.2 km at maximum and 1.4 km in most cases. The 80th percentile is not reached.

8.1.5. Intervention: Stable iodine prophylaxis

Intervention: Stable iodine prophylaxis, adults, source term FKA

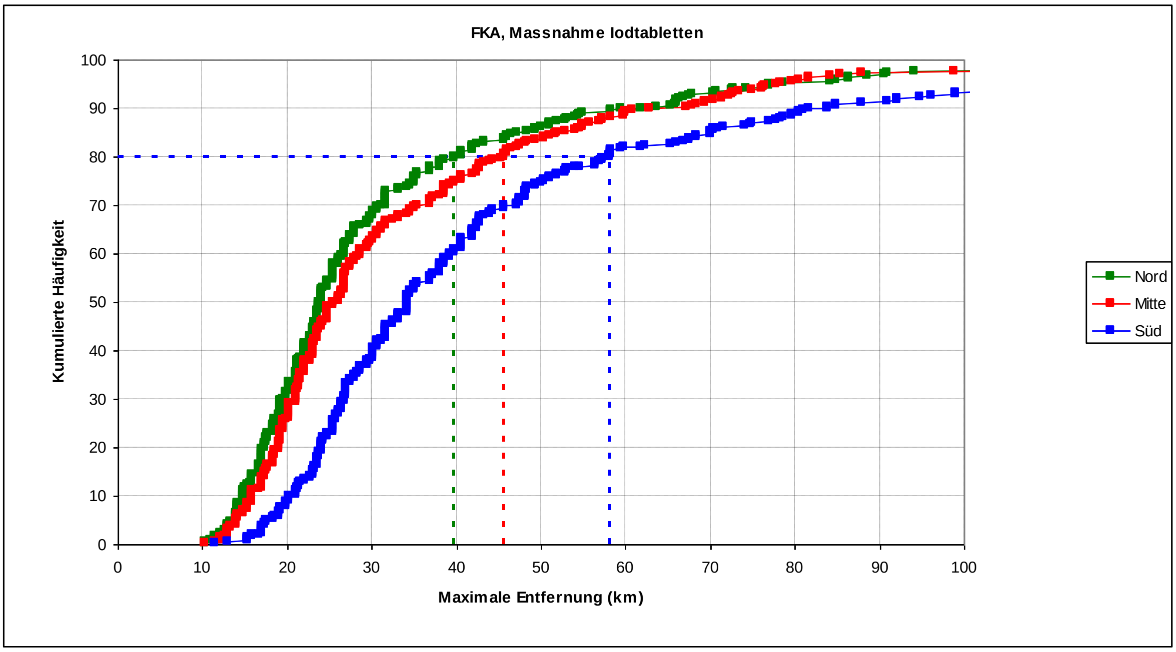


Fig. 8.1.5 a: Cumulative frequency distribution of the maximum distance for the intervention Stable iodine prophylaxis, source term FKA

Table 8.1.5 a: Data on the cumulative frequency distribution of the maximum distance for the intervention Stable iodine prophylaxis, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Stable iodine prophylaxis	Organ dose (thyroid)	Adults (aged 18 - 45)	250 mSv	Committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			24	40	59
Central site (Grohnde)			26	46	63
Southern site (Philippsburg)			34	58	84

The figure above shows the cumulative frequency of the intervention Stable iodine prophylaxis for adults with an emergency reference level of 250 mSv for individuals aged 18 to 45 and the source term FKA. The integration times and exposure paths are the committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 250 mSv the intervention Stable iodine prophylaxis should be recommended within an area with an outer limit of up to 46 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of up to 40 km, and the outer limit for the Southern site would be defined as a distance of up to 58 km.
Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Intervention: Stable iodine prophylaxis, children, teenagers and pregnant women, source term FKA

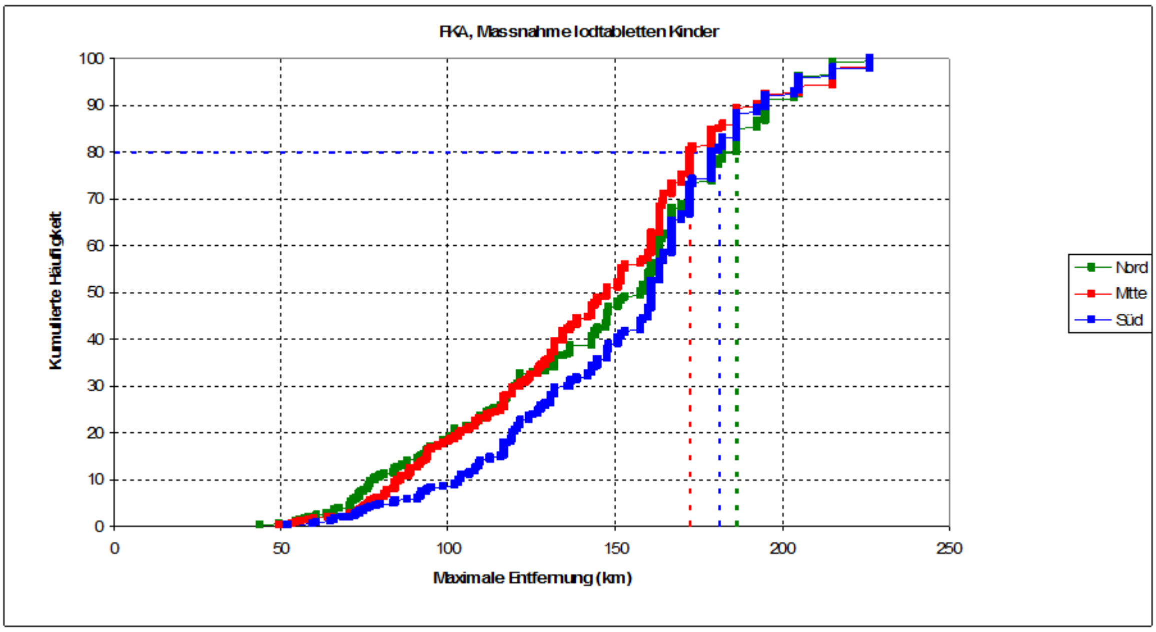


Fig. 8.1.5 b: Cumulative frequency distribution of the maximum distance for the intervention Stable iodine prophylaxis, source term FKA

Table 8.1.5 b: Data on the cumulative frequency distribution of the maximum distance for the intervention Stable iodine prophylaxis, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Stable iodine prophylaxis	Organ dose (thyroid)	Children and teenagers under the age of 18 and pregnant women	50 mSv	Committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			158	187	195
Central site (Grohnde)			148	172	195
Southern site (Philippsburg)			161	181	195

The figure above shows the cumulative frequency of the intervention Stable iodine prophylaxis for children and teenagers under the age of 18 and pregnant women with an emergency reference level of 50 mSv and the source term FKA. The integration times and exposure paths are the committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 50 mSv the intervention Stable iodine prophylaxis should be recommended within an area with an outer limit of up to 172 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of up to 187 km, and the outer limit for the Southern site would be defined as a distance of up to 181 km.

Distances of more than 160-225 km (depending on the direction of dispersion) were not investigated. A value of more than 160 km thus means that the relevant dose criterion can be exceeded at least up to the distances indicated and in some cases even beyond. More expansive dispersion calculations would be required to analyse more exactly up to which distances the relevant dose criterion can indeed be exceeded; such calculations are scheduled but have not been performed yet.

Intervention: Stable iodine prophylaxis, adults, source term FKF

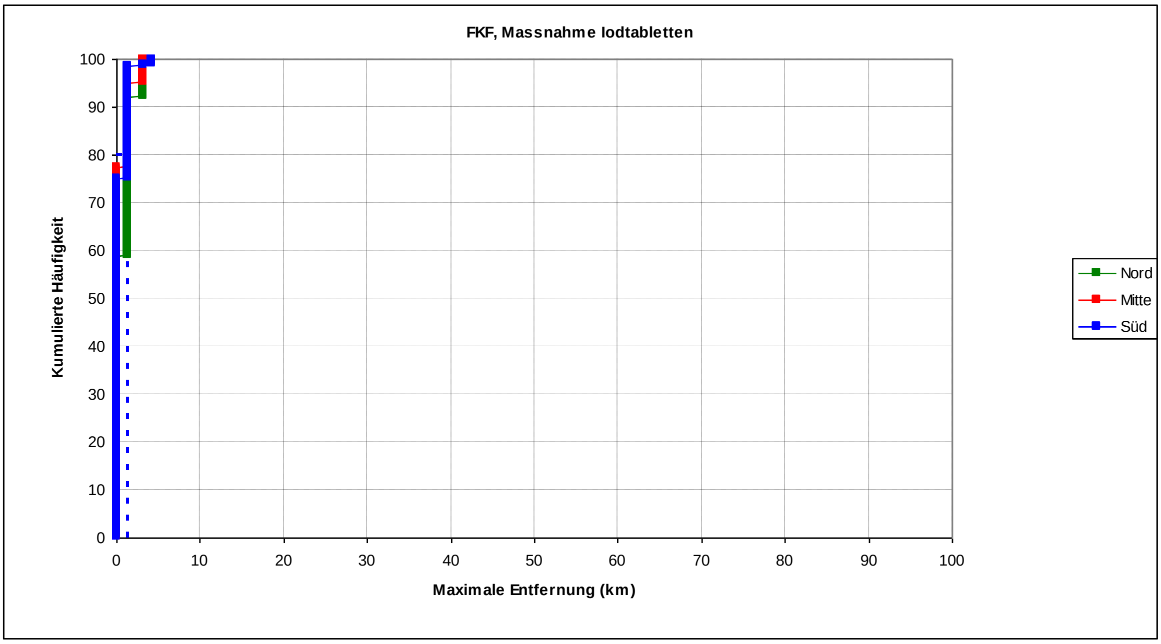


Fig. 8.1.5 c: Cumulative frequency distribution of the maximum distance for the intervention Stable iodine prophylaxis, source term FKF

Table 8.1.5 c: Data on the cumulative frequency distribution of the maximum distance for the intervention Stable iodine prophylaxis, source term FKF

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Stable iodine prophylaxis	Organ dose (thyroid)	Adults (aged 18 - 45)	250 mSv	Committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			0	1.4	1.4
Central site (Grohnde)			0	1.4	1.4
Southern site (Philippsburg)			0	1.4	1.4

The figure above shows the cumulative frequency of the intervention Stable iodine prophylaxis for adults with an emergency reference level of 250 mSv for individuals aged 18 to 45 and the source term FKF. The integration times and exposure paths are the committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 250 mSv the intervention Stable iodine prophylaxis should be recommended within an area with an outer limit of up to 1.4 km from the Central site in 80% of the considered cases. The same distance applies to the Northern and the Southern site.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

Stable iodine prophylaxis, children, teenagers and pregnant women, source term FKF

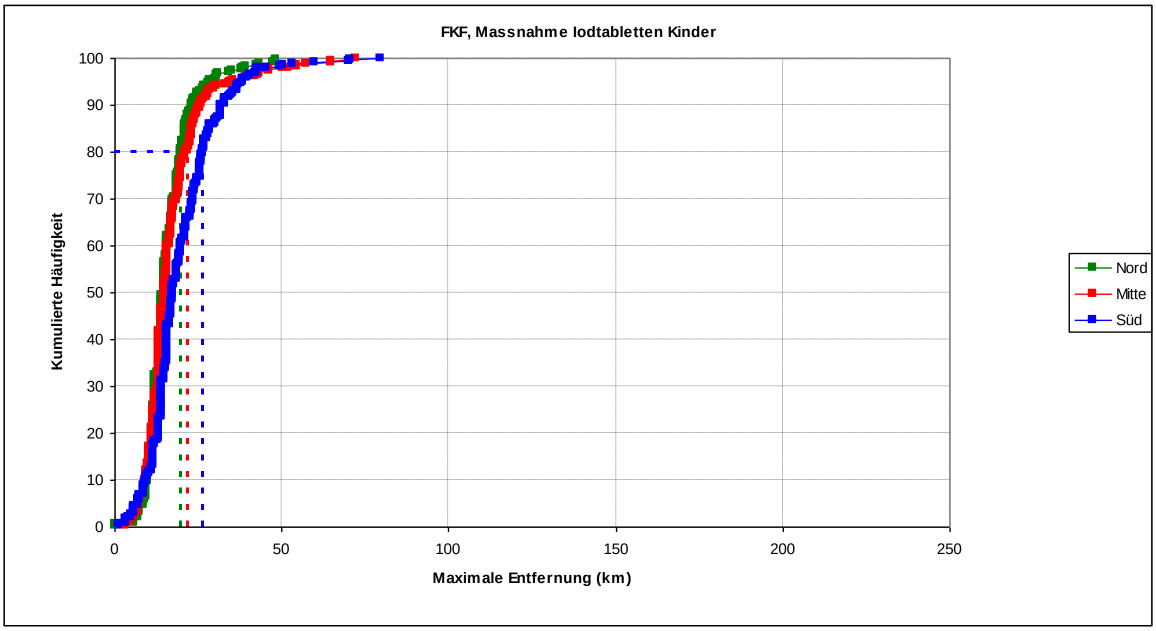


Fig. 8.1.5 d: Cumulative frequency distribution of the maximum distance for the intervention Stable iodine prophylaxis, source term FKF

Table 8.1.5 d: Data on the cumulative frequency distribution of the maximum distance for the intervention Stable iodine prophylaxis, source term FKF

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Stable iodine prophylaxis	Organ dose (thyroid)	Children and teenagers under the age of 18 and pregnant women	50 mSv	Committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside	
			Maximum distance (km) at which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			15	20	23
Central site (Grohnde)			15	22	26
Southern site (Philippsburg)			18	26	32

The figure above shows the cumulative frequency of the intervention Stable iodine prophylaxis for children and teenagers under the age of 18 and pregnant women with an emergency reference level of 50 mSv and the source term FKF. The integration times and exposure paths are the committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 50 mSv the intervention Stable iodine prophylaxis should be recommended within an area with an outer limit of up to 22 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of up to 20 km, and the outer limit for the Southern site would be defined as a distance of up to 26 km.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

8.1.6. Deterministic effects and high doses

This investigation generally takes account of two different source terms, FKA and FKF (see chapter 4). In particular in the case of a release based on the source term FKA serious deterministic effects and high stochastic effects in the proximity of the plant must be expected unless protective measures are initiated or implemented. It is thus important to assess the impact for the source term FKA also with respect to the threshold doses for deterministic effects. The Commission on Radiological Protection (SSK) recently published (SSK 2014a) threshold doses for the occurrence of serious deterministic effects amounting to

- 1,000 mGy for the dose to the red bone marrow in adults and infants,
- 100 mSv for the effective dose or uterus dose to the foetus (2nd – 7th week) and
- 300 mGy for the dose to the foetal brain (8th – 15th week)

In addition to these threshold doses the SSK introduced an effective dose of 1,000 mSv as a further dose criterion. This criterion helped to determine the area where measures need to be taken with top priority and where protective measures are particularly effective (prioritisation of protective measures).

Calculations were performed in order to obtain the areas where the above cited threshold levels and the additional dose criterion would be reached or exceeded. The results of these calculations are described and explained in the following paragraphs.

<u>Additional information on the dose units Gy and Sv:</u>

In the context of radiation protection it is important to determine the absorbed doses averaged over biological tissue or over an organ. The absorbed dose is the energy imparted to a volume element, divided by the mass of this volume element. The unit used for the absorbed dose is Gray (Gy, 1 Gy = 1 J/kg).

The biological effects do not only depend on the energy but also on the type of radiation. The biological effectiveness of alpha particles and neutrons differs from that of X-rays, beta radiation or gamma radiation. In order to obtain a measure for the stochastic radiation effects which is valid for all types of radiation, the energy dose is multiplied by a dimensionless weighting factor. This factor is defined for each type of radiation and characterises the biological effectiveness in relation to that of photons. The average absorbed dose to a tissue or organ, multiplied by the weighting factor, is called the organ dose. The unit used for the organ dose is Sievert (Sv, 1 Sv = 1 J/kg).

The biological effectiveness of ionising radiation also varies between the different tissues and organs in the human body. These differences are particularly important with respect to stochastic effects since the probability of radiation-induced cancer depends on the type of tissue or organ considered. In order to express the different sensitivity to the dose, dimensionless tissue weighting factors were introduced that are defined according to ICRP 103 (ICRP 2007). The sum of the organ doses weighted in this manner is called the effective dose; it is also stated in Sievert (Sv).

The organ dose and the effective dose should not be used in the context of deterministic effects since the conversion factors used for multiplication with the absorbed dose are considerably lower than those for stochastic effects.

High doses (effective dose > 1,000 Sv), adults, source term FKA

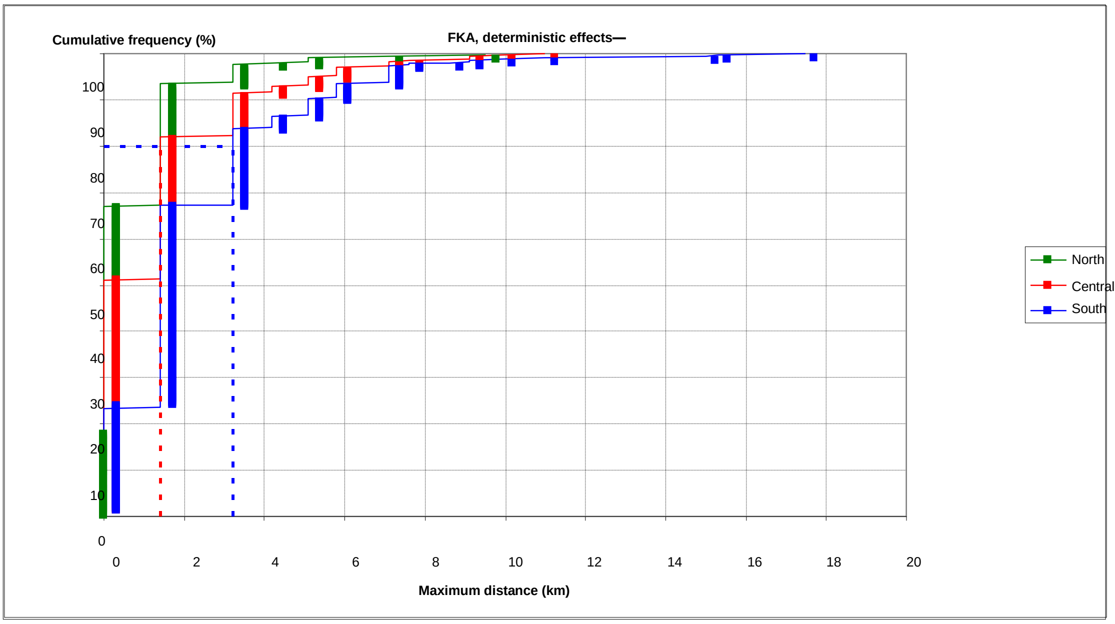


Fig. 8.1.6 a: Cumulative frequency distribution of the maximum range where the effective dose exceeds 1,000 mSv, adults, source term FKA

Table 8.1.6 a: Data on the cumulative frequency distribution of the maximum range where the effective dose exceeds 1,000 mSv, adults, source term FKA

	Dose criterion	Group of individuals	Criterion	Integration times and exposure paths	
	Effective dose	Adults	1,000 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the criterion is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			0	1.4	1.4
Central site (Grohnde)			0	1.4	3.2
Southern site (Philippsburg)			1.4	3.2	5.1

The figure above shows the cumulative frequency of the maximum distance at which the effective dose of 1,000 mSv is exceeded in adults for the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

The 1,000 mSv criterion is exceeded within an area whose outer limit is at a distance of up to 1.4 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of up to 1.4 km, and the outer limit for the Southern site would be defined as a distance of up to 3.2 km.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

High doses (effective dose > 1,000 Sv), infants, source term FKA

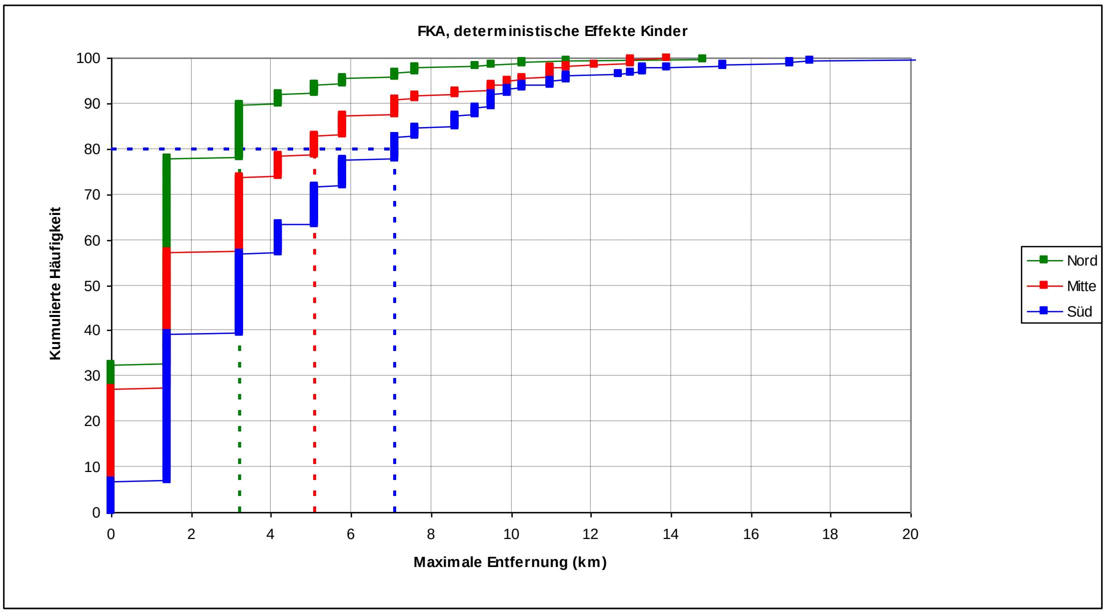


Fig. 8.1.6 b: Cumulative frequency distribution of the maximum range where the effective dose exceeds 1,000 mSv, infants, source term FKA

Table 8.1.6 b: Data on the cumulative frequency distribution of the maximum range where the effective dose exceeds 1,000 mSv, infants, source term FKA

	Dose criterion	Group of individuals	Criterion	Integration times and exposure paths	
	Effective dose	Infants	1,000 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the criterion is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			1.4	3.2	4.2
Central site (Grohnde)			1.4	5.1	7.1
Southern site (Philippsburg)			3.2	7.1	9.5

The figure above shows the cumulative frequency of the maximum distance at which the effective dose of 1,000 mSv is exceeded in infants for the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

The 1,000 mSv criterion is exceeded within an area whose outer limit is at a distance of up to 5.1 km from the Central site in 80% of the considered cases. Similarly the outer limit for the Northern site would be defined as a distance of up to 3.2 km, and the outer limit for the Southern site would be defined as a distance of 7.1 km.

Please refer to the table above in order to obtain the distances resulting for 50% or 90% of the cases.

High doses (effective dose > 1,000 Sv), adults, source term FKF

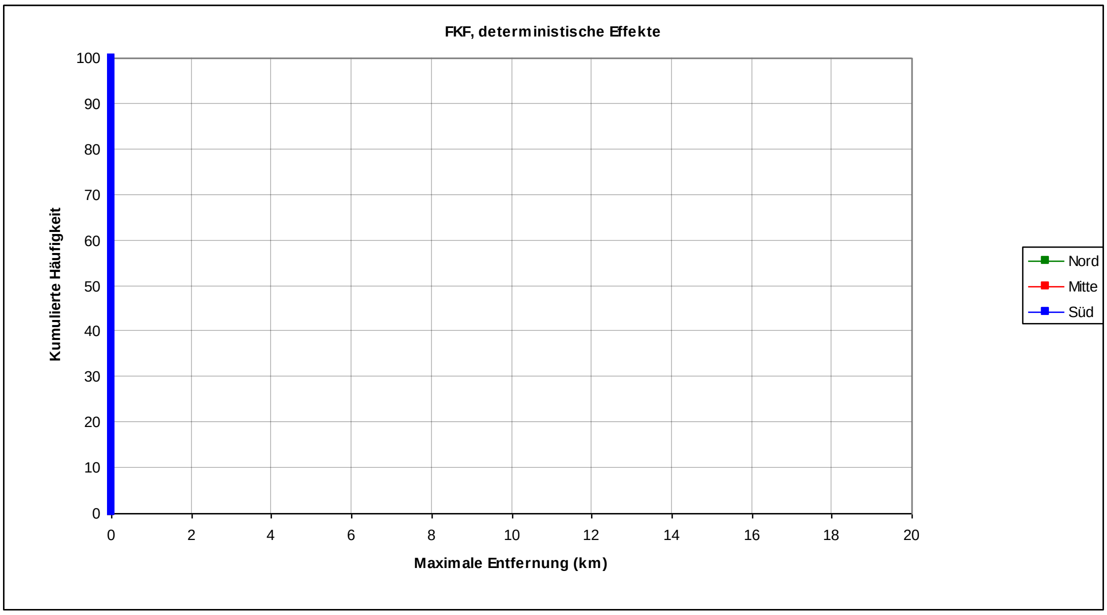


Fig. 8.1.6 c: Cumulative frequency distribution of the maximum range where the effective dose exceeds 1,000 mSv, adults, source term FKF

Table 8.1.6 c: Data on the cumulative frequency distribution of the maximum range where the effective dose exceeds 1,000 mSv, adults, source term FKF

	Dose criterion	Group of individuals	Criterion	Integration times and exposure paths	
	Effective dose	Adults	1,000 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the criterion is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			0	0	0
Central site (Grohnde)			0	0	0
Southern site (Philippsburg)			0	0	0

The figure above shows the cumulative frequency of the maximum distance at which the effective dose of 1,000 mSv is exceeded in adults for the source term FKF. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

The calculations show that the 1,000 mSv criterion is not reached in any of the cases (distances of less than 1.4 km from the plant were not investigated).

High doses (effective dose > 1,000 Sv), infants, source term FKF

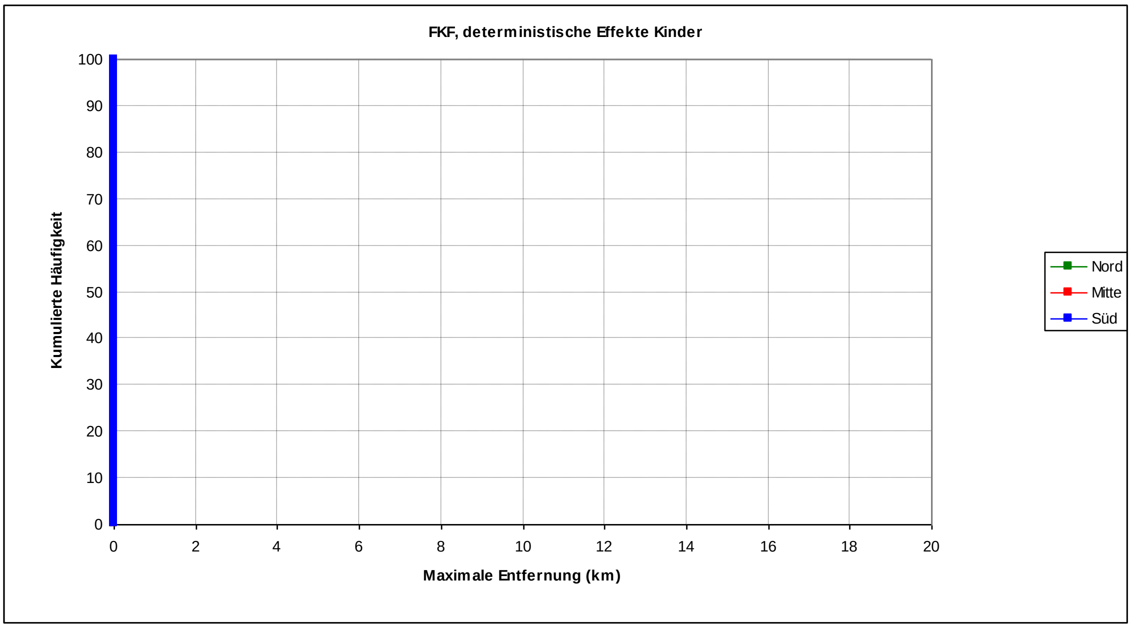


Fig. 8.1.6 d: Cumulative frequency distribution of the maximum range where the effective dose exceeds 1,000 mSv, infants, source term FKF

Table 8.1.6 d: Data on the cumulative frequency distribution of the maximum range where the effective dose exceeds 1,000 mSv, infants, source term FKF

	Dose criterion	Group of individuals	Criterion	Integration times and exposure paths	
	Effective dose	Infants	1,000 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Maximum distance (km) at which the criterion is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			0	0	0
Central site (Grohnde)			0	0	0
Southern site (Philippsburg)			0	0	0

The figure above shows the cumulative frequency of the maximum distance at which the effective dose of 1,000 mSv is exceeded in infants for the source term FKF. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

The calculations show that the 1,000 mSv criterion is not reached in any of the cases (distances of less than 1.4 km from the plant were not investigated).

8.1.7. Dose to the red bone marrow

<u>Dose to the red bone marrow, adults, Grohnde, source term FKA</u>

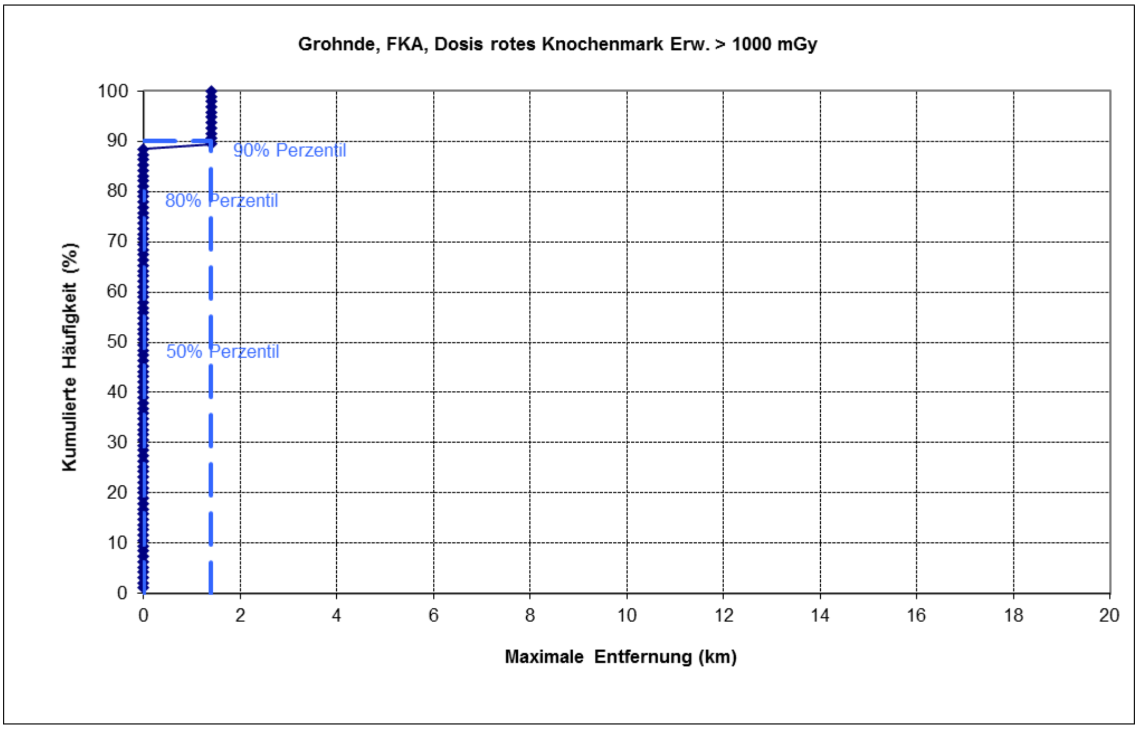


Fig. 8.1.7 a: Cumulative frequency distribution of the maximum distance at which the dose to the red bone marrow in adults exceeds 1,000 mGy, source term FKA.

Table 8.1.7 a: Data on the cumulative frequency distribution of the maximum distance at which the dose to the red bone marrow in adults exceeds 1,000 mGy, source term FKA.

	Dose criterion	Group of individuals	Threshold level	Integration times and exposure paths	
	Dose to red bone marrow	Adults	1,000 mGy	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
Adults			Maximum distance (km) at which the threshold level is exceeded		
			50th percentile	80th percentile	90th percentile
Central site (Grohnde)			0	0	1.4

The figure above shows the cumulative frequency of the maximum distance at which the dose to the red bone marrow in adults exceeds 1,000 mGy for the source term FKA. These calculations were only performed for the Grohnde site and for 95 cases within one year (i.e. roughly every 4th day). The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

The calculations show that the criterion of 1,000 mGy is only exceeded in 10% of the considered cases (actually in 11 cases); the distances are up to 1.4 km from the plant.

Dose to the red bone marrow, infants, Grohnde, source term FKA

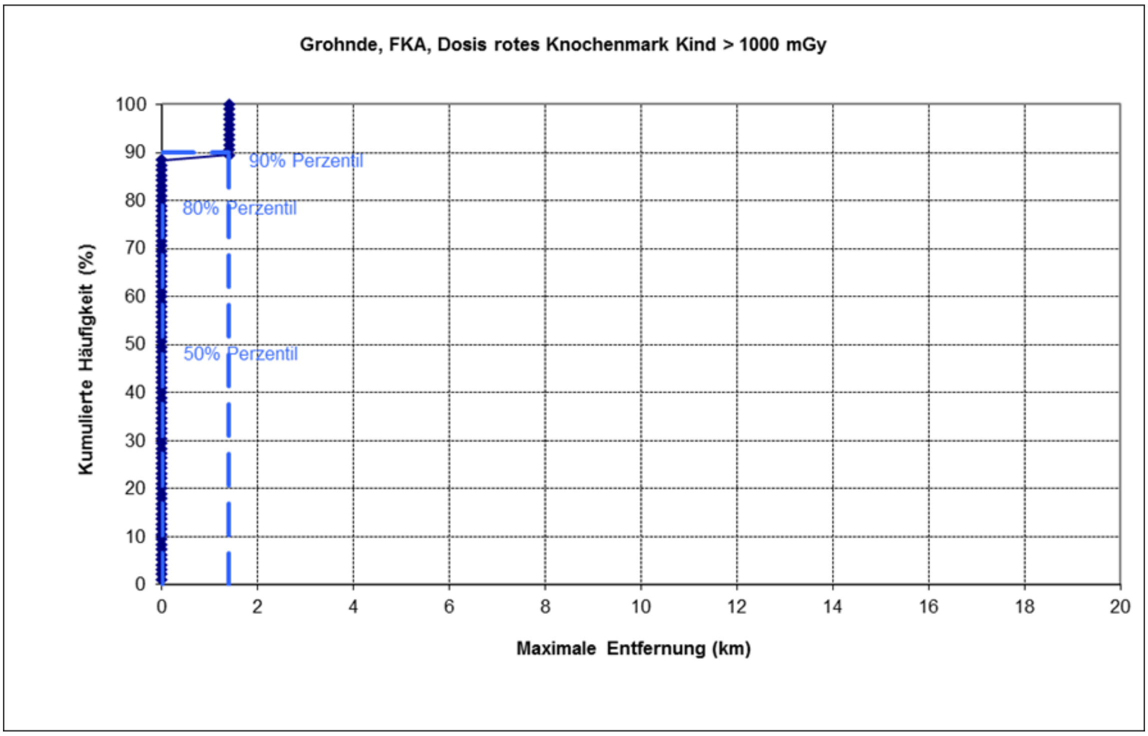


Fig. 8.1.7 b: Cumulative frequency distribution of the maximum range where the absorbed dose to the red bone marrow in infants exceeds 1,000 mGy, source term FKA.

Table 8.1.7 b: Data on the cumulative frequency distribution of the maximum distance at which the absorbed dose to the red bone marrow in infants exceeds 1,000 mGy, source term FKA.

	Dose criterion	Group of individuals	Threshold level	Integration times and exposure paths	
	Dose to red bone marrow	Infants	1,000 mGy	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
Infants			Maximum distance (km) at which the threshold level is exceeded		
			50th percentile	80th percentile	90th percentile
Central site (Grohnde)			0	0	1.4

The figure above shows the cumulative frequency of the maximum distance at which the dose to the red bone marrow in infants exceeds 1,000 mGy for the source term FKA. These calculations were only performed for the Grohnde site and for 95 cases within one year (i.e. roughly every 4th day). The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

The calculations show that the criterion of 1,000 mGy is only exceeded in 90 % of the considered cases (actually in 11 cases); the distances are up to 1.4 km from the plant.

8.1.8. Dose to the foetus

<u>Dose to the foetus, 2nd -7th week</u>

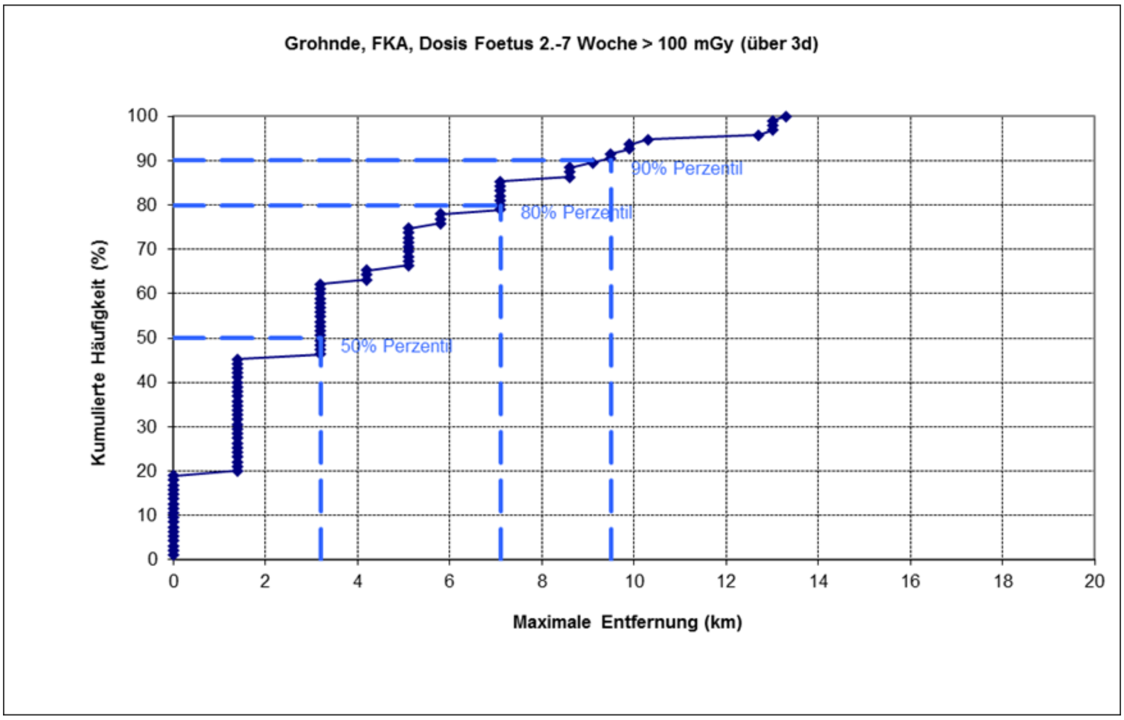


Fig. 8.1.8 a: Cumulative frequency distribution of the maximum distance at which the absorbed dose to the foetus (2nd - 7th week) exceeds 100 mGy, source term FKA.

Table 8.1.8 a: Data on the cumulative frequency distribution of the maximum distance at which the absorbed dose to the foetus (2nd - 7th week) exceeds 100 mGy, source term FKA

Effectiveness	Dose criterion	Group of individuals	Threshold level	Integration times and exposure paths	
Absorbed dose	Dose to the brain	Foetus (2nd to 7th week)	100 mGy	External exposure within 7 days and committed dose due to the radionuclides inhaled by the mother in this time if she were to remain permanently outside	
Foetus (2nd to 7th week)			Maximum distance (km) at which the threshold level is exceeded		
			50th percentile	80th percentile	90th percentile
Central site (Grohnde)			3.2	7.1	9.5

The figure above shows the cumulative frequency of the maximum distance at which the dose to the foetus (2nd to 7th week) exceeds 100 mGy for the source term FKA. These calculations were only performed for the Grohnde site and for 95 cases within one year (i.e. roughly every 4th day). The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled by the mother in this time if she were to remain permanently outside.

The calculations show that the 100 mGy criterion is exceeded at the 80th percentile up to a distance of 7.1 km from the plant. The 50th percentile is exceeded up to a distance of 3.2 km from the plant, and the 90th percentile up to a distance of 9.5 km from the plant.

Dose to the foetus, 8th - 15th week

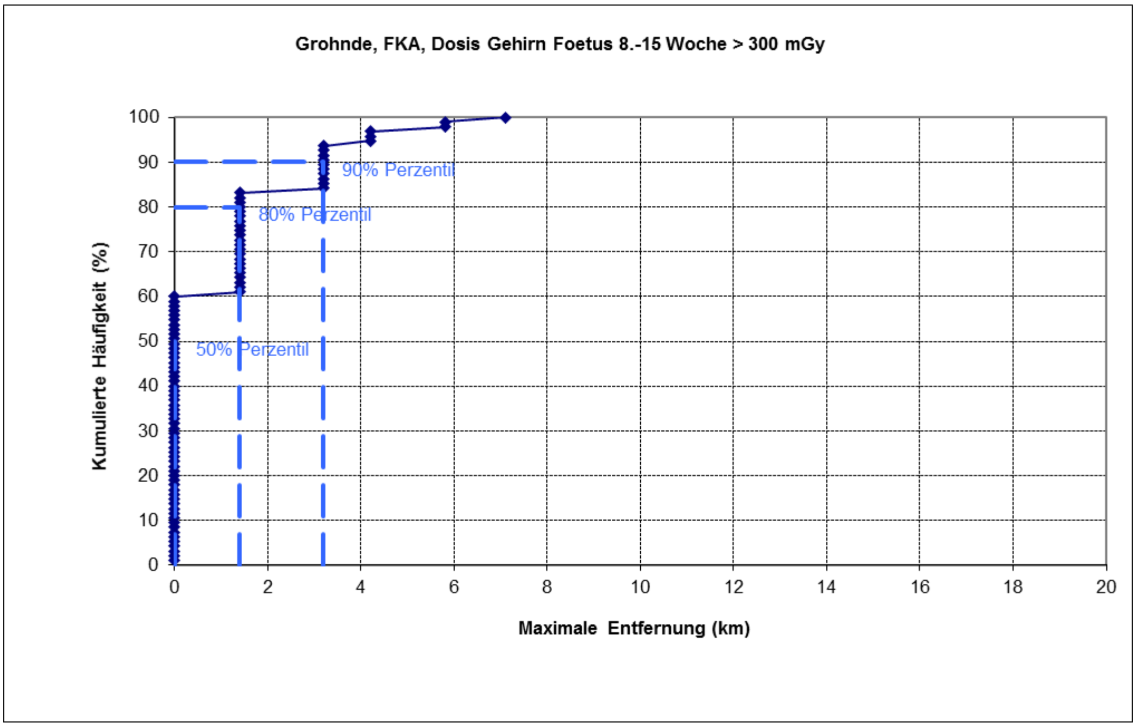


Fig. 8.1.8 b: Cumulative frequency distribution of the maximum distance at which the absorbed dose to the foetus (8th - 15th week) exceeds 300 mGy, source term FKA.

Table 8.1.8 b: Data on the cumulative frequency distribution of the maximum distance at which the absorbed dose to the foetus (8th - 15th week) exceeds 300 mGy, source term FKA

Effectiveness	Dose criterion	Group of individuals	Threshold level	Integration times and exposure paths	
Absorbed dose	Dose to the brain	Foetus (8th to 15th week)	300 mGy	External exposure within 7 days and committed dose due to the radionuclides inhaled by the mother in this time if she were to remain permanently outside	
Foetus (8th - 15th week)			Maximum distance (km) at which the threshold level is exceeded		
			50th percentile	80th percentile	90th percentile
Central site (Grohnde)			0	1.4	3.2

The figure above shows the cumulative frequency of the maximum distance at which the dose to the foetus (8th - 15th week) exceeds 300 mGy for the source term FKA. These calculations were only performed for the Grohnde site and for 95 cases within one year (i.e. roughly every 4th day). The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled by the mother in this time if she were to remain permanently outside.

The calculations show that the 300 mGy criterion is exceeded at the 80th percentile up to a distance of 1.4 km from the plant. The 50th percentile is not reached at all (distances of less than 1.4 km from the NPP were not investigated); the 90th percentile is exceeded at a distance of up to 3.2 km.

8.2. Size of the affected areas

Areas affected by the intervention Sheltering

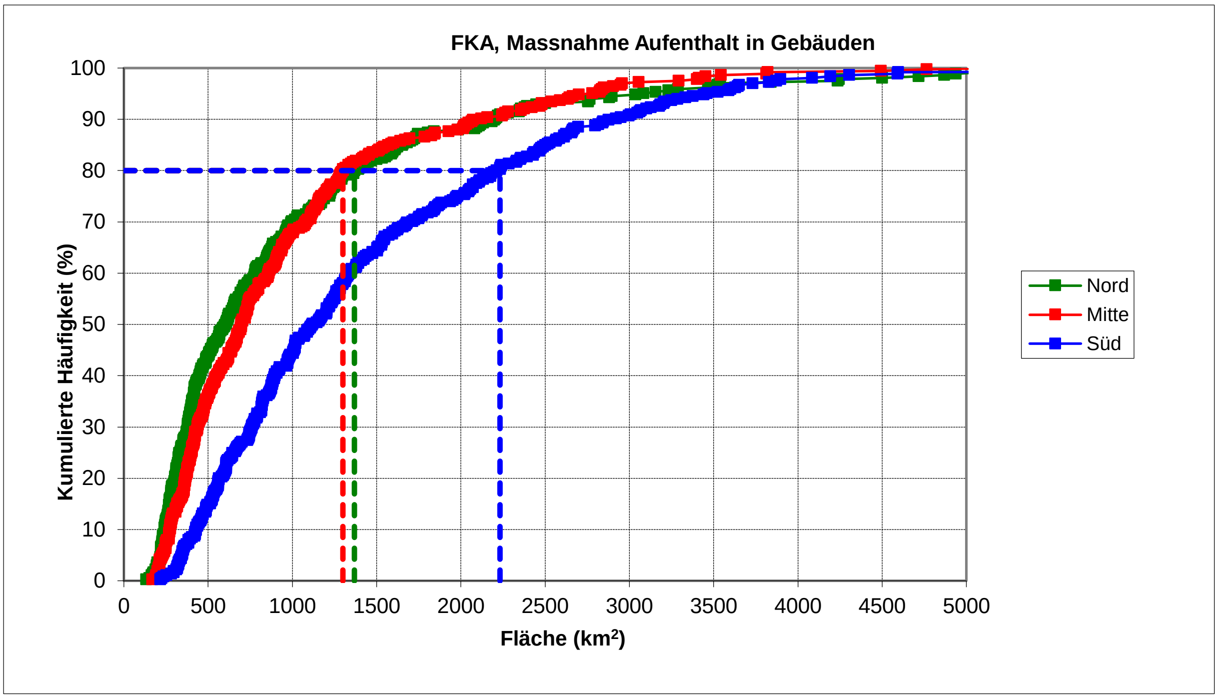


Fig. 8.2 a: Cumulative frequency distribution of the areas affected by the intervention Sheltering, adults, source term FKA

Table 8.2 a: Data on the cumulative frequency distribution of the areas affected by the intervention Sheltering, adults, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Sheltering	Effective dose	Adults	10 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Area (km^2) in which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			600	1368	2196
Central site (Grohnde)			696	1300	2120
Southern site (Philippsburg)			1120	2232	2920

The figure above shows the cumulative frequency of areas affected by the intervention Sheltering for adults with an emergency reference level of 10 mSv and the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 10 mSv an area of up to 1,300 km^2 is affected by the intervention Sheltering at the Central site in 80% of the considered cases. Similarly an area of up to 1,368 km^2 is affected at the Northern site and an area of up to 2,232 km^2 at the Southern site. Please refer to the table above in order to obtain the areas resulting for 50% or 90% of the cases.

Areas affected by the intervention Evacuation

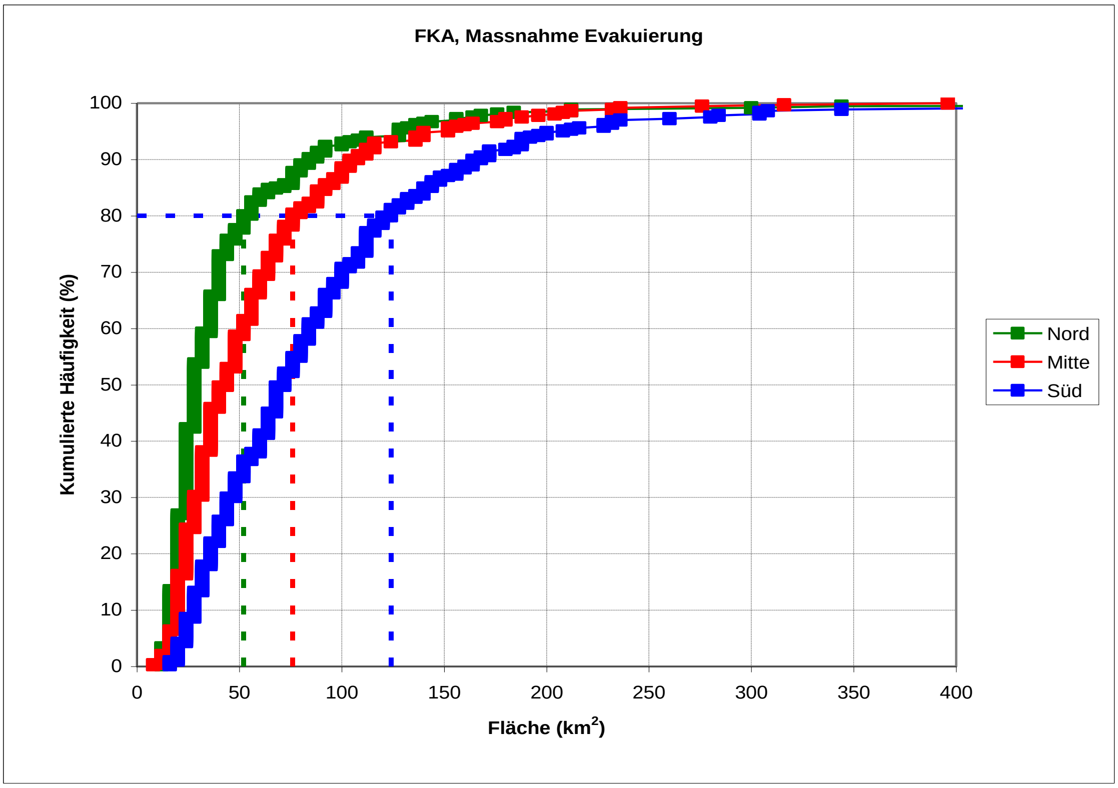


Fig. 8.2 b: Cumulative frequency distribution of the areas affected by the intervention Evacuation, adults, source term FKA

Table 8.2. b: Data on the cumulative frequency distribution of the areas affected by the intervention Evacuation, adults, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Evacuation	Effective dose	Adults	100 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Area (km^2) in which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			28	52	84
Central site (Grohnde)			44	76	108
Southern site (Philippsburg)			72	124	168

The figure above shows the cumulative frequency of areas affected by the intervention Evacuation for adults with an emergency reference level of 100 mSv and the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 100 mSv an area of up to 76 km^2 is affected by the intervention Evacuation at the Central site in 80% of the considered cases. Similarly an area of up to 52 km^2 is affected at the Northern site and an area of up to 124 km^2 at the Southern site. Please refer to the table above in order to obtain the areas resulting for 50% or 90% of the cases.

Areas affected by the intervention Stable iodine prophylaxis for adults

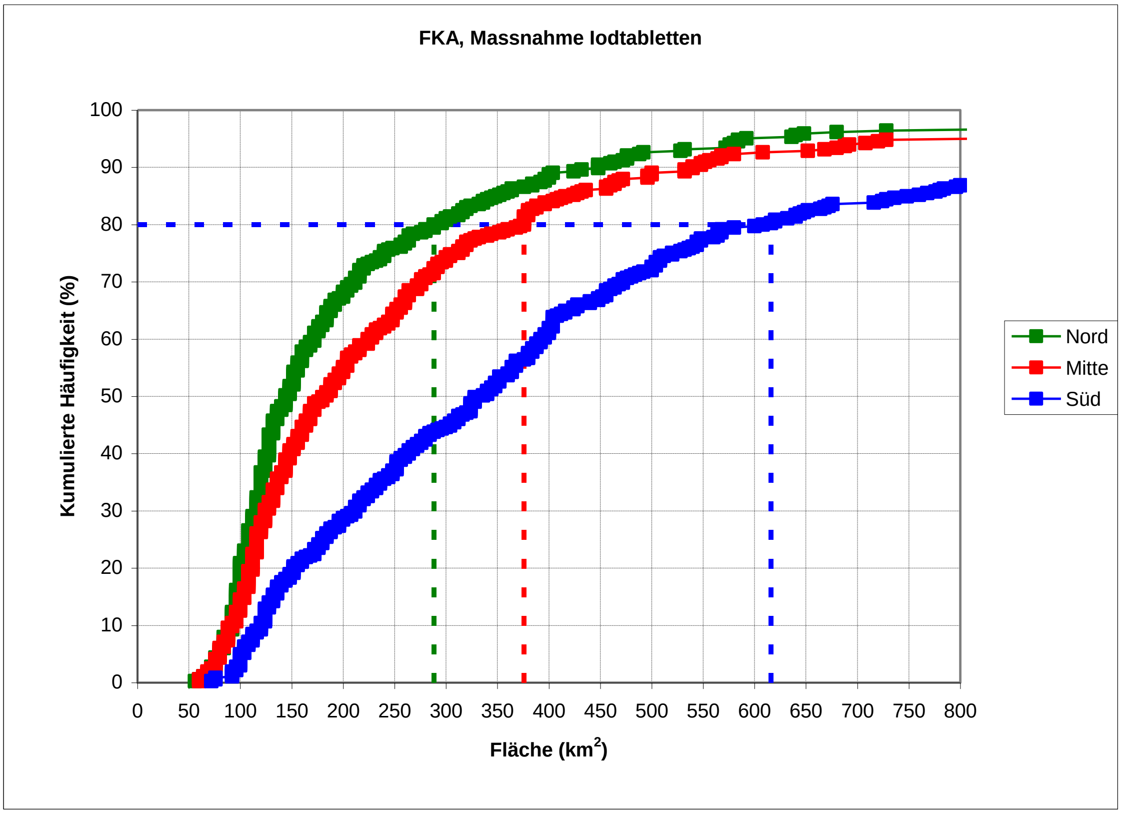


Fig. 8.2 c: Cumulative frequency distribution of the areas affected by the intervention Stable iodine prophylaxis, adults (aged 18 to 45), source term FKA

Table 8.2 c: Data on the cumulative frequency distribution of the areas affected by the intervention Stable iodine prophylaxis, adults (aged 18 to 45), source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Stable iodine prophylaxis	Effective dose	Adults (aged 18 to 45)	250 mSv	Committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside	
			Area (km^2) in which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			144	288	448
Central site (Grohnde)			184	376	540
Southern site (Philippsburg)			336	616	956

The figure above shows the cumulative frequency of areas affected by the intervention Stable iodine prophylaxis for adults (aged 18 to 45) with an emergency reference level of 250 mSv and the source term FKA. The integration times and exposure paths are the committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside.
Based on the relevant emergency reference level of 250 mSv an area of up to 376 km^2 is affected by the intervention Stable iodine prophylaxis at the Central site in 80% of the considered cases. Similarly an area of up to 288 km^2 is affected at the Northern site and an area of up to 616 km^2 at the Southern site.
Please refer to the table above in order to obtain the areas resulting for 50% or 90% of the cases.

Areas affected by the intervention Stable iodine prophylaxis for children, teenagers and pregnant women

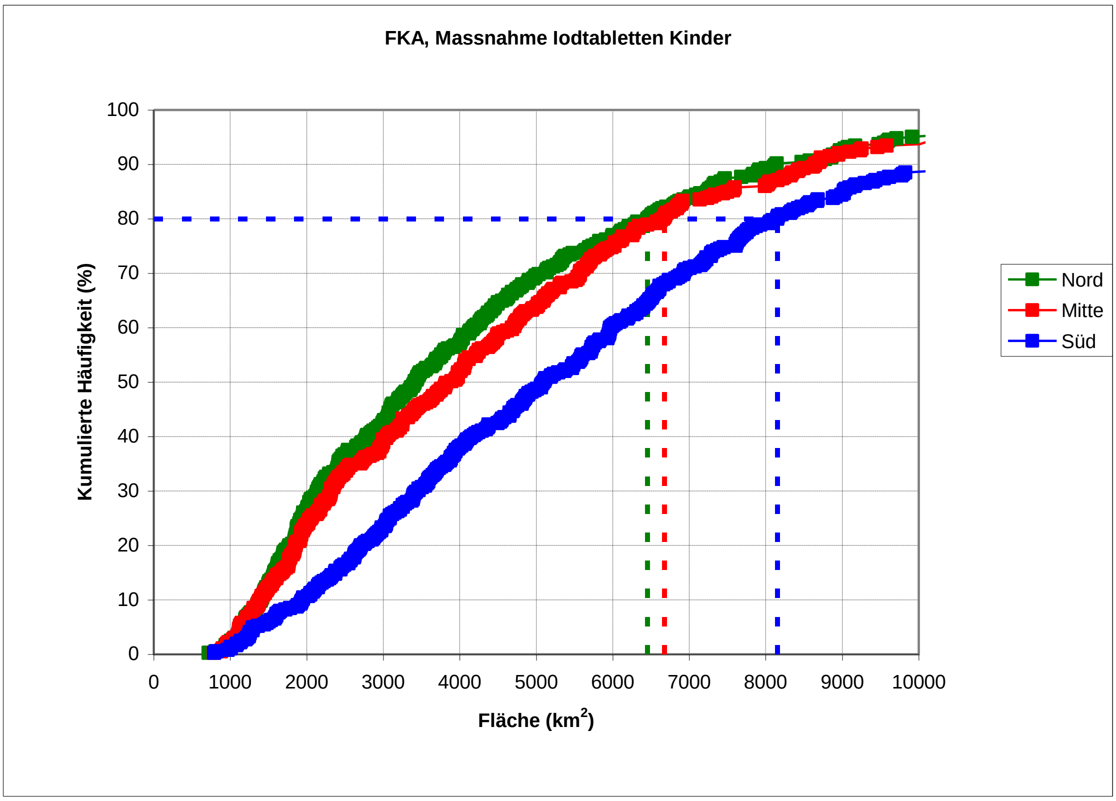


Fig. 8.2 d: Cumulative frequency distribution of the areas affected by the intervention Stable iodine prophylaxis, children, teenagers under the age of 18 and pregnant women, source term FKA

Table 8.2 d: Data on the cumulative frequency distribution of areas affected by the intervention Stable iodine prophylaxis, children, teenagers under the age of 18 and pregnant women, source term FKA

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Stable iodine prophylaxis	Effective dose	Children, teenagers under the age of 18 and pregnant women	50 mSv	Committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside	
			Area (km^2) in which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Northern site (Unterweser)			3408	6456	8124
Central site (Grohnde)			3892	6676	8648
Southern site (Philippsburg)			5104	8156	10,444

The figure above shows the cumulative frequency of areas affected by the intervention Stable iodine prophylaxis for children, teenagers under the age of 18 and pregnant women with an emergency reference level of 50 mSv and the source term FKA. The integration times and exposure paths are the committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 50 mSv an area of up to 6,676 km^2 is affected by the intervention Stable iodine prophylaxis at the Central site in 80% of the considered cases. Similarly an area of up to 6,456 km^2 is affected at the Northern site and an area of up to 8,156 km^2 at the Southern site. Please refer to the table above in order to obtain the areas resulting for 50% or 90% of the cases.

Areas affected by the intervention Evacuation outside a 20-km radius

Grohnde site

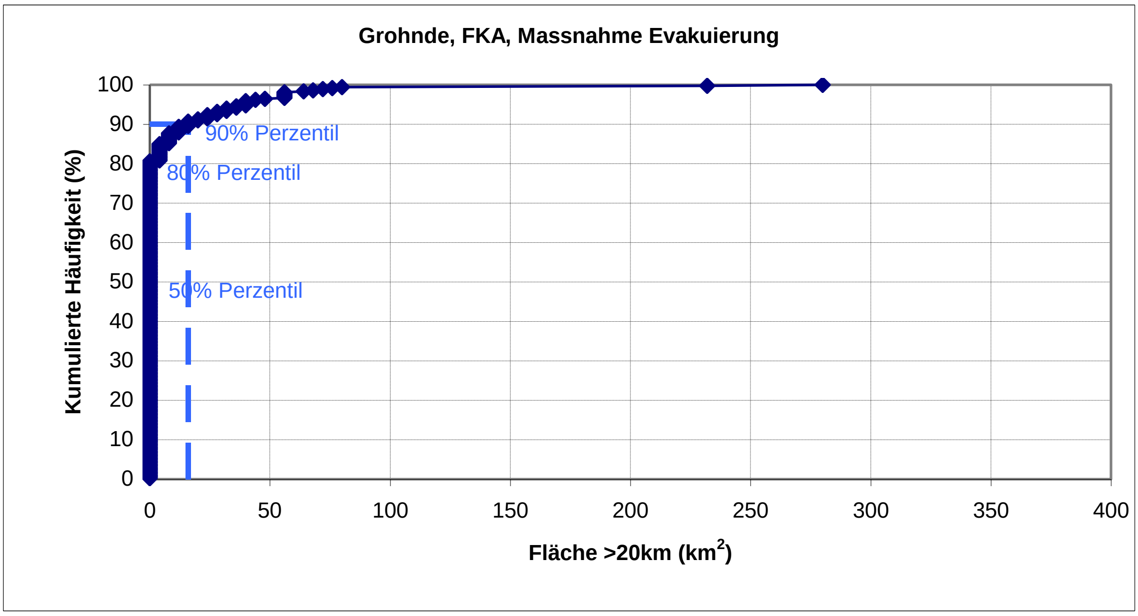


Fig. 8.2 e: Cumulative frequency distribution of the areas at a distance of more than 20 km affected by the intervention Evacuation, adults, source term FKA, Grohnde site

Table 8.2 e: Data on the cumulative frequency distribution of the areas at a distance of more than 20 km affected by the intervention Evacuation, adults, source term FKA, Grohnde site

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Evacuation	Effective dose	Adults	100 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Area (km^2) at a distance of more than 20 km in which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Central site (Grohnde)			0	0	16

The figure above shows the cumulative frequency of areas (at a distance of more than 20 km) affected by the intervention Evacuation for adults with an emergency reference level of 100 mSv and the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 100 mSv no area at a distance of more than 20 km is affected in 80% of the considered cases at the Central site. The same applies to the 50th percentile. Only for 90% of the considered cases an area of 16 km^2 is affected.

8.3. Number of individuals in affected areas

<u>Number of individuals in areas affected by the intervention Evacuation, adults, Grohnde</u>

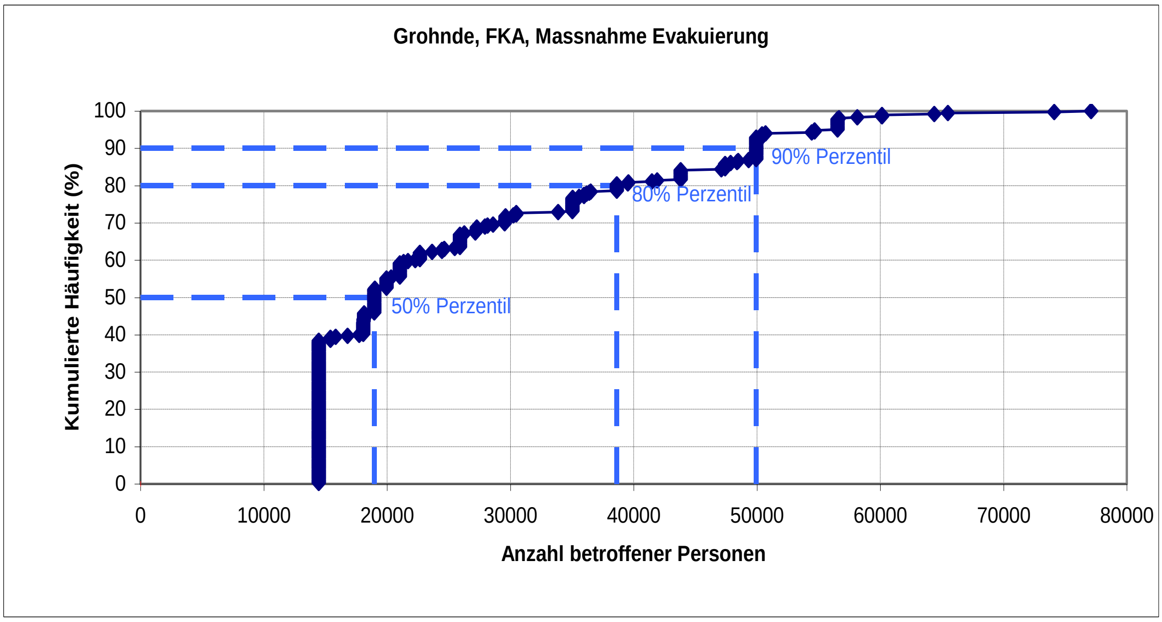


Fig. 8.3 a: Cumulative frequency distribution of the number of individuals within a 20-km radius affected by the intervention Evacuation, adults, source term FKA, Grohnde site

Table 8.3 a: Data on the cumulative frequency distribution of the number of individuals within a 20-km radius affected by the intervention Evacuation, adults, source term FKA, Grohnde site

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Evacuation	Effective dose	Adults	100 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Number of individuals in areas within a 20-km radius where the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Central site (Grohnde)			18,959	38,632	49,945

The figure above shows the cumulative frequency of the number of individuals within a 20-km radius from the plant for the intervention Evacuation for adults with an emergency reference level of 100 mSv and the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 100 mSv up to 38,632 individuals are affected by the intervention Evacuation in 80% of the considered cases. Up to 18,959 individuals are affected at the 50th percentile and up to 49,945 individuals are affected at the 90th percentile.

Number of individuals in the areas affected by the intervention Evacuation, adults, Philippsburg

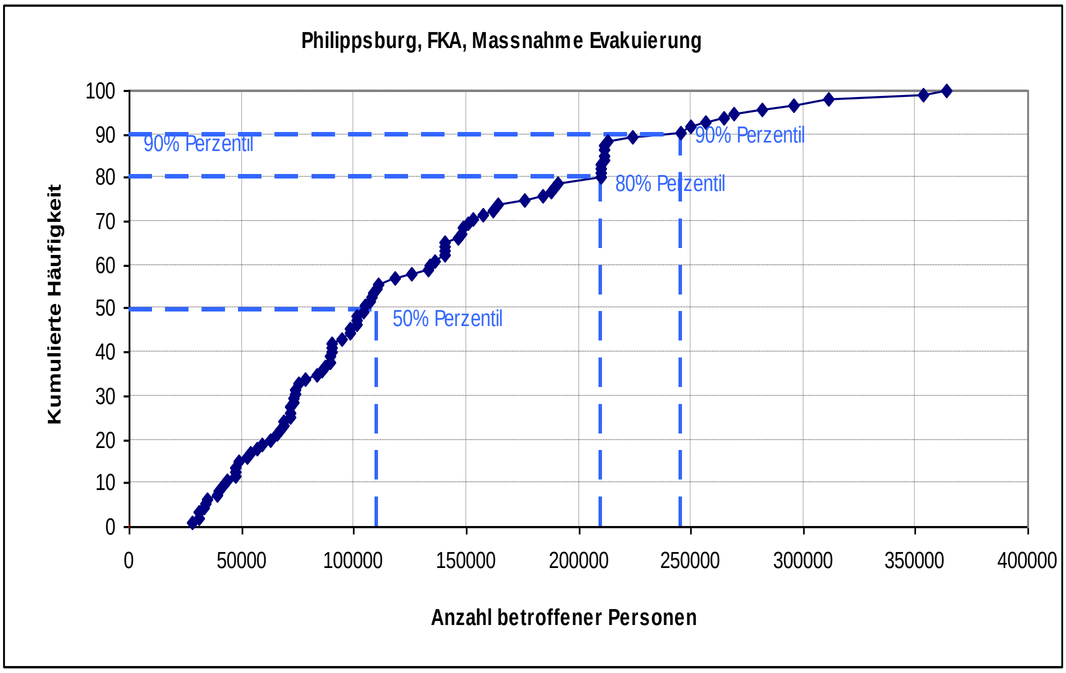


Fig. 8.3 b: Cumulative frequency distribution of the number of individuals in areas affected by the intervention Evacuation, adults, source term FKA, Philippsburg site

Table 8.3 b: Data on the cumulative frequency distribution of the number of individuals in areas affected by the intervention Evacuation, adults, source term FKA, Philippsburg site

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Evacuation	Effective dose	Adults	100 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Number of individuals in areas within a 20-km radius where the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
Philippsburg			109,881	210,176	245,169

The figure above shows the cumulative frequency of the number of individuals in the areas affected by the intervention Evacuation, Philippsburg site, for adults, with an emergency reference level of 100 mSv and the source term FKA. The integration times and exposure paths are external exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside.

Based on the relevant emergency reference level of 100 mSv, up to 210,176 individuals are affected in 80% of the considered cases. Similarly a maximum of 109,881 individuals are affected in 50% of the considered cases and a maximum of 245,169 individuals are affected in 90% of the considered cases.

8.4. Number of affected sectors

<u>Number of sectors affected by the intervention Sheltering, adults</u>

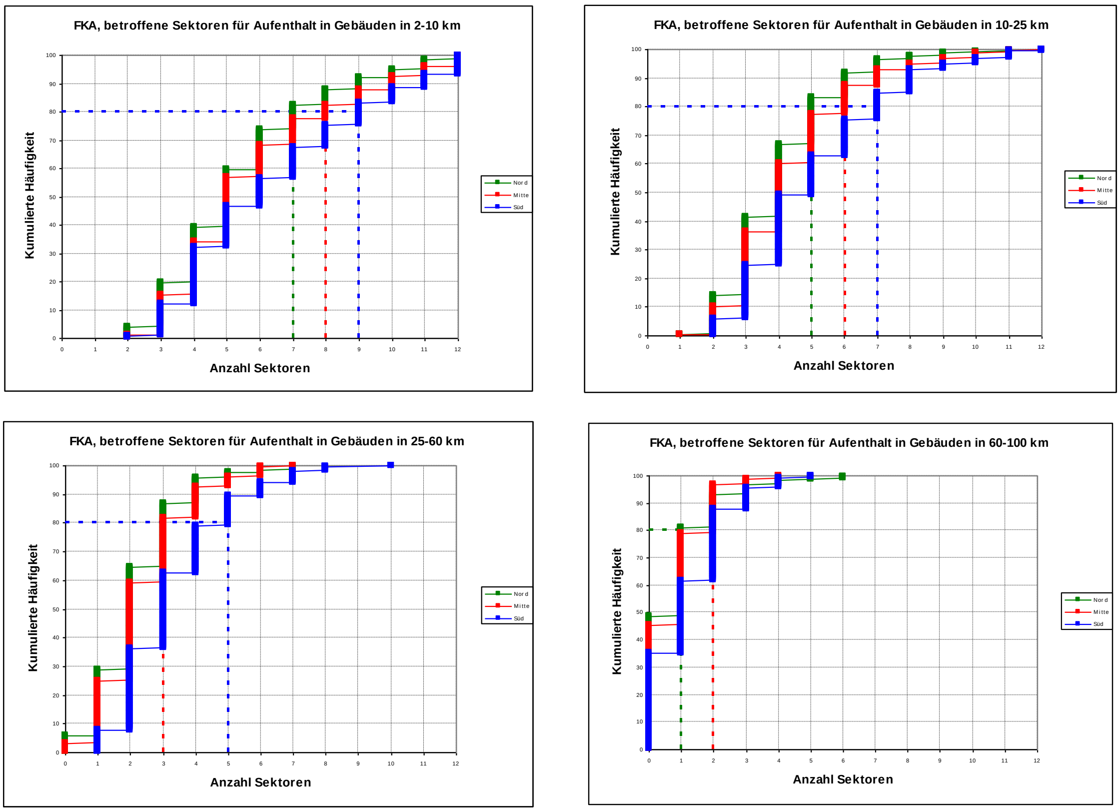


Fig. 8.4.1 a, b, c, d: Cumulative frequency distribution of the sectors affected by the intervention Sheltering for adults and the source term FKA at various distance ranges from the plant

Table 8.4.1: Data on the cumulative frequency distribution of the sectors affected by the intervention Sheltering for adults and the source term FKA at various distance ranges from the plant

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Sheltering	Effective dose	Adults	10 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
			Number of sectors in which the emergency reference level is exceeded		
Distance range from the plant (km)			50th percentile	80th percentile	90th percentile
2 - 10			5 - 6	7 - 9	9 - 11
10 - 25			4 - 5	5 - 7	6 - 8
25 - 60			2 - 3	3 - 5	4 - 6
60 - 100			0 - 1	1 - 2	2 - 3

The figure and table relating to the cumulative frequency distribution of sectors affected by the intervention Sheltering for adults and the source term FKA show that a rather high number of sectors is impacted in the near range (between 5 and 9 sectors at the 80th percentile). The affected area in the near range is thus a semi-circle or three-quarter circle around the point of emission. The number of affected sectors decreases with increasing distance so that only very few sectors (a maximum of 3 sectors) are affected at a distance of 60 to 100 km. The impact on sectors correlates with the meteorological dispersion situation.

Number of sectors affected by the intervention Evacuation, source term FKA, adults

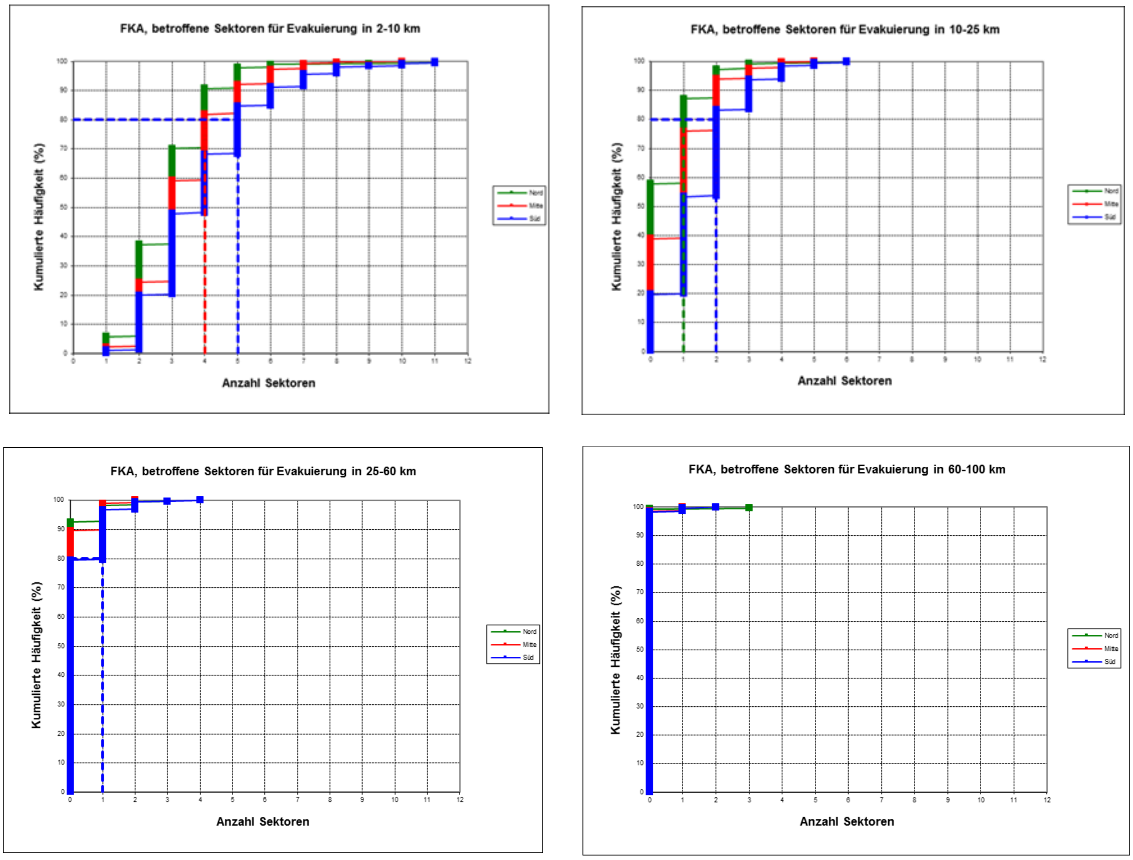


Fig. 8.4.2 a, b, c, d: Cumulative frequency distribution of the sectors affected by the intervention Evacuation for adults and the source term FKA at the Northern, Central and Southern sites.

Table 8.4.2: Data on the cumulative frequency distribution of the number of sectors affected by the intervention Evacuation, adults, source term FKA, Northern, Central and Southern sites

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Evacuation	Effective dose	Adults	100 mSv	External exposure within 7 days and committed dose due to the radionuclides inhaled in this time if the individual were to remain permanently outside	
Distance in km			Number of sectors in which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
2 - 10			3 - 4	4 - 5	4 - 6
10 - 25			0 - 1	1 - 2	2 - 3
25 - 60			0	0 - 1	0 - 1
60 - 100			0	0	0

The figure and table relating to the cumulative frequency distribution of the sectors affected by the intervention Evacuation for adults and the source term FKA show that 4 to 5 sectors are impacted in the near range at the 80th percentile. The number of sectors decreases significantly with increasing distance. At a larger distance of up to 60 km the number of affected sectors is reduced to one sector. The impact on sectors correlates with the meteorological dispersion situation.

Number of sectors affected by the intervention Stable iodine prophylaxis for individuals aged 18 to 45

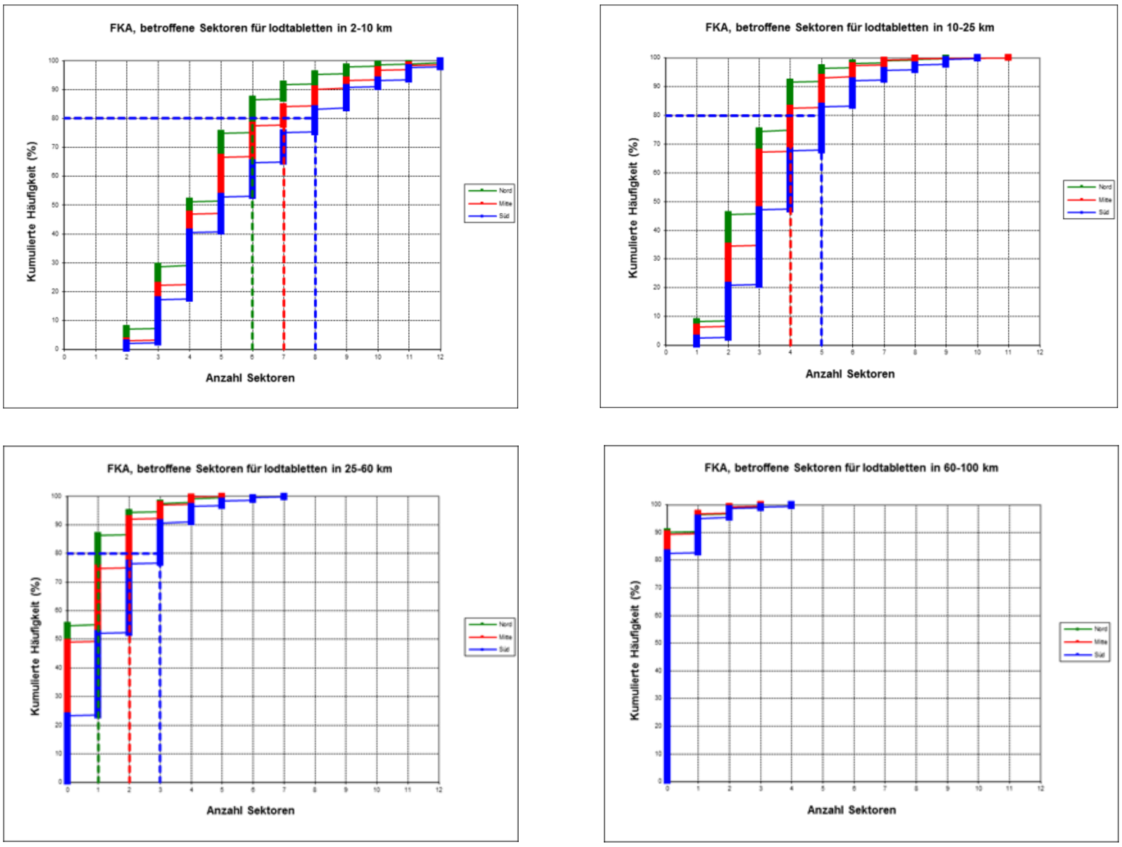


Fig. 8.4.3 a, b, c, d: Cumulative frequency distribution of the sectors affected by the intervention Stable iodine prophylaxis for individuals aged 18 to 45 and the source term FKA at the Northern, Central and Southern sites.

Table 8.4.3: Data on the cumulative frequency distribution of the number of sectors affected by the intervention Stable iodine prophylaxis for individuals aged 18 to 45, source term FKA, Northern, Central and Southern sites

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Stable iodine prophylaxis	Effective dose	Individuals aged 18 to 45	100 mSv	Committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside	
Distance in km			Number of sectors in which the emergency reference level is exceeded		
			50th percentile	80th percentile	90th percentile
2 - 10			4-5	6-8	7-9
10 - 25			3-4	4-5	4-6
25 - 60			0-1	1-3	2-3
60 - 100			0	0	0-1

The figure and table relating to the cumulative frequency distribution of the sectors affected by the intervention Stable iodine prophylaxis for individuals aged 18 to 45 and the source term FKA show that a rather high number of sectors is impacted in the near range at all sites (80th percentile between 6 and 8 sectors). The affected area in the near range is thus a circle segment with an angle of 180° to 240° around the point of emission. The number of affected sectors decreases with increasing distance so that only 1 to 3 sectors are affected at a distance of 25 to 60 km (each at the 80th percentile). Please refer to the table above for the other percentile data.

The impact on sectors correlates with the meteorological dispersion situation.

Number of sectors affected by the intervention Stable iodine prophylaxis for children, teenagers under the age of 18 and pregnant women

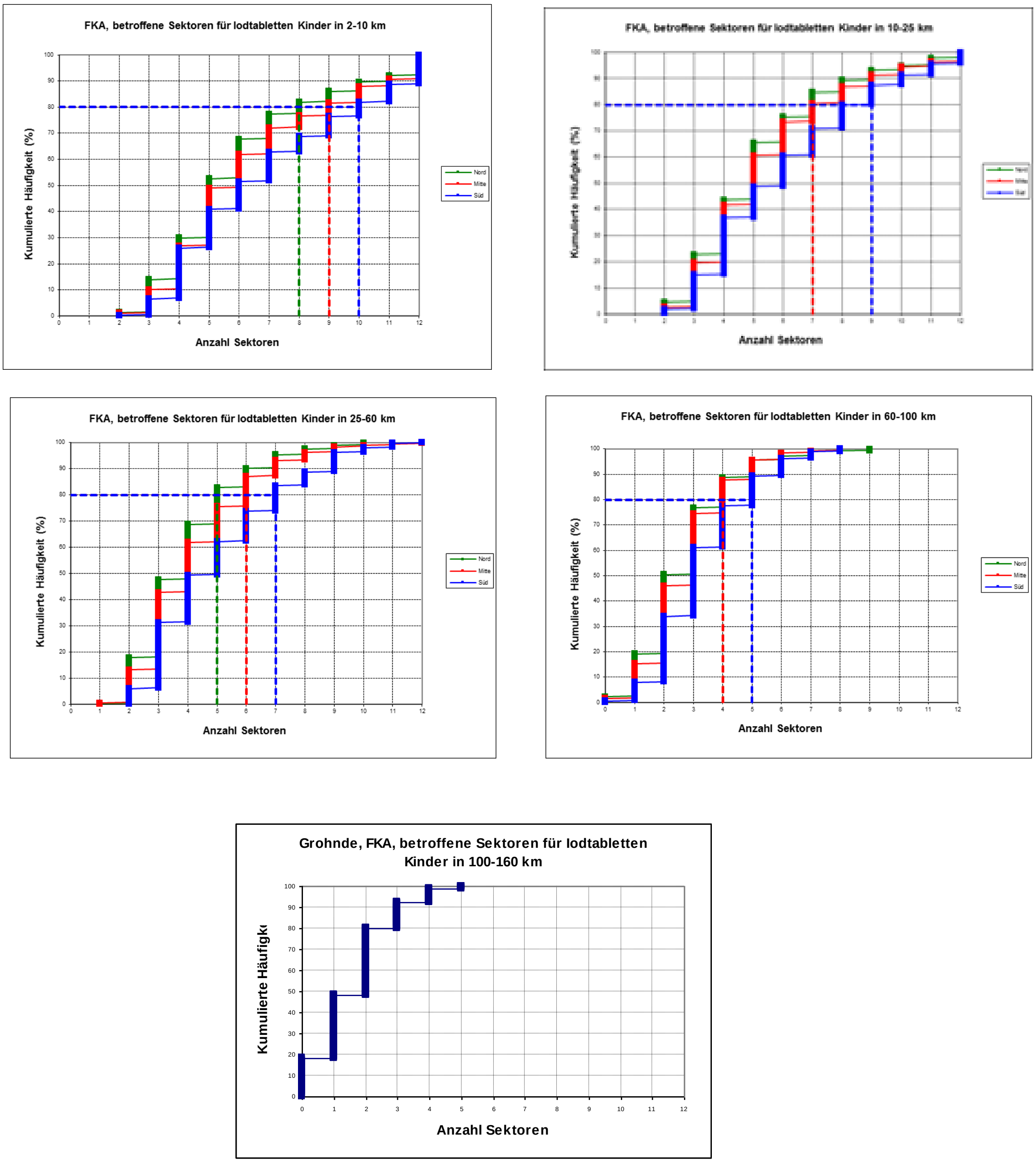


Fig. 8.4.4 a, b, c, d, e: Representation of the cumulative frequency distribution of the sectors affected by the intervention Stable iodine prophylaxis for children, teenagers under the age of 18 and pregnant women at the Northern, Central and Southern sites (Calculations for the distance range 100 – 160 km were only performed for Grohnde, Fig. 8.4.4 e.)

Table 8.4.4: Data on the cumulative frequency distribution of the sectors affected by the intervention Stable iodine prophylaxis for children, teenagers under the age of 18 and pregnant women at the Northern, Central and Southern sites

Type of intervention	Dose criterion	Group of individuals	Emergency reference level	Integration times and exposure paths	
Stable iodine prophylaxis	Effective dose	Children, teenagers under the age of 18 and pregnant women	50 mSv	Committed organ dose due to radioiodine inhaled within 7 days if the individual were to remain permanently outside	
			Number of sectors in which the emergency reference level is exceeded		
Distance range from the plant (km)			50th percentile	80th percentile	90th percentile
2 - 10			5-6	8-10	10-12
10 - 25			5-6	7-9	9-10
25 - 60			4-5	5-7	6-9
60 - 100			2-3	4-5	5-6
100 - 160			2 [1)]	2 [1)]	3 [1)]

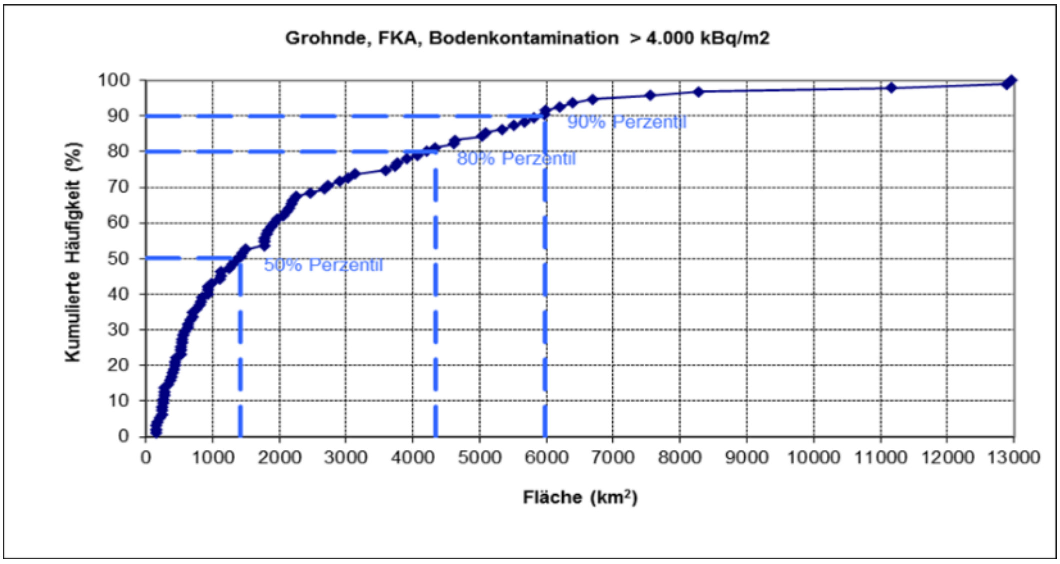
1) Calculation results for the distance range 100 - 160 km are only available for the Northern site.

The figure and table relating to the cumulative frequency distribution of the sectors affected by the intervention Stable iodine prophylaxis for children, teenagers under the age of 18 and pregnant women and the source term FKA show that a rather high number of sectors is impacted in the near range at all sites (80th percentile between 8 and 10 sectors). The affected area in the near range is thus roughly a circle segment with an angle of 240° to 300° around the point of emission. The number of affected sectors decreases with increasing distance so that only 4 to 5 sectors are affected at a distance of 60 to 100 km (each at the 80th percentile). Please refer to the table above for the other percentile data.

The impact on sectors correlates with the meteorological dispersion situation.

8.5. Size of areas with high soil contaminations

Areas with soil contaminations exceeding 4,000 kBq/m², source term FKA



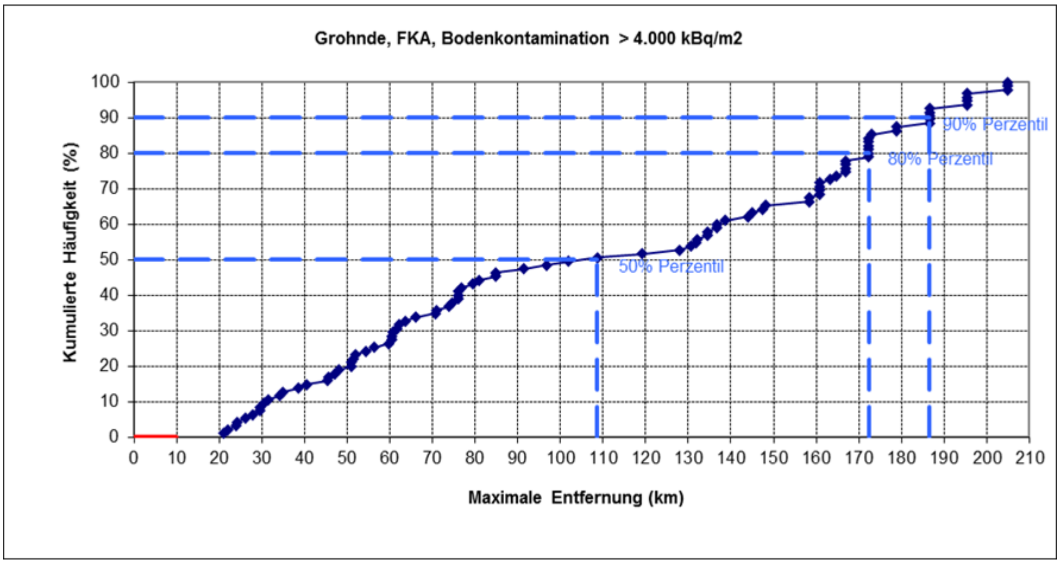


Fig. 8.5.1 a, b: Representation of the cumulative frequency distribution of the maximum distance and/or affected surface area where the soil concentration exceeds 4,000 kBq/m² for the source term FKA at the Grohnde site

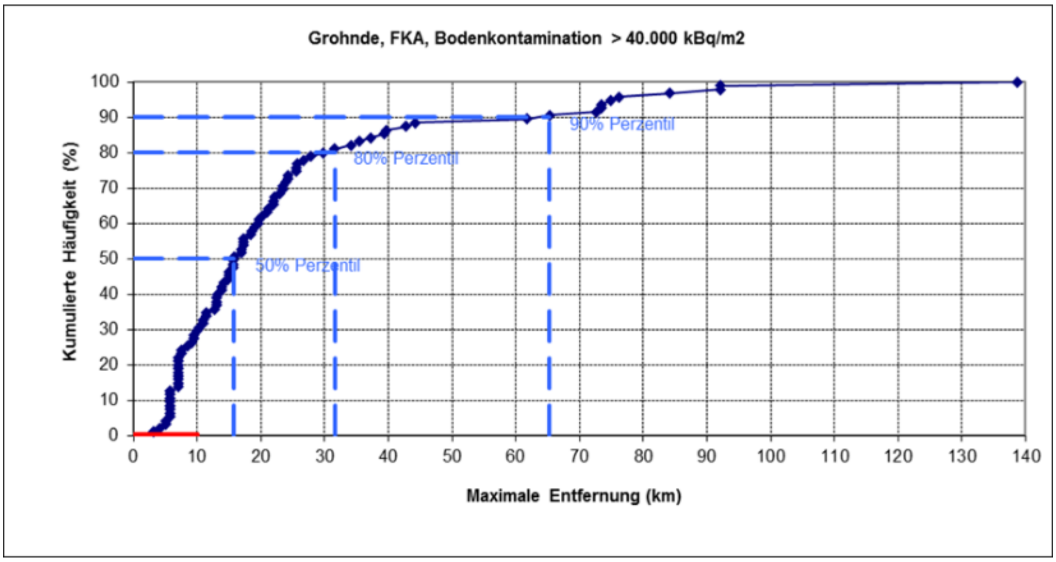
The figure above shows the cumulative frequency of the maximum distance (km) up to which an activity of 4,000 kBq/m² is exceeded. A distance of up to 109 km is reached in 50% of the considered cases. Similarly, a distance of up to 172 km is reached in 80% of the considered cases and up to 187 km in 90% of the considered cases.

The cumulative frequency at which an activity of 4,000 kBq/m² is exceeded amounts to an area of 1,416 km² in 50% of the considered cases, an area of 4,336 km² in 80% of the cases and an area of 5,972 km² in 90% of the cases.

Table 8.5.1: Data on the cumulative frequency distribution of the maximum distance and/or affected surface area where the soil contamination exceeds 4,000 kBq/m² for the source term FKA at the Grohnde site

Site	Maximum distance (km) at which an activity of 4,000 kBq/m² is exceeded		
	50th percentile	80th percentile	90th percentile
Central site (Grohnde)	109	172	187
	Surface area (km^2) in which an activity of 4,000 kBq/m² is exceeded		
	50th percentile	80th percentile	90th percentile
Central site (Grohnde)	1416	4336	5972

<u>Areas with soil contaminations exceeding 40,000 kBq/m², source term FKA</u>



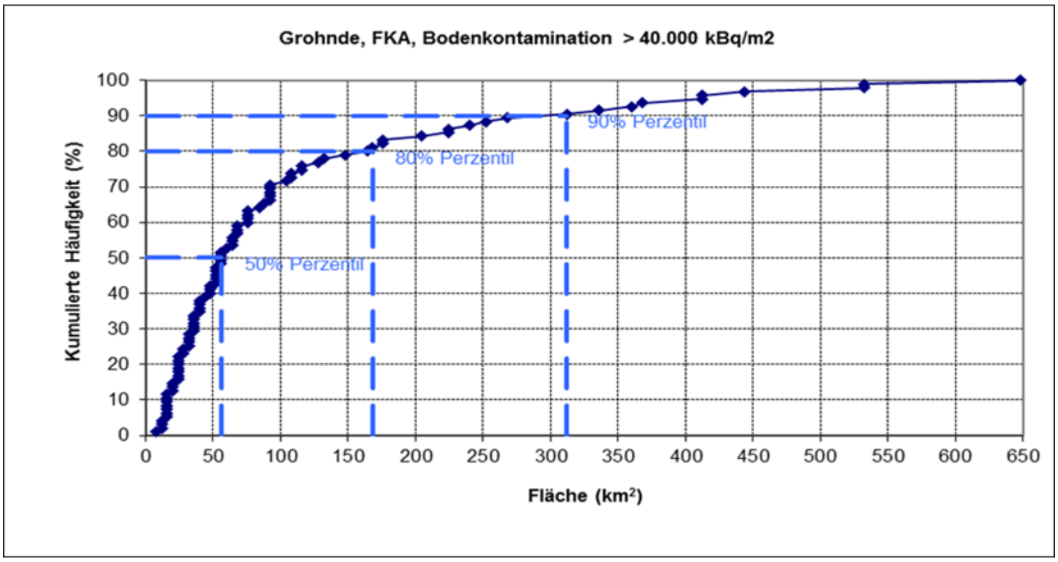


Fig. 8.5.2 a, b: Representation of the cumulative frequency distribution of the maximum distance and/or affected surface area where the soil contamination exceeds 40,000 kBq/m² for the source term FKA at the Grohnde site

Table 8.5.2: Data on the cumulative frequency distribution of the maximum distance and/or affected surface area where the soil contamination exceeds 40,000 kBq/m² for the source term FKA at the Grohnde site

Site	Maximum distance (km) at which an activity of 40,000 kBq/m² is exceeded		
	50th percentile	80th percentile	90th percentile
Central site (Grohnde)	16	32	65
	Surface area (km²) in which an activity of 40,000 kBq/m² is exceeded		
	50th percentile	80th percentile	90th percentile
Central site (Grohnde)	56	168	312

The figure above shows the cumulative frequency of the maximum distance (km) at which an activity of 40,000 kBq/m² is exceeded. A distance of up to 16 km is reached in 50% of the considered cases. Similarly, a distance of up to 32 km is reached in 80% of the considered cases and up to 65 km in 90% of the considered cases.

The cumulative frequency at which an activity of 40,000 kBq/m² is exceeded amounts to an area of 56 km^2 in 50% of the considered cases, an area of 168 km^2 in 80% of the cases and an area of 312 km^2 in 90% of the cases.

8.6. Residual dose according to ICRP

In the framework of the present study BfS also analysed the question if the new ICRP concept of a reference value for the residual dose in the first year following the incident matches the existing German emergency reference levels. To this end, roughly 100 individual RODOS calculations were assessed, based on releases starting on every fourth day between 1 November 2011 and 31 October 2012 at the Grohnde site and for the source term FKA (i.e. a release over 50 hours). The dose reduction achieved through protective measures was taken into account for all areas where the German emergency reference levels were exceeded. When the protective measures were completed, a dose reduction due to normal living and leisure habits (percentage of indoor and outdoor activities) was taken into account. For each of the individual calculations the maximum residual effective dose for adults was determined that occurred in the entire computational domain. The median value of the maximum residual dose and the 10th and 90th percentiles for all calculations are shown in Table 8.6.1.

Table 8.6.1: Statistical analysis of the maximum residual dose for almost 100 individual calculations for the Grohnde site and the source term FKA

			Maximum residual dose (effective dose, adults, in **mSv**)		
Protective measures	Additionally: Relocation	Case	10%	Median value	90%
Evacuation, Sheltering, Stable iodine prophylaxis	No	1a	46	77	296
	After 30 d	1b	20	29	69
	After 7 d	1c	14	18	32

Protective measures were taken into account in all areas where the German emergency reference levels for the relevant measures were exceeded. It was assumed that the intervention Sheltering would be maintained for two days, that the effects of the intervention Stable iodine prophylaxis would last while the clouds pass and that the intervention Evacuation would mean that people do not return to their homes within the first year so that the residual dose at the evacuated places is zero. This also means that neither Sheltering nor Iodine thyroid prophylaxis nor Relocation had to be taken into account for the evacuated places since the residual dose was reduced to zero simply by the Evacuation. In other words, the residual dose assessed in Table 8.6.1 only occurs in non-evacuated areas where only the interventions Sheltering and Stable iodine prophylaxis are applied. The places with the maximum residual dose are situated at roughly 10 km from the NPP on average since the reference level for Evacuation is exceeded for shorter distances in most cases and the residual dose is zero due to the Evacuation.

The dose reduction achieved by protective measures and normal living and leisure habits was based on the following assumptions: reduction factor for external exposure and inhalation in the case of Evacuation = 0, in the case of Relocation = 0, in the case of Sheltering = 0.33 (ingestion was not taken into account). Additional reduction factor due to inhalation of iodine isotopes in the case of iodine thyroid prophylaxis = 0.1. Reduction factor for external exposure in the case of normal living and leisure habits = 0.55 (assumption: remaining outdoor 8 h per day, indoor 16 h, reduction factor indoor = 0.33).

It can be seen from Table 8.6.1 that the implementation of the three protective measures (Evacuation, Sheltering, Stable iodine prophylaxis in those places where the relevant emergency reference level is exceeded) leads to a median value of the residual dose that is below 100 mSv in all scenarios. In the event that the intervention Relocation is not additionally taken into account (case 1a) a significant portion of the scenarios (roughly 40 %; see Fig. 8.6 a) remains above 100 mSv (with a median value of 77 mSv). If a Relocation after 30 days is taken into account, the 90th percentile (69 mSv) remains significantly below 100 mSv in all scenarios (case 1b) and the residual dose is below 100 mSv in all scenarios except one (Fig. 8.6 b). However, the residual dose exceeds 50 mSv in one third of cases. If a Relocation after 7 days is taken into account, the 90th percentile (32 mSv) remains even significantly below 50 mSv in all scenarios (case 1c) and the residual dose is below 50 mSv in all scenarios (Fig. 8.6 c).

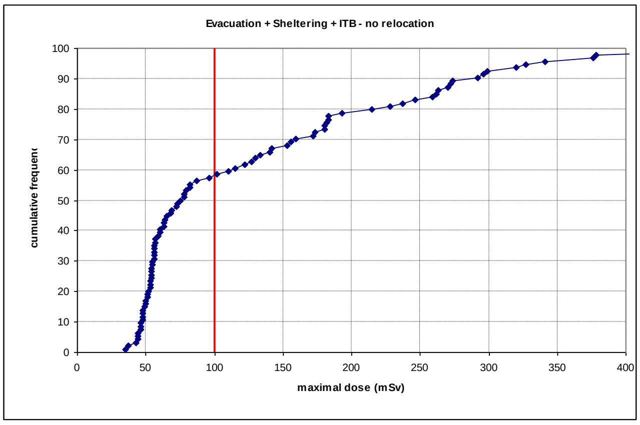


Fig. 8.6 a: Cumulative frequency of the maximum residual dose for case 1a (Evacuation + Sheltering + Iodine thyroid prophylaxis, no Relocation)

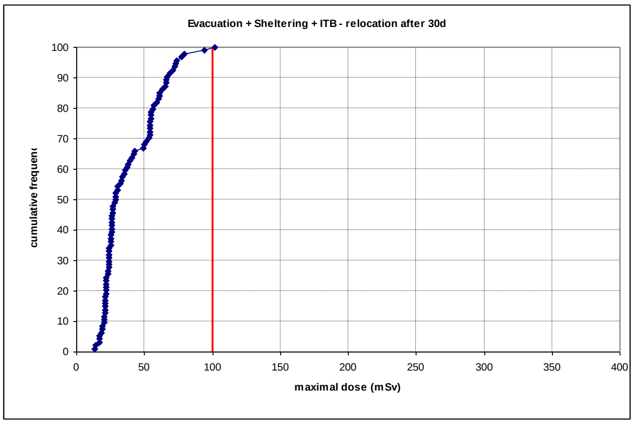


Fig. 8.6 b: Cumulative frequency of the maximum residual dose for case 1b (Evacuation + Sheltering + Iodine thyroid prophylaxis, Relocation after 30 days)

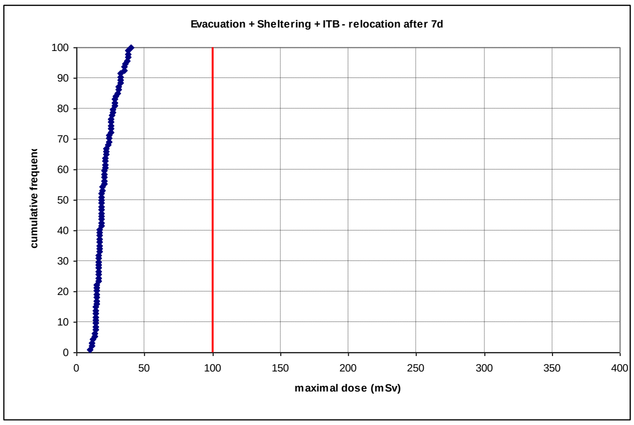


Fig. 8.6 c: Cumulative frequency of the maximum residual dose for case 1c (Evacuation + Sheltering + Iodine thyroid prophylaxis, Relocation after 7 days)

It was additionally investigated which dose can occur if an evacuation is impossible although the emergency reference levels are exceeded (e.g. due to the current weather conditions or if the time for advance warning is too short; cases 2a, b and c) or if both Evacuation and Stable iodine prophylaxis are impossible (cases 3a, b and c).

The red line shown in the diagrams represents the maximum value for the residual dose of 100 mSv within the first year, to be defined in the framework of emergency planning according to ICRP 103.

Table 8.6.2: Statistical analysis of the maximum residual dose for roughly 100 individual calculations for the cases 2 and 3, i.e. assuming that the interventions Evacuation (cases 2a, b, c) or Evacuation and Stable iodine prophylaxis (cases 3a, b, c) cannot be implemented although the emergency reference levels are exceeded.

			Maximum residual dose (effective dose, adults, mSv)		
Protective measures	Additionally: Relocation	Case	10%	Median value	90%
Sheltering, Iodine thyroid prophylaxis	No	2a	238	694	2036
	After 30 d	2b	88	271	925
	After 7 d	2c	54	171	568
Sheltering	No	3a	300	835	2723
	After 30 d	3b	151	412	1381
	After 7 d	3c	123	331	1090

If an Evacuation is impossible (cases 2) or both Evacuation and Stable iodine prophylaxis are impossible (cases 3) the median value of the residual dose exceeds 100 mSv in all cases (even significantly, for some parts). This shows that a residual dose of more than 100 mSv can occur in a number of weather conditions if no evacuation is implemented, in particular in the immediate vicinity and even if the population is relocated as early as 7 days after the event. Nearly all of the places where the residual dose is at its maximum (cases 2 and 3) are situated in the immediate vicinity of the NPP (distance of 1 to 3 km).

The results presented above lead to the following conclusions:

- A reference value of 100 mSv for the residual effective dose within the first year only matches the German emergency reference levels if Relocation is implemented – in addition to earlier protective measures.

- In the event of Relocation 30 days after the release has started, a level of 50 mSv for the residual effective dose within the first year is exceeded in almost one third of cases. However, the residual dose can remain below the level of 100 mSv in almost all scenarios even if the Relocation is only implemented after 30 days.

- A strategy comprising only the early protective measures – i.e. without Relocation – would lead to a residual dose above 100 mSv in a significant part (roughly 40%) of the scenarios considered.

- In the event that an Evacuation is impossible, the residual doses occurring in the immediate vicinity of the NPP can be very high so that even serious deterministic effects cannot be excluded. This demonstrates the key importance of appropriate planning that allows for an Evacuation in the immediate vicinity of the NPP in almost all circumstances within a very short delay.

9. SUMMARY OF THE RESULTS

9.1. Maximum dimensions of the affected areas

Tables 9.1 a and 9.1 b list the most important results of this study with respect to the maximum dimensions of the affected areas in which the indicated dose criteria are exceeded. Example: The dose criterion for the intervention Evacuation, i.e. an effective dose of 100 mSv, is exceeded in an area with a maximum distance of 6 to 31 km from the place of release in 80% of the considered weather scenarios (for release category FKA, see Table 9.1 a). The indicated maximum distances do not include those 10% of weather scenarios that would lead to a larger or smaller maximum distance since those cases are based on rare meteorological conditions. On average (median value), the area affected by an Evacuation extends to a maximum distance of between 9 km and 18 km from the place of release, depending on the NPP site. The indicated distances are not indicative of the shape, location or dimension of the affected areas; these types of analyses are represented in Tables 9.2 and 9.3 below.

Table 9.1 a: Summary of the results for the maximum dimensions of the affected areas in which the dose criteria are exceeded (for release category FKA)

Dose criterion	Type of intervention	Group of individuals	Range of maximum distance at which the dose criterion is exceeded 1) (km)	Median value of the maximum distance at which the dose criterion is exceeded 2) (km)
Threshold levels for the occurrence of serious deterministic effects:				
1,000 mGy for the dose to the red bone marrow	-	Adults	0 - 1	0
(see above)	-	Infants	0 - 1	0
300 mGy for the brain dose to the foetus in 8th to 15th week	-	Foetus	0 - 3	0
100 mSv for the effective dose to the foetus in 2nd to 7th week	-	Foetus	3 - 11	3
High doses:				
Effective dose of 1,000 mSv	-	Adults	0 - 5	0 - 1
~	-	Infants	0 - 10	1 - 3
Reference levels for emergency response measures:				
Effective dose of 100 mSv	Evacuation	Adults	6 – 31	9 – 18
~		Infants	9 – 47	14 – 24
Effective dose of 10 mSv	Sheltering	Adults	29 – 163	62 – 80
~	~	Infants	43 – 173	91 – 114
Thyroid dose of 250 mSv	Stable iodine prophylaxis	Individuals aged 18 to 45	15 – 84	24 – 34
Thyroid dose of 50 mSv	Stable iodine prophylaxis	Children, teenagers and pregnant women	20 – 195 3)	148 – 161
Effective dose of 30 mSv in one month	Temporary relocation	Adults	7 – 100	16 – 27
~	~	Infants	8 – 121	22 – 32
Effective dose of 100 mSv in one year	Permanent relocation	Adults	6 – 82	15 – 26
~	~	Infants	7 – 117	20 – 32

1) The lower value of the indicated range describes the maximum dimension of the affected area if 10% of all weather scenarios that lead to the smallest distances are taken into account.
The higher value of the indicated range describes the maximum dimension of the affected area if 90% of all weather scenarios that lead to the smallest distances are taken into account.
All three sites (Unterweser, Grohnde, Philippsburg) were taken into account in all calculations.
2) The indicated interval describes the minimum and maximum level of the median value for all three sites.

3) Distances of more than 160-225 km (depending on the direction of dispersion) were not investigated. A value of more than 160 km thus means that the relevant dose criterion can be exceeded at least up to the distances indicated and in some cases even beyond.

The key results of this study with respect to the maximum dimensions of the affected areas where dose criteria may be exceeded are given below (all results are given for the largest nuclear release scenario “FKA”):

- Threshold levels for deterministic effects and high doses (effective doses higher than 1,000 mSv) can be reached or exceeded within a distance of about 3 km on average.
- The emergency reference level for the intervention Evacuation can be reached or exceeded within a distance of up to 9 to 18 km (adults) and/or up to 14 to 24 km (infants) on average (the indicated interval describes the minimum and maximum levels of the median value at all three NPP sites).
- The emergency reference level for the intervention Sheltering can be reached or exceeded within a distance of up to 62 to 80 km (adults) and/or up to 91 to 114 km (infants) on average.
- The emergency reference level for the intervention Stable iodine prophylaxis can be reached or exceeded within a distance of up to 24 to 34 km (adults) and/or up to 148 to 161 km (children, teenagers and pregnant women) on average.

Table 9.1 b: Summary of the results for the maximum dimensions of the affected areas in which the dose criteria are exceeded (for release category FKF)

Dose criterion	Type of intervention	Group of individuals	Range of maximum distance at which the dose criterion is exceeded [1] (km)	Median value of the maximum distance at which the dose criterion is exceeded [2] (km)
High doses:				
Effective dose of 1,000 mSv	-	Adults	0 - 0	0
~	-	Infants	0 - 0	0
Reference levels for emergency response measures:				
Effective dose of 100 mSv	Evacuation	Adults	0 - 0	0
~		Infants	0 - 0	0
Effective dose of 10 mSv	Sheltering	Adults	0 - 8	3
~	~	Infants	1 - 16	7 - 8
Thyroid dose of 250 mSv	Stable iodine prophylaxis	Individuals aged 18 to 45	0 - 1	0
Thyroid dose of 50 mSv	Stable iodine prophylaxis	Children, teenagers and pregnant women	10 - 32	15 - 18
Effective dose of 30 mSv in one month	Temporary relocation	Adults	0 - 1	0
~	~	Infants	0 - 1	0
Effective dose of 100 mSv in one year	Permanent relocation	Adults	0 - 0	0
~	~	Infants	0 - 0	0

1) The lower value of the indicated range describes the maximum dimension of the affected area if 10% of all weather scenarios that lead to the smallest distances are taken into account.
The higher value of the indicated range describes the maximum dimension of the affected area if 90% of all weather scenarios that lead to the smallest distances are taken into account.
All three sites (Unterweser, Grohnde, Philippsburg) were taken into account in all calculations.

2) The indicated interval describes the minimum and maximum level of the median value for all three sites.

The calculations for release category FKF show (see Table 9.1 b) that the criterion of 1,000 mSv (effective dose) and the emergency reference level of 100 mSv (effective dose) are not reached in any case. Distances of less than 1.4 km from the NPP were not included in the calculations.

9.2. Size of the affected areas and number of affected persons

Table 9.2 shows the most important results of this study with respect to the size of the affected areas in which the indicated dose criteria are exceeded. Example: The dose criterion for the intervention Evacuation, i.e. an effective dose of 100 mSv, is exceeded in an area sized between 16 and 168 km^2 in 80% of the considered weather scenarios. This analysis does not include those 10% of weather scenarios that would lead to larger or smaller areas since those cases are based on rare meteorological conditions. On average (median value), the area affected by an Evacuation has a size of between 28 km^2 and 72 km^2, depending on the NPP site.

Table 9.2: Summary of the results for the size of the affected areas in which the dose criteria are exceeded (for release category FKA)

Dose criterion	Type of intervention	Group of individuals	Size of affected areas in which the dose criterion is exceeded [1)] (km^2)	Median value of the size of the affected areas in which the dose criterion is exceeded [2)] (km^2)
Reference levels for emergency response measures:				
100 mSv Effective dose	Evacuation	Adults	16 - 168	28 - 72
10 mSv Effective dose	Sheltering	Adults	240 - 2920	604 - 1120
250 mSv Thyroid dose	Stable iodine prophylaxis	Individuals aged 18 to 45	92 - 956	144 - 336
50 mSv Thyroid dose	Stable iodine prophylaxis	Children, teenagers and pregnant women	1400 - 10444 [3)]	3410 - 5104

1) The lower value of the indicated range describes the maximum size of the affected area if 10% of all weather scenarios that lead to the smallest affected areas are taken into account.
The higher value of the indicated range describes the maximum size of the affected area if 90% of all weather scenarios that lead to the smallest affected areas are taken into account.
All three sites (Unterweser, Grohnde, Philippsburg) were taken into account in all calculations.
2) The indicated interval describes the minimum and maximum level of the median value for all three sites.
3) Distances of more than 160-225 km (depending on the direction of dispersion) were not investigated. The higher value of the indicated range is thus only a minimum limit, since the actually affected area might be larger than indicated here.

The key results of this study with respect to the size of the affected areas where dose criteria may be exceeded are as follows (all results are given for the largest nuclear release scenario “FKA”):

- The emergency reference level for the intervention Evacuation can be reached or exceeded in an area sized 28 to 72 km^2 (adults) on average.
- The emergency reference level for the intervention Sheltering can be reached or exceeded in an area sized roughly 600 to 1,100 km^2 (adults) on average.
- The emergency reference level for the intervention Stable iodine prophylaxis can be reached or exceeded in an area sized 144 to 336 km^2 (adults) or roughly 3,400 to 5,100 km^2 (children, teenagers and pregnant women) on average.

The number of persons who would be affected by an Evacuation because the dose criterion of 100 mSv (effective dose) is exceeded amounts to between roughly 14,000 and 50,000 individuals for the Grohnde site and between roughly 45,000 and 245,000 individuals for the Philippsburg site in 80% of the considered weather scenarios. In this analysis 10% of those weather scenarios that would lead respectively to a larger or smaller number of persons were not taken into account.

9.3. Number of affected sectors

Table 9.3 summarizes the key results of this study with respect to the number of affected sectors where the indicated dose criteria are exceeded. (A sector includes an angle of 30 degrees, twelve sectors thus form a full circle around the NPP; a sector is considered as affected if the dose criterion is exceeded at any point within this sector.) Example: The dose criterion for the intervention Evacuation of 100 mSv (effective dose) is exceeded in 2 to 6 sectors (i.e. an angle of 60 to 180 degrees) at a distance of 2 to 10 km in 80% of the considered weather scenarios. This analysis does not include those 10% of weather scenarios that would lead to larger or smaller numbers of affected sectors since those cases are based on rare meteorological conditions. On average (median value), the area affected by an Evacuation includes 3 to 4 sectors (which corresponds to an angle of 90 to 120 degrees) at a distance of 2 to 10 km, depending on the NPP site.

Table 9.3: Summary of the results for the number of affected sectors[3)] in which the dose criteria are exceeded (for release category FKA)

Dose criterion	Type of intervention	Group of individuals	Distance from the NPP	Number of affected sectors in which the dose criterion is exceeded [1)]	Median value for the number of affected sectors in which the dose criterion is exceeded [2)]
	Reference levels for emergency response measures:				
Effective dose of 100 mSv	Evacuation	Adults	2 - 10 km	2 - 6	3 - 4
			10 - 25 km	0 - 3	0 - 1
			25 - 60 km	0 - 1	0
			60 - 100 km	0	0
Effective dose of 10 mSv	Sheltering	Adults	2 - 10 km	3 - 11	5 - 6
			10 - 25 km	2 - 8	4 - 5
			25 - 60 km	1 - 6	2 - 3
			60 - 100 km	0 - 3	0 - 1
250 mSv Thyroid dose	Stable iodine prophylaxis	Individuals aged 18 to 45	2 - 10 km	3 - 9	4 - 5
			10 - 25 km	2 - 6	3 - 4
			25 - 60 km	0 - 3	0 - 1
			60 - 100 km	0 - 1	0 - 0
50 mSv Thyroid dose	Stable iodine prophylaxis	Children, teenagers and pregnant women	2 - 10 km	3 - 12	5 - 6
			10 - 25 km	3 - 10	5 - 6
			25 - 60 km	2 - 9	4 - 5
			60 - 100 km	1 - 6	2 - 3
			100 - 160 km	0 - 3	2

1) The lower value of the indicated range describes the maximum size of the affected area if 10% of all weather scenarios that lead to the smallest affected areas are taken into account.
The higher value of the indicated range describes the maximum size of the affected area if 90% of all weather scenarios that lead to the smallest affected areas are taken into account.
All three sites (Unterweser, Grohnde, Philippsburg) were taken into account in all calculations.
2) The indicated interval describes the minimum and maximum level of the median value for all three sites.
3) A sector includes an angle of 30 degrees; a sector is considered as affected if the dose criterion is exceeded at any point within this sector.

The key results of this study with respect to the number of affected sectors in which dose criteria may be exceeded are as follows (all results are given for the largest nuclear release scenario “FKA”):

- The emergency reference level for the intervention Evacuation can be reached or exceeded on average in 3 to 4 sectors at a distance of 2 to 10 km and in 0 to 1 sector at a distance of 10 to 25 km.
- The emergency reference level for the intervention Sheltering can be reached or exceeded on average in 5 to 6 sectors at a distance of 2 to 10 km, in 4 to 5 sectors at a distance of 10 to 25 km, in 2 to 3 sectors at a distance of 25 to 60 km and in 0 to 1 sector at a distance of 60 to 100 km.
- The emergency reference level for the intervention Stable iodine prophylaxis for children, teenagers and pregnant women can be reached or exceeded on average in 5 to 6 sectors at a distance of 2 to 10 km, in 5 to 6 sectors at a distance of 10 to 25 km, in 4 to 5 sectors at a distance of 25 to 60 km, in 2 to 3 sectors at a distance of 60 to 100 km and in 2 sectors at a distance of 100 to 160 km.

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This is Exhibit..........................referred to in the affidavit of...Shawn-Patrick Stensil................ affirmed before me, this...fifteenth.................. day of......August..................................2016....

....
A COMMISSIONER FOR TAKING AFFIDAVITS

Dr. Binder
President
Canadian Nuclear Safety Commission
280 Slater St
PO Box 1046, Station B
Ottawa, Ontario
K1P 5S9

Dear Dr. Binder;

We are a group of specialists at the CNSC. We are writing to you so that we can be heard.

We are writing anonymously because our opinions will be well received by management at the CNSC and we are not confident in whistle blower protection.

Our primary concern is that CNSC Commissioners do not receive sufficient information to make balanced judgments.

Secondly, because insufficient information is made available, other branches of government cannot make informed decisions. For example, the Government of Ontario cannot make a good decision about financing the refurbishment of Darlington without knowing all the facts.

Finally, knowledgeable and interested members of the public cannot be involved in the licensing process unless all non-confidential information is released.

We have attached a number of cases that we know about and that have been significant issues at recent public hearings

We have made some suggestions that may alleviate the problems we have identified.

cc. Dr. J. Moyra McDill, CNSC Commissioner
Ms. Rumina Velshi, CNSC Commisioner
Mr. S. P. Stensil, Greenpeace Canada
Theresa McClenaghan, Canadian Environmental Law Association.

Case 1

In 2014 the CNSC granted OPG a one-year licence for Darlington NGS on the basis that it would provide the safety case for the refurbishment period of the station, i.e. approximately 2016 to 2030. However, OPG did not submit regulatory quality studies for the refurbishment configuration prior to being granted a long term licence in December 2015.

For example:

- CNSC regulatory standard S-294 requires an update of the Probabilistic Safety Assessment (PSA) '.... if major changes occur in the facility."
- Isolating a single unit for refurbishment changes the containment boundary, changes the containment volume and changes the reliability of inter-unit systems.
- Isolating a single unit constitutes a major change to the facility. *If refurbishment does not require a fully updated PSA, then this regulatory requirement is meaningless.*
- OPG has not completed a S-294 quality PSA for the refurbishment configuration.
- CNSC staff did not inform the Commission that the PSA had not been updated or recommend a licence condition that an update was required

Without a detailed PSA, OPG is not in compliance with S-294, and neither OPG nor the Commission can make an informed decision about the safety of the plant during refurbishment.

Case 2

OPG did submit an updated PSA in 2015, and informed CNSC staff and the Commission that it is compliant with Regulatory Standard S-294.

The CMD from CNSC staff presented information from OPG's PSA. What CNSC staff did not tell the Commissioners is that they had completed little or no review of the 2015 PSA.

In fact, CNSC staff only resolved all comments from the review of the *2011* PSA in early 2015.

Without some review of a regulatory document such as a PSA, the CNSC staff cannot endorse the results and findings of the document. As a minimum CNSC staff should make it clear how extensive a review of regulatory documents was completed.

Case 3

Bruce Power's operating licences required the completion of S-294 compliant PSAs by the end of 2013. Bruce Power did not complete the PSAs until late 2014.

Bruce Power did not inform the Commission of this issue in the 2014 day 1 licensing hearing.

CNSC staff did not inform the Commission of this issue in the 2014 day 1 licensing hearing.

CNSC management went further and actively discouraged any review of Bruce Power's PSAs by technical specialists. They argued that acceptance of the methodology was sufficient, there was no need to confirm that the PSA met the methodology.

We disagree with management's position. However, even if management's position is correct, the status of the PSA and the level of review should have been made clear to the Commissioners. This may have resulted in the imposition of licence conditions upon Bruce Power as it has done upon OPG.

Case 4

The CNSC engaged technical experts for Natural Resources Canada to review the seismic hazard for the Darlington site. This is used in the seismic PSA.

The experts from Natural Resources Canada concluded that the hazard used by OPG in its 2011 seismic PSA under-estimated the hazard by a factor of two.

It is our understanding that OPG updated its seismic hazard assessment for Darlington in 2012 or 2013 based upon a series of geological tests completed in 2011. We understand that the OPG assessment also concluded that the seismic hazard had been underestimated by a factor of two.

Neither OPG nor CNSC staff informed the CNSC Commissioners that the seismic hazard was under-estimated by a factor of two in the PSA submitted in 2015. Therefore, no information was presented by either organization on how this might affect seismic risk.

Case 5

Intervenors in recent OPG licensing hearings have asked about the impact of INES – 7 events. In particular, the extent of evacuation following an INES-7 event.

We believe that OPG completed a Level 3 PSA in 2011 2012 Darlington to support the environmental assessment required as part of the refurbishment project. The Level 3 PSA analyzed the impact of an INES-7 event upon evacuation.

OPG did not release the results of the Level 3 PSA as it was not required to do so by the rules for an environmental assessment.

Without the information from the Level 3 PSA, the CNSC Commissioners cannot judge whether Ontario's emergency response plan is adequate. Additionally, the Government of Ontario cannot fully assess the economic and social risks associated with extending the life of Darlington.

Correcting the Identified Issues

1. Assign an independent expert to review the accuracy of the claims made in this letter. Make the expert's report available to the public.

2. Instruct OPG to complete and issue a regulatory quality update of the Darlington PSA by the end of 2016.

3. Instruct the CNSC staff that in future they must prepare a public review of all studies that are mandated by the licence or the licence condition handbook, e.g. the PSA and the Safety Report. The review should include the review plan, the resources spent in the review, the findings and the importance of any deficiencies.

4. Instruct the CNSC staff to complete a review of the Darlington PSA following item 3 by Juin 30, 2017.

5. Instruct OPG to complete an assessment of off-site effects, e.g. area meeting provincial Protective Action Limits by June 30, 2017.

6. Hold a public meeting to discuss the Darlington PSA and the CNSC's review in the second half of 2017.

7. Instruct all Canadian operators that in future they must conduct an independent peer review of their PSAs. This practice is used in many jurisdictions and is mandatory in the USA.

   A peer review will confirm that a PSA has been completed following regulatory requirements, including the methodologies accepted by CNSC staff. A summary of the findings of the peer review should be issued to the public.

8. Track resolution of the findings of peer reviews at Commission meetings.

9. Instruct Bruce Power to complete a peer review of the latest PSA for Bruce B by June 30, 2017.

Appeal No. PA14-543

Information and Privacy Commissioner of Ontario

IN THE MATTER OF Appeal No. PA14-543
under the
Freedom of Information and Protection of Privacy Act, RSO 1990, c F 31

SUR-REPLY REPRESENTATIONS OF THE APPELLANT

OVERVIEW

1. The public cannot meaningfully scrutinize the government of Ontario's decisions on off-site nuclear emergency planning, namely, the planning basis or reference accident that will underlie all decisions about emergency measures to be put in place, without understanding the technical basis for those decisions. The Appellant is deeply concerned that Ontario is ill-prepared for a major nuclear accident. That concern is amplified by the government's secretive approach to nuclear emergency planning, which reveals a fundamental disregard for the lessons learned from the Fukushima Daiichi nuclear accident.

PART I – STATEMENT OF FACTS

2. The Appellant requested documents from the Ministry of Energy ("Ministry") relating to "a short project to provide technical recommendations to us (Emergency Management Ontario & Ontario Power Generation) related to the scientific basis of the PNERP" under the *Freedom of Information and Protection of Privacy Act*.[1] Ten responsive records were identified. The Ministry no longer disputes the release of Record 1.[2] Records 2-10 remain at issue.

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[1] RSO 1990, C F31 ("*FIPPA*")
[2] Representations of the Ministry of Energy dated June 8, 2015, para 10 ("Ministry Representations").

PART II – POINT IN ISSUE

3. The ten responsive records should be disclosed in their entirety.

PART III – SUBMISSIONS

4. The Appellant relies on its submission dated December 18, 2015. These Sur-Reply Representations respond to the Ministry's Reply Representations. The Appellant consents to its representations being shared with the Ministry.

A. THE MINISTRY HAS NOT PROVIDED SUFFICIENT EVIDENCE TO SHOW THE EXEMPTIONS APPLY

5. The Ministry's Representations and Reply Representations do not justify the application of sections 12, 13, 14 and 16 of *FIPPA* to the records. Exemptions to disclosure must be "limited and specific".[3] The Ministry's vague and broad claims about intermingled categories of information, inferences, and interwoven analyses do not demonstrate a real connection between the documents being withheld and the exemptions being claimed.

6. The recent decisions in PO-3642 and PO-3629 illustrate the requirement in *Ontario (Community Safety and Correctional Services) v Ontario (Information and Privacy Commissioner)*, 2014 SCC 31 that the government must prove there is a reasonable basis for concluding that the exemptions apply.[4] In PO-3642, the Ministry of Community Safety and Correctional Services ("MCSCS") was ordered to release information being withheld under subsection 13(1) relating to the Nuclear Emergency Management Coordinating Committee's ("NEMCC")

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[3] *FIPPA*, s 1(a)(ii)
[4] *Ontario (Community Safety and Correctional Services) v Ontario (Information and Privacy Commissioner)*, 2014 SCC 31, [2014] 1 SCR 674, Appellant's Book of Authorities, Tab 3, paras 59-66.

stakeholder discussion regarding engagement of the public in emergency planning. It failed to demonstrate that the NEMCC stakeholder discussion should be categorized as the advice of public servants.[5] Likewise, Ontario Power Generation ("OPG") was ordered in PO-3629 to release a copy of a spreadsheet used to calculate the Levelized Unit Energy Costs for the proposed refurbishment and life-extension of the Darlington Nuclear Generating Station. OPG did not provide sufficient evidence to demonstrate that the information had intrinsic monetary value,[6] or that it was more than merely possible or speculative that disclosure of the information could be broken down by "sophisticated prospective suppliers or contractors" to harm OPG's ability to negotiate contracts.[7]

B. SECTION 12 DOES NOT APPLY

1) <u>The records do not fall under section 12</u>

7. The records are too far removed from any future cabinet deliberation, both in time and in substance, to be covered by the introductory wording of section 12, or sections 12(1)(b) or 12(1)(c).[8] Records exempted under section 12 must be linked to a tradition of collective ministerial responsibility or Cabinet prerogative.[9] The records at issue were created during the early stages of a much larger, ongoing consultation process being conducted by MCSCS staff. The content of the records will not reveal what Cabinet might ultimately discuss at a future time when the consultation process is complete. Sections 12(1)(b) and (c)

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[5] PO-3642 (15 August 2016), Appellant's Supplementary Book of Authorities, Tab 2, para 31
[6] PO-3629 (11 July 2016), Appellant's Supplementary Book of Authorities, Tab 1, paras 24-26 ("PO-3629")
[7] PO-3629, paras 44-45
[8] PO-3199 (14 May 2013), Appellant's Book of Authorities, Tab 16, paras 43-45
[9] PO-2707 (11 August 2008), Appellant's Book of Authorities, Tab 12, p 13; P-604 (31 December 1993), Appellant's Book of Authorities, Tab 5, pp 8-9

cannot be stretched so far as to include any document created at any time in a government decision-making process.

8. It is MCSCS, through the Office of the Fire Marshall and Emergency Management ("OFMEM"), which is conducting the review of the Provincial Nuclear Emergency Response Plan ("PNERP") and planning basis. The records relate to the Ministry of Energy's 2014 presentation and report.[10]

9. Contrary to the Ministry's claim that the April 2, 2014 NEMCC meeting was held "in camera", there is no indication of this in the meeting minutes.[11] The NEMCC stakeholder meeting included representatives of the federal government, representatives from affected municipalities, and representatives from the nuclear industry, such as Bruce Power and OPG.[12] The records and more recent information have been shared with other levels of government and industry stakeholders, as acknowledged by the Ministry in its Reply Representations.[13]

10. The evidence demonstrates that at a minimum the following intervening steps to review the PNERP and planning basis have taken place, or will take place, between the Ministry's presentation at the April 2, 2014 NEMCC stakeholder meeting and its 2014 report and any ultimate decision by cabinet.

   i. The information in the records was shared with the NEMCC stakeholder committee on April 2, 2014[14];

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[10] Supplementary Affidavit of Shawn-Patrick Stensil dated August 15, 2016, Sur-Reply Submission of the Appellant, Tab 1 ("Stensil Supplementary Affidavit"), para 2
[11] Ministry's Representations, paras 3, 13; Nuclear Emergency Management Coordinating Committee Meeting Minutes dated April 2, 2014, Sur-Reply Submission of the Appellant, Tab 1A ("NEMCC minutes")
[12] NEMCC minutes, p 7
[13] Reply Representations of the Ministry of Energy dated May 18, 2016 ("Ministry's Reply Representations"), paras 11-16
[14] Ministry's Reply Representations, para 12; NEMCC minutes, p 2

ii. NEMCC created a working group at the meeting to "discuss/resolve specific PNERP issues"[15];

iii. MCSCS requested input from NEMCC stakeholders on a draft discussion paper on the PNERP in late November, 2015[16];

iv. CNSC staff met with MCSCS in December 2015[17];

v. MCSCS requested technical assistance from CNSC staff for modelling of accidents and off-site impacts[18];

vi. CNSC agreed to provide further scientific and technical work to MCSCS[19];

vii. A stakeholder consultation on the PNERP, which includes other government entities and the nuclear industry, but not the public, was completed in early 2016[20];

viii. CNSC staff met with MCSCS in April 2016 to provide the requested technical information.[21] The meeting was not conclusive and CNSC and MCSCS agreed to meet again in August 2016[22];

ix. A second stakeholder consultation on the planning basis is scheduled for late summer or early fall 2016[23];

x. A public consultation on the planning basis and PNERP through the Environmental Registry is scheduled for late fall 2016[24]; and

xi. Cabinet approval is scheduled for January 2017.[25]

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[15] NEMCC minutes, p 2
[16] Stensil Supplementary Affidavit, para 9
[17] CNSC, Exercise Unified Response Action Plan Updates dated August 18, 2016, Sur-Reply Submission of the Appellant, Tab 1I ("Exercise Unified Response Action Plan Presentation"), p 16
[18] Letter from Al Suleman, Ministry of Community Safety and Correctional Services to CNSC dated December 18, 2015, Sur-Reply Submission of the Appellant, Tab 1C ("Suleman letter"), p 1
[19] Transcripts from CNSC Public Meeting dated April 7, 2016, Sur-Reply Submission of the Appellant, Tab 1D, p 6
[20] Exercise Unified Response Action Plan Presentation, p 14
[21] Exercise Unified Response Action Plan Presentation, p 16; CNSC, Office of the Fire Marshall and Emergency Management Meeting Notes dated April 15, 2016, Sur-Reply Submission of the Appellant, Tab 1G ("OFMEM Meeting Notes")
[22] CNSC, Regulatory Oversight Report for Nuclear Power Plants in Canada: 2015 Supplemental dated August 18, 2016, Sur-Reply Submission of the Appellant, Tab 1H, p 8
[23] Exercise Unified Response Action Plan Presentation, p 14
[24] Exercise Unified Response Action Plan Presentation, p 14
[25] OFMEM Meeting Notes

11. Unless it is the government's position that the further work on the PNERP and planning basis for the last two years has been meaningless, and the upcoming public consultation will be meaningless, cabinet deliberations will necessarily be different in substance than a 2014 report and presentation created by the Ministry of Energy very early in the MCSCS's process.

2) <u>The appendices form part of the review and should be disclosed</u>

12. The initial *FIPPA* request covered "all documents" relating to the Ministry's review of the scientific basis for the PNERP. Subsection 10(2) of *FIPPA* requires disclosure of as much of a document as can reasonably be severed.[26] Appendices B, C, and D form part of the review, are directly responsive to the request and should be disclosed.[27]

C. SECTION 13 DOES NOT APPLY

13. The Ministry's decision to withhold the records actually undermines the purpose of section 13 to protect the neutrality of the public service[28] and protect the government from unfair pressure[29]. The Ministry has claimed that release of the information may interfere with MCSCS's approval process with respect to the revised planning basis assumptions.[30] While the MCSCS is seeking input from OPG and Bruce Power on the technical information underlying any revisions to the planning basis, there is no concurrent citizen engagement. This process raises concerns about the neutrality of the public service and unfair influence by

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[26] *FIPPA*, s 10(2)
[27] Ministry's Representations, para 40; Ministry's Reply Representations, para 10
[28] *Ontario (Minister of Finance) v Ontario (Information and Privacy Commissioner),* 2014 SCC 36, [2014] 2 SCR 3 ("Ontario (Minister of Finance)"), Appellant's Book of Authorities, Tab 4, at para 43
[29] PO-2725 (2008), Appellant's Book of Authorities, Tab 13, p 15
[30] Ministry's Representations, para 18

industry, and echoes the fateful regulatory approach in Japan before the Fukushima Daiichi nuclear accident.[31]

D. SECTIONS 14 AND 16 DO NOT APPLY

14. The Ministry has mischaracterized the nature of the information at issue.

15. There is no distinction between evidence regarding source term information and source term information in conjunction with associated analyses.[32] The analyses associated with source term information include the use of source terms to calculate the dose of radioactivity to the public as a result of hypothetical nuclear accidents.[33] Source terms are combined with site-specific details about a nuclear power plant, such as the terrain and prevailing winds, to estimate exposure to radioactivity off-site.[34]

16. The source term data and analyses in the records are not different in any meaningful way from previously released data.[35] CNSC released source term data and modelling for Release Category 1 accident scenarios, which are major release events, from the Darlington Probabilistic Safety Assessment.[36]

17. As well, both Switzerland and Germany have published information similar to the information in the records at issue. The Swiss government published modelling of three major accidents at each nuclear station to determine what

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[31] The National Diet of Japan, The Official Report of the Fukushima Nuclear Accident Independent Investigation Commission – Executive Summary, p 6, Submission of the Appellant, Vol 2, Tab 1T; Greenpeace International, Lessons from Fukushima dated February, 2012, Submission of the Appellant, Vol 2, Tab 1S

[32] Ministry's Reply Representations, para 24

[33] Affidavit of Frank Greening dated December 15, 2015, Submission of the Appellant, Vol. 2, Tab 2 ("Greening Affidavit"), paras 21-22

[34] Stensil Affidavit, para 20

[35] Ministry's Reply Representations, paras 27, 29

[36] Stensil Supplementary Affidavit, paras 18-20; CNSC Graphs for Release Category 1, Darlington NGS Risk Assessment Summary Report – 2012 (Refurb Project), Sur-Reply Submission of the Appellant, Tab 1E

protective measures should be in place to protect the public.[37] The German government published source terms for major accident scenarios and predicted what emergency response measures would be needed for each planning basis.[38] The Emergency Management Division of the German Federal Office for Radiation Protection recommended expanding the geographic areas covered by emergency plans.[39]

18. As explained by the Ministry, the records do not make recommendations to prevent nuclear emergencies.[40] Any site-specific detail about how or why the accident occurred is quite distinct from the numerical results of source term calculations.[41] A Design Basis Threat analysis relates to designing safeguards to protect a nuclear station from sabotage or theft of nuclear material. It is not relevant to the selection of a planning basis or off-site emergency planning.[42]

E. PUBLIC INTEREST IN DISCLOSURE

19. The public interest in disclosure outweighs the purpose of the exemptions. In the event of a nuclear accident, the public will assume the health risks, emotional stress, economic losses and societal disruption caused by inadequate emergency planning. The public has a right to understand why the government is taking certain steps, but not others, to protect it during a major nuclear accident.

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[37] Stensil Affidavit, paras 80-84; Inspection federale de la secruité nucleaire, Examen des scénarios de référence pour la planification d'urgence au voisinage des centrales nucléaires dated April 12, 2013, Submission of the Appellant, Vol 2, Tab 1V

[38] Stensil Supplementary Affidavit, paras 30-33; RODOS-based Simulation of Potential Accident Scenarios for Emergency Response Management in the Vicinity of Nuclear Power Plants dated June, 2015, Sur-Reply Submission of the Appellant, Tab 1K

[39] Florian Gering, Updated Emergency Planning Zones in Germany and the Importance of Release Source Term dated March, 2016, Sur-Reply Submission of the Appellant, Tab 1J ("Updated Emergency Planning Zones")

[40] Ministry's Representations, para 33

[41] Greening Affidavit, paras 22-23

[42] Stensil Supplementary Affidavit, para 34

20. The government has shared the information in the records with industry stakeholders.[43] NEMCC includes representatives from the nuclear industry.[44] It is only the public who does not have access to the information.

21. The Ministry agreed at paragraph 33 of its Reply Representations that the records would allow the public, in particular Shawn-Patrick Stensil and Frank Greening, to assess emergency preparedness in a more meaningful way.[45]

22. The choice of planning basis greatly impacts what emergency measures will be put in place. The Release Category 1 graphs show that the current trigger levels for an order of evacuation and KI pill consumption could extend up to 50 km from the Darlington nuclear power plant.[46] The German Federal Office for Radiation Protection also recommended expanding geographic areas covered by emergency plans on the basis of major accident models.[47]

23. Anonymous CNSC employees recently raised concerns with CNSC president Michael Binder about their ability to voice their opinions about nuclear risk. The employees detail how CNSC management discouraged them from advising the public and independent CNSC Commissioners about risk-related information during re-licensing hearings on the Bruce and Darlington nuclear stations. The employees express concern about whether the public can "judge whether Ontario's emergency plan is adequate".[48] The letter raises strong

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[43] Ministry's Reply Representations, para 12; Stensil Supplementary Affidavit, paras 5, 9-13, 26-28; Exercise Unified Response Action Plan Updates, pp 14, 16

[44] NEMCC minutes, pp 1, 7

[45] Ministry's Reply Representations, para 33

[46] Stensil Supplementary Affidavit, paras 20-21; Shawn-Patrick Stensil, Graphs to Compare Release Category 1 to Protective Action Levels, Sur-Reply Submission of the Appellant, Tab 1F

[47] Updated Emergency Planning Zones

[48] Stensil Supplementary Affidavit, paras 35-36; Letter from Anonymous CNSC Employees to CNSC President Michael Binder, Sur-Reply Submission of the Appellant, Tab 1L

concerns about the neutrality of the public service involved with the nuclear industry and further justifies release of the records to allow public scrutiny.

24. There is, and should be, vigorous debate about the selection of the planning basis that will form the foundation of Ontario's nuclear emergency plans. Toshimitsu Homma of the Japan Atomic Energy Agency's stated that before the Fukushima Daiichi nuclear accident, there was an "implicit assumption" that a severe accident could not happen and insufficient attention was paid to such accidents by authorities.[49] The Ministry's understanding of the lessons from the Fukushima Daichii nuclear accident, that the concerns raised by Japanese authorities relate only to the prevention of nuclear emergencies but not to responses to nuclear emergencies, is very narrow.[50] The public must be able to scrutinize Ontario's choice of planning basis to avoid the dangerous pitfalls of regulatory capture and complacency identified in Japan.

PART IV – ORDER REQUESTED

25. The ten records should be disclosed in their entirety. In the alternative, the records should be disclosed to the extent possible pursuant to subsection 10(2) of *FIPPA*.[51]

ALL OF WHICH IS RESPECTFULLY SUBMITTED

Dated at Toronto this 24th of August, 2016.

Jacqueline Wilson
Counsel for the Appellant

[49] Stensil Affidavit, para 76
[50] Ministry's Reply Representations, para 35
[51] *FIPPA*, s10(2)