The Detroit Edison Company
One Energy Plaza, Detroit, MI 48226-1279

DTE Energy
Detroit Edison

10 CFR 51.45
10 CFR 52.77
10 CFR 52.79

September 1, 2010
NRC3-10-0040

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

References:
1) Fermi 3
Docket No. 52-033
2) Letter from Stephen Lemont (USNRC) to Peter W. Smith (Detroit Edison), "Requests for Additional Information Related to the Environmental Review for the Combined License Application for Fermi Nuclear Power Plant, Unit 3," dated May 12, 2009
3) Letter from Jerry Hale (USNRC) to Jack M. Davis (Detroit Edison), "Request for Additional Information Letter No. 9 Related to the SRP Sections Chapter 1, 05.03.02, 09.05.02.02, 13.01.01, 13.03, and 14.03.07 for the Fermi 3 Combined License Application," dated July 29, 2009
4) Letter from Peter W. Smith (Detroit Edison) to USNRC, "Detroit Edison Company Response to NRC Request for Additional Information Letter No. 9," NRC3-09-0025 dated September 24, 2009
5) Letter from Peter W. Smith (Detroit Edison) to USNRC, "Detroit Edison Company Response to NRC Requests for Additional Information Related to the Environmental Review," NRC3-09-0010 dated June 19, 2009
6) Letter from Peter W. Smith (Detroit Edison) to USNRC, "Detroit Edison Company Response to NRC Requests for Additional Information Related to the Environmental Review," NRC3-09-0012 dated July 31, 2009
7) Letter from Peter W. Smith (Detroit Edison) to USNRC, "Detroit Edison Company Response to NRC Requests for Additional Information Related to the Environmental Review," NRC3-09-0013 dated August 25, 2009
8) Letter from Peter W. Smith (Detroit Edison) to USNRC, "Detroit Edison Company Response to NRC Requests for Additional Information Related to the Environmental Review," NRC3-09-0014 dated September 30, 2009

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9) Letter from Peter W. Smith (Detroit Edison) to USNRC, "Detroit Edison Company Response to NRC Requests for Additional Information Related to the Environmental Review," NRC3-09-0015 dated October 30, 2009
10) Letter from Peter W. Smith (Detroit Edison) to USNRC, "Detroit Edison Company Response to NRC Requests for Additional Information Related to the Environmental Review," NRC3-09-0016 dated November 23, 2009
11) Letter from Peter W. Smith (Detroit Edison) to USNRC, "Detroit Edison Company Response to NRC Requests for Additional Information Related to the Environmental Review," NRC3-09-0017 dated December 23, 2009
12) Letter from Peter W. Smith (Detroit Edison) to USNRC, "Detroit Edison Company Response to NRC Requests for Additional Information Related to the Environmental Review," NRC3-10-0025 dated July 9, 2010

Subject: Detroit Edison Company Response to NRC Requests for Additional Information Letter No. 9 and Requests for Additional Information Letter Related to the Environmental Review

In References 2 and 3, the NRC requested additional information to support the review of certain portions of the Fermi 3 Combined License Application (COLA). Since June 2009, Detroit Edison has submitted responses to all of the Requests for Additional Information (RAIs) identified in Reference 2 in a series of monthly letters (References 5 through 11). This letter is providing revised responses to five RAIs previously submitted in References 5 through 11. These responses are consistent with the schedule outlined in Appendix B of Reference 12. Additionally, Detroit Edison is providing a revised response to FSAR RAI 01-1, which was originally submitted in Reference 4.

Enclosed with this letter is a disk containing GASPAR input and output files requested by ER RAI HH5.4.2-1.

The file format and names on the enclosed disk do not comply with the requirements for electronic submission in NRC guidance document, "Guidance for Electronic Submissions to the NRC," dated May 17, 2010; the files are not ".pdf" formatted. The NRC staff requested the files be submitted in their native formats required by the software in which they are utilized to support the Environmental Report development.

If you have any questions, or need additional information, please contact me at (313) 235-3341.

I state under penalty of perjury that the foregoing is true and correct. Executed on the 1st day of September 2010.

Sincerely,

Peter W. Smith, Director
Nuclear Development – Licensing and Engineering
Detroit Edison Company

Attachments:
1) Response to FSAR RAI Question 01-1
   Response to ER RAI Question GE1.2-3
2) Response to ER RAI Question GE2-2
3) Response to ER RAI Question HH5.4.2-1
   Response to ER RAI Question HH5.4.3-3
4) Response to ER RAI Question HH5.4.4-1

cc: Adrian Muniz, NRC Fermi 3 Project Manager
Jerry Hale, NRC Fermi 3 Project Manager
Bruce Olson, NRC Fermi 3 Environmental Project Manager
Fermi 2 Resident Inspector (w/o attachments)
NRC Region III Regional Administrator (w/o attachments)
NRC Region II Regional Administrator (w/o attachments)
Supervisor, Electric Operators, Michigan Public Service Commission (w/o attachments)
Michigan Department of Natural Resources and Environment Radiological Protection Section (w/o attachments)

Attachment 1
NRC3-10-0040

Response to FSAR RAI Letter No. 9 and RAI letter related to Fermi 3 ER

RAI Question 01-1
RAI Question GE1.2-3

NRC RAIs

The following RAIs concern the U.S. Department of Energy (DOE) Nuclear Waste Fund waste disposal contract. Detroit Edison has elected to address these RAIs with a single response.

FSAR RAI 01-1

Section 302(b)(1)(B) of the Nuclear Waste Policy Act of 1982, as amended, states "The Commission, as it deems necessary or appropriate, may require as a precondition to the issuance or renewal of a license under section 103 or 104 of the Atomic Energy Act of 1954 (42 U.S.C. 2133, 2134) that the applicant for such license shall have entered into an agreement with the Secretary for the disposal of high-level radioactive waste and spent nuclear fuel that may result from the use of such license."

Please identify the DOE contract number applicable to Fermi 3 for disposal of high-level radioactive waste and spent nuclear fuel or provide Detroit Edison's plans, including the time frame, for entering into such a contract.

ER RAI GE1.2-3

Provide documentation or a description of the status of the required Nuclear Waste Fund waste disposal contract with the U.S. Department of Energy (DOE).

Supporting Information

Per the Nuclear Waste Policy Act of 1982, as amended, before a combined license can be issued by the NRC for Fermi 3, Detroit Edison must provide either proof that such a contract is in place with DOE or an official document from DOE stating that Detroit Edison is making a good faith effort to get a contract.

Supplemental Response

Detroit Edison has completed all reviews of the "Contract for Disposal of Spent Nuclear Fuel and/or High-level Radioactive Waste" prescribed by the Nuclear Waste Policy Act of 1982 (Pub. L. 97-425, 42 U.S.C. 10101 *et seq.*) and the "Amendment to Contract (for Disposal of Spent Nuclear Fuel and/or High-level Radioactive Waste)." Both the Contract and the Amendment are awaiting signature and will then be sent to the U.S. Department of Energy. Detroit Edison will notify the NRC once the fully executed contract has been received from the U.S. Department of Energy.

Attachment 2
NRC3-10-0040

Supplemental Response to RAI letter related to Fermi 3 ER

RAI Question GE2-2

NRC RAI GE2-2

Provide electronic versions of all Environmental Report Rev. 0, September 2008 (the "ER") figures in .jpeg, .png or .tif format at a resolution of at least 300 dpi.

Supporting Information

Electronic versions of the figures used in the ER at sufficiently high resolution would facilitate production of the EIS and prevent the need for redrafting figures.

Supplemental Response

Environmental Report Rev. 0 figures were provided in .tif format in Detroit Edison letter NRC3-09-0019 (ML092380595), dated July 29, 2009, in RAI GE2-2.

The NRC indicated in an email dated June 25, 2010 that 13 ER figures had poor image clarity, and were therefore unsuitable for use in the draft Environmental Impact Statement (EIS). The NRC is tracking these figure-clarity issues under RAI GE3.1-1 in their RAI status tracking document. Six additional ER figures were identified with image-clarity issues by the NRC during a conference call on August 23, 2010. To date, ten of the 19 image-clarity issues have been resolved and courtesy copies have been provided to the NRC. Detroit Edison will work with the NRC staff to resolve the remaining image clarity issues for inclusion in the draft EIS.

Additionally, on June 7, 2010, the NRC staff requested 43 figures in the ER be converted to black and white to support the issuance of the draft EIS. Detroit Edison notes that NUREG-1943, "Environmental Impact Statement for Combined Licenses (COLs) for Comanche Peak Nuclear Power Plant Units 3 and 4", dated August 2010, contains 45 color figures. Detroit Edison believes that the color figures presented in the ER are adequate for issuance of the draft EIS and will not pursue the conversion of color figures.

Proposed COLA Revision

None.

Attachment 3
NRC3-10-0040

Supplemental Response to RAI letter related to Fermi 3 ER

RAI Question HH5.4.2-1
RAI Question HH5.4.3-3

NRC RAIs

The following RAIs concern the GASPAR and MEI dose from gaseous effluent releases analyses. Detroit Edison has elected to address these RAIs with a single response.

RAI HH5.4.2-1

Provide input and output data (in electronic format) of the LADTAP and GASPAR computer codes.

Supporting Information

ESRP 5.4.2, Section III, states "Assess the computer outputs to ensure that data were entered properly and that the outputs appear normal."

The input and output files for LADTAP and GASPAR codes used in dose calculations will enable the staff to perform confirmatory analyses. Provide the basis for any factors other than defaults used as input to the computer codes.

RAI HH5.4.3-3

Provide updated calculations of dose from gaseous effluent releases for the MEI and population based on the new site layout.

Supporting Information

During the site audit it was mentioned that the site layout for Fermi 3 would change. This change may result in changes to the MEI and population doses from gaseous effluent releases. These revised estimates are needed for the analysis that will be presented in the EIS.

Supplemental Response

In the original response to ER RAI HH5.4.3-3 in Detroit Edison letter NRC3-09-0015 (ML093090165), dated October 30, 2009, the long-term, routine dispersion estimates (X/Qs) were based on ESBWR DCD Rev. 5. A supplemental response to ER RAI HH5.4.3-3 in Detroit Edison letter NRC3-10-0015 (ML100960474), dated March 30, 2010, provided the long-term, routine X/Qs for all possible release source locations determined by XOQDOQ utilizing the new-site layout described in FSAR Rev. 2, ER Rev. 1 and the joint frequency distributions provided in supplemental response to RAI 02.03.01-3 in Detroit Edison letter NRC3-10-0015.

As a result of changes to the source term in DCD Rev. 7 and utilizing previously communicated changes to the X/Qs presented in Detroit Edison Letter NRC3-10-0033 (ML102180224), dated

July 25, 2010, the gaseous effluent release calculations for the Maximum Exposed Individual (MEI), population, and biota were updated as described below.

The gaseous source term presented in DCD Rev. 7 Table 12.2-16 was increased to account for the pumped-forward design of the ESBWR feed water heaters. In a pumped-forward feed water heater configuration, a significant portion of the steam flow bypasses the condensate demineralizers, increasing the concentration of radionuclides in the reactor water and, when the methodology of NUREG-0016 is applied, increasing the concentration of radionuclides in the gaseous effluents. The full gaseous effluents predicted from DCD Rev. 7 Table 12.2-16 result in exposure that could exceed 15 mrem to the Fermi 3 MEI critical organ during a calendar year. Although based upon ANSI 18.1-1999, the gaseous effluent predicted by the NUREG-0016 methodology are overly conservative given the industries low tolerance for fuel failures and industry wide efforts to reduce radiation exposures as low as is reasonably achievable (ALARA) in operations.

Fermi 3 FSAR Section 11.5.4.5, "Offsite Dose Calculation Manual" incorporates by reference NEI 07-09A, Rev 0 which states in Section 6.3.4, "I-131, I-133, H-3 & Radionuclides in Particulate Form Effluent Dose Limit":

a. *Requirement*

1. *Methods shall be implemented to ensure that the dose to any organ of a member of the public from I^{131}, I^{133}, tritium, and all radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents released from the site to unrestricted areas from each reactor unit shall be:*
    a. *During any calendar quarter less than or equal to 7.5 mrem to the critical organ*
    b. *During any calendar year less than or equal to 15 mrem to the critical organ*
2. *Cumulative dose contributions to a member of the public from I^{131}, I^{133}, tritium, and radionuclides in particulate form with half-lives less greater than 8 days, in gaseous effluents released to unrestricted areas for the current calendar quarter and current calendar year shall be determined at least once per 31 days in accordance with Step 6.3.4.c* ("Dose Calculations").

Consistent with Subsection 11.5.4.5, the ESBWR Safety Evaluation Report (SER) for Chapter 2 recognizes that "other parameters, such as release rates, can also be adjusted to demonstrate compliance with 10 CFR Part 50, Appendix I, dose criteria." (ML100491205, see page 2-38). In accordance with FSAR Section 11.5.4.5, the Fermi 3 ODCM, and the ESBWR SER, methods shall be implemented to ensure that the annual estimated dose to the MEI is less than 15 mrem to the critical organ or thyroid. Such methods could include, if needed, altering the feed water system valve lineup to secure pump forward feed water heaters to produce an increase in the amount of the steam flow passing through the condensate demineralizer. Such actions would only be necessary should the reactor water radioiodine concentrations approach the radioiodine concentrations assumed in the calculations.

Consistent with the Fermi 3 ODCM and the ESBWR SER, Detroit Edison will limit the Fermi 3 gaseous effluent release rates by limiting the radioiodine concentrations in the reactor water to the concentrations prescribed in FSAR Table 12.2-205 in the attached markup and repeated here:

Isotope	Reactor Water Concentration	
	(MBq/gm)	(µCi/gm)
I-131	5.6 E -05	1.5 E -03
I-132	5.3 E -04	1.4 E -02
I-133	3.8 E -04	1.0 E -02
I-134	9.7 E -04	2.6 E -02
I-135	5.5 E -04	1.5 E -02

Source: DCD Rev. 5 Table 11.1-4b

These concentration limits would not present an operational issue, e.g. restricting pumped forward feed water heaters, and are representative of measured concentrations found in operating boiling water reactors, adjusting for power level, reactor water mass, and system flows, as described in DCD Section 11.1.3.

The corresponding radioiodine gaseous effluent estimates, consistent with NUREG-0016, are listed in FSAR Table 12.2-206 in the attached markup and repeated here:

Nuclide	Reactor Building	Turbine Building	Radwaste Building	Mechanical Vacuum Pump	Turbine Seal	Offgas System	Drywell
I-131	9.4E+02	5.2E+03	3.4E+02	1.8E+03	4.7E+01		3.4E+02
I-132	8.5E+03	4.6E+04	3.0E+03				4.9E+01
I-133	6.2E+03	3.4E+04	2.2E+03		8.4E+01		3.3E+02
I-134	1.5E+04	8.4E+04	5.5E+03				3.4E+01
I-135	8.6E+03	4.7E+04	3.1E+03				1.4E+02

Source: DCD Rev. 6 Table 12.2-16

The gaseous source term presented in DCD Rev. 7 Table 12.2-16 with the radioiodine concentrations in new FSAR Table 12.2-206 and the previously communicated changes to the atmospheric dispersion estimates presented in Detroit Edison Letter NRC3-10-0033 were utilized to provide updated estimates for the dose to the MEI, population, and biota.

All changes to the FSAR and ER which address the gaseous effluent releases, including MEI, population, and biota dose analyses are shown in the attached Fermi 3 COLA markups. The requested GASPAR input and output files, used for gaseous effluent release calculations, are also provided in Enclosure 1.

Proposed COLA Revision

Proposed revisions to FSAR Table 1.9-201, FSAR Chapter 11, and FSAR Chapter 12 are shown on the attached markup.

Proposed revisions to ER Sections 3.5, 5.4, and 7.2 are shown on the attached markup.

NRC3-10-0040
RAI Question HH5.4.2-1

Enclosure 1

GASPAR Input/Output Files
(following 2 pages)

GASPAR Input/Output Files

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Markup of Detroit Edison FSAR
(following 32 pages)

The following markup represents how Detroit Edison intends to reflect this RAI response in the next submittal of the Fermi 3 FSAR Revision 3. However, the same COLA content may be impacted by revisions to the ESBWR DCD, responses to other COLA RAIs, other COLA changes, plant design changes, editorial or typographical corrections, etc. As a result, the final COLA content that appears in a future submittal may be different than presented here.

Table 1.9-201 Conformance with Standard Review Plan (Sheet 28 of 47) [EF3 COL 1.9-3-A]

SRP Section	Title	Rev	Date	Specific Acceptance Criteria	Evaluation
10.4.7	Condensate and Feedwater System (Continued)			II.8	Conforms. Addressed in DCD Sections 3.9.3, 5.2.4, and 10.4.7, and DCD Tables 1.9-22 and 1.11-1.
10.4.8	Steam Generator Blowdown System (PWR)	Rev. 3	Mar-07		Not applicable to the ESBWR
10.4.9	Auxiliary Feedwater System (PWR)	Rev. 3	Mar-07		Not applicable to the ESBWR
BTP 10-1	Design Guidelines for Auxiliary Feedwater System Pump Drive and Power Supply Diversity for Pressurized Water Reactor Plants	Rev. 3	Mar-07		Not applicable to the ESBWR
BTP 10-2	Design Guidelines for Avoiding Water Hammers in Steam Generators	Rev. 4	Mar-07		Not applicable to the ESBWR
11.1	Source Terms	Rev. 3	Mar-07	II.1, II.2, II.3, II.4, II.6, II.7, II.8, II.9	Conforms. Addressed in DCD Section 12.2 and in FSAR Section 12.2.
				II.5	Conforms. Addressed in Section 11.2 and 11.3
11.2	Liquid Waste Management System	Rev. 3	Mar-07	II.1, II.2, II.3, II.4, II.5	Conforms. Addressed in DCD Sections 11.2 and 12.2, and in Section 11.2 and 12.2.
				II.6	Not applicable. Applies to ESP applications.

For acceptance criteria II.9, an alternate computer code to the BWR GALE code is used as described in the DCD.

- Labor Cost Correction Factor (LCCF) - Obtained from RG 1.110, Table A-4, this factor takes into account the relative labor cost differences among geographical regions. A factor of 1.5 is assumed in the analysis based on Fermi being located in Region II as shown on RG 1.110, Figure A-1.

A value of $1,000 per person-rem is prescribed in 10 CFR 50, Appendix I.

There are three augments which fall below the $1000 per person-rem threshold value; these are a 20 gpm cartridge filter, evaporator distillate demineralizer, and 10,000 gallon tank.

If it is conservatively assumed that each radwaste treatment system augment is a "perfect" technology that reduces the effluent dose by 100 percent, the annual cost of the augment can be determined and the lowest annual cost can be considered a threshold value. The lowest-cost option for augments is a 20 gpm cartridge filter at $11,900 per year, which yields a threshold value of 11.9 person-rem whole body or thyroid dose from liquid effluents.

Neglecting the modeling of filters in the development of the source term, the addition of a 20 gpm cartridge filter would treat only 20 percent of the total analyzed liquid radwaste discharge of 105 gpm. Assuming 100 percent effectiveness, this would represent a dose reduction of 30.07 person-rem x 20 percent = 6.014 person-rem. The cost benefit ratio for this augment is therefore greater than the $1000/person-rem and not a cost benefit augment.

The addition of an evaporator distillate demineralizer is dependent on the existence of an evaporator. Even though the cost of the option, $16,400, is below the threshold value, this system cannot be incorporated without the use of an evaporator which would have a cost greater than the ~~$21,080~~ threshold. Based on the threshold of ~~$21,080~~ and the presence of the evaporator, it is determined that this augment is not cost-beneficial.

$30,700

The cost to incorporate a 10,000 gallon tank is $18,600. The purpose of such a tank is to provide additional holdup capacity to allow decay of short-lived radionuclides prior to discharge. The 10,000 gallon tank would be used for holdup, based on 105 gpm effluent discharge; holdup time would be 95 minutes. The list of nuclides in the effluent discharge can be found from the average annual liquid release in ESBWR DCD Table 12.2-19b. By examining the half-life of each nuclide, only three of the half-lives are less than the 95 minute holdup time Compared to overall person-rem and/or $1000 per person-thyroid-rem, should be implemented in order of diminishing cost-benefit. TAC of radwaste system augments considered herein is determined following Regulatory Guide 1.110, Appendix A, assuming that Fermi 2 and Fermi 3 will have separate radwaste systems and a seven percent per year cost of money. The maximum reduction of any augment is bounded by the total annual dose exposures. As shown in Table 12.2-204, the annual whole body dose from gaseous effluents is less than ~~4.5~~ 6.7 person-rem/year whole body and ~~24.4~~ 27.1 person-rem/year thyroid for the 80-km (50-mile) population. Therefore, for augments that have a TAC below the ~~$4500 and $24,100~~ $6700 and $27,100 thresholds, the TAC is divided by the amount of the total annual dose that the augment is assumed to eliminate.

3-Ton Charcoal Absorber

The annual cost of the 3-ton charcoal absorber is $9691/year; thus, potential reductions to thyroid dose are considered. Per DCD Table 11.3-1, the total mass of charcoal in the Offgas System (OGS) is 237,000 kg (523,000 lb), or approximately 237 metric tonnes (262 tons). Addition of a 3-ton charcoal absorber provides an additional 1.1 percent capacity to the existing OGS. Section 12.2 shows that the annual airborne releases from the OGS represent approximately 4 percent of the total annual airborne releases. Additional charcoal absorbers would improve the holdup times of the xenon and krypton isotopes, but those only contribute ~~4.4~~ 4.4 percent to the thyroid dose. Therefore, additional charcoal absorber material could make a maximum improvement of ~~0.16~~ 0.18 percent of the ~~23.5~~ 27.1 person-rem/year thyroid dose, or ~~0.04~~ 0.05 person-rem/year. The $9691/year cost of the 3-ton charcoal absorber augment divided by the annual dose reduction of ~~0.04~~ 0.05 person-rem/year, results in an estimated cost of over ~~$240,000~~ 190,000/person-rem saved. This augment exceeds the cost-benefit ratio of $1000/person-rem and is eliminated from further consideration.

Charcoal Vault Refrigeration

Charcoal vault refrigeration would improve the performance of the OGS which uses activated charcoal absorber beds to minimize and control the release of radioactive material into the atmosphere by delaying release of the offgas process stream. The annual cost of the charcoal vault refrigeration system is $29,655/year. This value exceeds ~~$24,100~~ $27,100 for person-rem/year thyroid dose and ~~$4500~~ $6700 person-rem/year whole body dose; therefore this augment exceeds the cost-benefit ratio of $1000/person-rem and is eliminated from further consideration.

Main Condenser Vacuum Pump Charcoal/HEPA Filtration System

The annual cost of the main condenser vacuum pump charcoal/HEPA filtration system is $8210/year; thus, potential reductions to thyroid dose are considered. The addition of a main condenser vacuum pump charcoal/HEPA filtration system would provide for a reduction in the amount of iodides discharged from the plant. DCD Table 12.2-16 shows the mechanical vacuum pump contributes approximately 0.7 percent of the total iodine releases. The maximum improvement to the off-site dose would be 0.7 percent of ~~the 24.1~~ 27.1 person-rem/year thyroid dose, or less than 0.20 person-rem/year. The $8210/year cost of the main condenser vacuum pump HEPA filtration system augment divided by the annual dose reduction of 0.2 person-rem/year, results in an estimated cost of over $41,000/person-rem saved. This augment exceeds the cost-benefit ratio of $1000/person-rem and is eliminated from further consideration.

15,000-cfm HEPA Filtration System

ESBWR has four structures that contain potentially radioactive air: the Fuel Building, Radwaste Building, Reactor Building, and Turbine Building. Because the buildings all have flow rates that exceed the 15,000-cfm flow rate, multiple 15,000-cfm HEPA filters would be needed. The total annual cost for each 15,000-cfm HEPA filter is $17,167 for those located in the Turbine Building, and $27,952 for all other locations. The number of HEPA filters and the total annual cost for those filters is shown in Table 11.3-201.

These values all exceed ~~$21,100~~ $27,100 for person-rem/year thyroid dose and ~~$4500~~ $6700 person-rem/year whole body dose; therefore this augment exceeds the cost-benefit ratio of $1000/person-rem and is eliminated from further consideration.

Charcoal/HEPA Filtration Systems

Table A-1 of Regulatory Guide 1.110 lists several charcoal/HEPA filtration system sizes, 1000-cfm, 15,000-cfm, and 30,000-cfm. It is assumed that these are to be combined in the most economical manner to envelope the building flow rates. There are different direct costs for the 15,000-cfm and 30,000-cfm systems depending on their location.

ESBWR has four structures that contain potentially radioactive air: the Fuel Building, Radwaste Building, Reactor Building, and Turbine Building. The exhaust systems for these buildings and their flow rates are listed in Table 11.3-201.

Because the buildings all have flow rates that exceed the 30,000-cfm flow rate, combinations of 1000-cfm, 15,000-cfm, and 30,000-cfm charcoal/HEPA filters are needed. The total annual cost for each 1000-cfm charcoal/HEPA filter is $8231; each 15,000-cfm charcoal/HEPA filter is $33,286 for those located in the Turbine Building, and $34,792 for all other locations; and each 30,000-cfm charcoal/HEPA filter is $54,958 for those located in the Turbine Building, and $57,578 for all other locations. The number of HEPA filters and the total annual cost for those filters is shown in Table 11.3-202. $27,100

$6700 These values all exceed ~~$24,100~~ for person-rem/year thyroid dose and ~~$4500~~ person-rem/year whole body dose; therefore this augment exceeds the cost-benefit ratio of $1000/person-rem and is eliminated from further consideration.

600-ft^3 Gas Decay Tank

The gas decay tank would be used as an augment to the OGS. The gas decay tank would be utilized to allow noble gas decay before release through the exhaust. Based on the OGS flow rate of 54 m^3/hr (31.8 cfm) (DCD Table 12.2-15), the average residence time in the decay tank is 18.9 minutes.

The total tank size would need to be sized for 4.48 hours (Kr-85m half-life) of hold-up to impact the half-lives of the Ar and Kr isotopes (with the exception of Kr-85). Fifteen 600 ft^3 tanks would be required to provide a hold-up of 4.48 hours. Each 600 ft^3 tank has a total annual cost of $27,100 $9036, and 15 tanks would cost over $135,000. This value exceeds the $6700 ~~$24,100~~ threshold for person-rem/year thyroid dose, and the ~~$4500~~ person-rem/year whole body dose; therefore this augment is not cost beneficial for dose reduction.

Conclusion

There are no gaseous radwaste system augments that are cost beneficial to implement for Fermi 3.

11.5 Process Radiation Monitoring System

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

Add the following paragraph at the end of this section.

STD COL 11.5-3-A Replace text references to DCD Table 11.5-5 with Table 11.5-201.

11.5.4.4 Setpoints

Replace the first sentence in this section with the following.

STD COL 11.5-2-A The derivation of setpoints used for offsite dose monitors described in the ODCM. Refer to Subsection 11.5.4.5 for a discussion regarding ODCM development and implementation.

11.5.4.5 Offsite Dose Calculation Manual

Replace this section with the following.

STD COL 11.5-2-A The methodology and parameters used for calculation of offsite dose and monitoring are described in the ODCM. NEI 07-09, Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description, which is under review by the NRC, is incorporated by reference. (Reference 11.5-201) The milestone for development and implementation of the ODCM is addressed in Section 13.4. **[START COM 11.5-001]** The provisions for sampling liquid and gaseous waste streams identified in Table 11.5-201and DCD Table 11.5-6 will be included in the ODCM. **[END COM 11.5-001]**

Iodine concentrations in the reactor water are maintained less than the values in Table 12.2-206 per the ODCM.

11.5.4.6 Process and Effluent Monitoring Program

Replace this section with the following.

STD COL 11.5-3-A The program for process and effluent monitoring and sampling is described in the ODCM. Refer to Subsection 11.5.4.5 for a discussion regarding ODCM development and implementation.

Instrument calibrators are normally used for calibrating gamma dose rate instrumentation. These may be self-contained, heavily shielded, multiple source calibrators. Beta and alpha radiation sources are also available for instrument calibration. Calibration sources are traceable to the National Institute of Standards and Technology, or equivalent.

Radiography sources are surveyed upon entry to the site. Radiation protection personnel maintain copies of the most recent leak test records for owner-controlled sources. Contractor radiography personnel provide copies of the most recent leak test records upon radiation protection personnel request. Radiography is conducted in accordance with approved procedures.

12.2.2.1 **Airborne Releases Offsite**

Replace this section with the following.

EF3 COL 12.2-2-A Airborne sources are calculated using the source terms given in Section 11.1.

conservative

The bases for these calculations are shown in Table 12.2-15R.

The ESBWR standard design employs three ventilation stacks (airborne release points). Individual stacks service the ventilation flows from the Reactor/Fuel Buildings (RB/FB), the Turbine Building (TB) and the Radwaste Building (RWB). The offsite airborne release analysis of the ESBWR ventilation stack design employs ~~separate~~ long term atmospheric dispersion (X/Q) and deposition (D/Q) parameter values for each release location. Fermi site-specific values for these parameters are shown in Table 12.2-15R.

Table 12.2-18bR

The subject X/Q and D/Q values in Table 12.2-15R are used in the calculation of the gaseous effluent normal operation doses in . Calculation of site-specific doses is discussed in Subsection 12.2.2.2.

Insert 1 Here

Table 12.2-15R contains values used in calculating the annual airborne release source term. ~~These source terms are provided in DCD Table 12.2-16. Design basis noble gas, iodine, and other fission product concentrations are taken from the tables in DCD Chapter 11.~~ Specific details and information on the derivation of the airborne source terms are provided in DCD Appendix 12B.

Insert 1 Section 12.2.2.1

The gaseous source term presented in DCD Table 12.2-16 accounts for the pumped forward design of the ESBWR feed water heaters. In a pumped-forward feed water heater configuration, a significant portion of the steam flow bypasses the condensate demineralizers, increasing the concentration of radionuclides in the reactor water and, when the methodology of NUREG-0016 is applied, increasing the concentration of radionuclides in the gaseous effluents. Gaseous effluents predicted from DCD Table 12.2-16 indicate that the resultant exposure could exceed 15 mrem to the Fermi 3 MEI critical organ during a calendar year. Based upon ANSI 18.1-1999, the gaseous effluent predicted by the NUREG-0016 methodology is overly conservative given the industry's low tolerance for fuel failures and industry wide efforts to reduce radiation exposures ALARA. Additionally, the NUREG-0016 calculated reactor water radioiodine concentrations, upon which the effluent release rates are based, are also overly conservative based upon the measured radioiodine concentrations seen at boiling water reactors, adjusting for power level, reactor water mass, and system flows consistent with DCD Section 11.1.3. In accordance with Subsection 11.5.4.5 and the Fermi 3 ODCM, methods, such as altering the feed water system valve lineup, if necessary, to secure pumped forward feed water heaters, are implemented to ensure that the estimated dose to the MEI is less than 15 mrem to the critical organ. Gaseous effluent release rates will be maintained by limiting the radioiodine concentrations in the reactor water to the annual limits prescribed in Table 12.2-205.

The radioiodine gaseous effluent estimates, consistent with NUREG-0016, are listed in Table 12.2-206. The gaseous source term presented in DCD Table 12.2-16 with the radioiodine concentrations in Table 12.2-206 were utilized to calculate estimates for the dose to the MEI and population. The source term for noble gas and other fission products are provided in DCD Table 12.2-16. Design basis noble gas and other fission product concentrations are taken from the tables in DCD Chapter 11. The source term for iodine is provided in Table 12.2-205. These concentration limits should not present an operational issue and are consistent with the measured concentrations found in operating boiling water reactors, adjusting for power level, reactor water mass, and system flows. Design basis iodine concentrations listed in Table 12.2-206.

and Table 12.2-206

Annual Releases

Based upon the above criteria, the normal operating source terms are given in DCD Table 12.2-16 and a comparison to 10 CFR 20 criteria is given in Table 12.2-17R. ~~For determining the maximum activity concentration at the site boundary, the site-specific X/Q values from each vent stack are conservatively assumed to be 800 meters (0.5 mile) from the site boundary.~~ This table also shows the maximum activity concentration for each nuclide at the site boundary from combined operation of Fermi 2 and Fermi 3, and the corresponding concentration limit from 10 CFR 20, Appendix B, Table 2, Column 1.

12.2.2.2 **Airborne Dose Evaluation Offsite**

Replace this section with the following.

EF3 COL 12.2-2-A

The bases for the calculation of Fermi 3-specific airborne offsite doses are provided in Table 12.2-18aR. The annual gaseous pathway doses are provided in Table 12.2-18bR. The methodology in RG 1.109 was used in determining the annual airborne dose values. The bases include values that are default parameters in RG 1.109 and other values that are Fermi 3 site-specific inputs. As part of the analysis, several sensitivities were performed to account for potentially limiting combinations of atmospheric dispersion, deposition and ingestion pathways. The ~~SSE~~ NNW direction provides the limiting ~~plume dose~~ ground exposure. The WNW direction at the site boundary provides the limiting dose for ~~non-milk iodine and particulate sources. This is conservative relative to the doses at the actual residences, vegetable gardens and meat cows.~~ The NW direction provides the limiting dose for residents and consumption of vegetables. The WNW direction ~~at the actual locations~~ provides the applicable dose ~~contribution~~ due to milk consumption. ~~In this case the cow and goat milk are both included for conservatism.~~ The NNW direction provides the limiting dose due to meat consumption. The limiting total dose is the sum of these individual limiting pathways. The results of the Fermi 3 gaseous pathway dose analysis are given in Table 12.2-18bR.

12.2.2.2.1 Compliance with 10 CFR 50, Appendix I, Sections II.B and II.C

Table 12.2-201 demonstrates that offsite doses due to Fermi 3 radioactive airborne effluents comply with the regulatory dose limits in 10 CFR 50, Appendix I, Sections II.B and II.C.

12.2.2.2.2 Compliance with 10 CFR 50, Appendix I, Section II.D

Population dose is determined for the gaseous effluent releases from Fermi 3 for both whole body dose and thyroid dose. The whole body dose is ~~4.5~~ 6.7 person-rem/yr as shown in Table 12.2-204. The thyroid dose is ~~24.1~~ 27.1 person-rem/yr. The cost-benefit analysis performed to consider gaseous radwaste augments to reduce doses due to gaseous effluents is presented in Section 11.3. Based on the results from the cost-benefit analyses, no augments are cost-beneficial. Therefore, Fermi 3 complies with 10 CFR 50, Appendix I, Section II.D.

12.2.2.2.3 Compliance with 10 CFR 20 Appendix B, Table 2, Column 1

Table 12.2-17R provides the gaseous effluent concentrations in comparison to the 10 CFR 20, Appendix B, Table 2, Column 1 limits. The Fermi 3 gaseous effluent concentrations comply with 10 CFR 20, Appendix B, Table 2, Column 1.

12.2.2.2.4 Compliance with 10 CFR 20.1301 and 20.1302

Compliance with 10 CFR 20.1301 and 20.1302 is demonstrated in Subsection 12.2.2.4.4 and 12.2.2.4.5, respectively.

12.2.2.4 Liquid Doses Offsite

Replace this section with the following.

EF3 COL 12.2-3-A

The ESBWR LWMS is designed with the capability to recycle 100 percent of the liquid radwaste (zero liquid release). The analysis of dose via liquid effluents is presented in order to provide a conservative representation of unit operation. Detroit Edison intends to operate Fermi 3 with zero liquid effluents.

Liquid pathway doses were calculated based on the criteria specified in DCD Section 12.2.2.3 for compliance with 10 CFR 50, Appendix I. Dose conversion factors and methodologies consistent with RGs 1.109 and

Using the Fermi 3-specific gaseous effluent release activities identified in Table 12.2-17R and the liquid effluent release activities identified in Table 12.2-19bR, the total annual doses to the MEI and the population resulting from Fermi 3 liquid and gaseous effluents are calculated and presented in Table 12.2-203 and Table 12.2-204, respectively.

The direct radiation contribution from operation of Fermi 3 is negligible. The direct dose contribution from Fermi 3 at two distances is provided in DCD Table 12.2-21. The annual dose of 5.93E-04 mrem/yr at 800 m (0.5 mi) is negligible. The distance to the site boundary from Fermi 3 (Reactor Building centerline) is at least 890 m (0.56 mi) and the increase in distance further reduces the low dose rate.

The total annual doses to the MEI and the population resulting from Fermi 2 liquid and gaseous effluents are provided in Table 12.2-203 and Table 12.2-204, respectively. The values shown are representative based on review of Fermi 2 annual radiological environmental reports (Reference 12.2-201).

The direct radiation contribution from operation of Fermi 2 is negligible. An evaluation of operating plants by the NRC states that:

> "...because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of light water reactors are generally undetectable and are less than 1 mrem/year at the site boundary."

The NRC concludes that the direct radiation from normal operation results in "small contributions at site boundaries" (Reference 12.2-202, Section 4.6.1.2).

Table 12.2-203 shows that the total Fermi site doses resulting from the normal operation of Fermi 2 and Fermi 3 are well within the regulatory limits of 40 CFR 190.

Table 12.2-204 shows the whole body doses from liquid and gaseous effluents doses attributable to Fermi 3 for the population within 80 km (50 mi) from the Fermi site.

12.2.2.4.5 **Compliance with 10 CFR 20.1302**

Surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas are conducted to demonstrate compliance with the dose limits given in 10 CFR 20.1302 for individual members of the public.

Table 12.2-15R Airborne Sources Calculation

[EF3 COL 12.2-2-A]

and Tables 2.3-XXX

	Calculation Bases	
	Methodology	DCD Appendix 12B
	Noble Gas Source at t=30 min	740 MBq/sec (20,000 µCi/sec)
	I-131 Release Rate	3.7 MBq/sec (100 µCi/sec)
EF3 COL 12.2-2-A	Meteorology Boundary	Table 2.3-305 and Table 2.3-306 ~~(Residences, Vegetable Gardens and Meat Cows conservatively assumed to be located at site boundary)~~
(1)		
EF3 COL 12.2-2-A	Meteorology X/Qs	
	RWB Ventilation Stack	Table 2.3-328 through Table 2.3-330
	RB/FB Ventilation Stack	Table 2.3-332 through Table 2.3-334
	TB Ventilation Stack	Table 2.3-336 through Table 2.3-338
EF3 COL 12.2-2-A	Meteorology D/Qs	
	RWB Ventilation Stack	Table 2.3-331 and Table 2.3-XXX
	RB/FB Ventilation Stack	Table 2.3-335 and Table 2.3-XXX
	TB Ventilation Stack	Table 2.3-339 and Table 2.3-XXX
	Plant Availability Factor	0.92
	Offgas System:	
	Offgas stream temperature	100°F
	Flow rate	54 m^3/hr
	K_d (Kr)	18.5 cm^3/g
	K_d (Xe)	330 cm^3/g
	K_d (Ar)	6.4 cm^3/g
	Guard tank charcoal mass	7,500 kg (single tank)
	Adsorber tank charcoal mass	27,750 kg (each)
	Adsorber tank arrangement	2 parallel trains of 4 tanks each
	Turbine Gland Sealing System Exhaust:	
	I-131 release	0.81 Ci/yr per µCi/g of I-131 in coolant
	I-133 release	0.22 Ci/yr per µCi/g of I-133 in coolant

(1) In Section 2.3.5, long-term routine release X/Q and D/Q values are determined based on meteorological data from both 1985-1989 and 2002-2007. The X/Q and D/Q values used in the airborne sources calculation are the greatest values from both time periods.

and Table 2.3-XXX through 2.3-XXX
and Table 2.3-XXX through 2.3-XXX
and Table 2.3-XXX through 2.3-XXX

Table 12.2-17R Comparison of Airborne Release Concentrations with 10 CFR 20 Limit (Sheet 1 of 5) [EF3 COL 12.2-2.A]

	Fermi 3 Annual Release		Fermi 3 Concentration		Fermi 2 + 3 Concentration	10 CFR 20 Concentration Limit	Fermi 2 + 3 Fraction of 10 CFR 20 Limit
Nuclide	**MBq/yr**	**Ci/yr**	**Bq/m^3**	**μCi/ml**	**μCi/ml**	**μCi/ml**	
Kr-83m	8.5E+01	2.3E-03	1.7E-06	4.6E-17	3.6E-12	5.0E-05	7.2E-08
Kr-85m	6.6E+05	1.8E+01	1.4E-02	3.9E-13	1.4E-10	1.0E-07	1.4E-03
Kr-85	5.2E+06	1.4E+02	1.1E-01	3.1E-12	2.2E-11	7.0E-07	3.2E-05
Kr-87	1.4E+06	3.9E+01	3.2E-02	8.6E-13	3.2E-12	2.0E-08	1.6E-04
Kr-88	2.1E+06	5.6E+01	4.6E-02	1.2E-12	5.4E-11	9.0E-09	6.0E-03
Kr-89	1.4E+07	3.7E+02	7.0E-01	1.9E-11	9.8E-11	1.0E-09	9.8E-02
Xe-131m	1.5E+05	4.1E+00	3.3E-03	8.9E-14	5.8E-12	2.0E-06	2.9E-06
Xe-133m	1.9E+02	5.2E-03	3.8E-06	1.0E-16	2.4E-12	6.0E-07	4.0E-06
Xe-133	4.1E+07	1.1E+03	4.0E+00	1.1E-10	1.1E-09	5.0E-07	2.1E-03
Xe-135m	2.2E+07	6.0E+02	7.8E+00	2.1E-10	2.1E-10	4.0E-08	5.3E-03
Xe-135	2.8E+07	7.5E+02	4.5E+00	1.2E-10	1.4E-10	7.0E-08	2.1E-03
Xe-137	2.8E+07	7.6E+02	1.8E+00	4.8E-11	7.1E-11	1.0E-09	7.1E-02
Xe-138	2.3E+07	6.3E+02	5.4E-01	1.5E-11	1.1E-10	2.0E-08	5.7E-03
I-131	8.7E+03	2.3E-01	4.0E-04	1.1E-14	2.2E-14	2.0E-10	1.1E-04
I-132	5.8E+04	1.6E+00	3.1E-03	8.3E-14	1.8E-13	2.0E-08	9.2E-06
I-133	4.3E+04	1.2E+00	2.3E-03	6.1E-14	1.4E-13	1.0E-09	1.4E-04

Insert Table 12.2-17R

Table 12.2-17R Comparison of Airborne Release Concentrations with 10 CFR 20 Limit (Sheet 2 of 5) [EF3 COL 12.2-2.A]

	Fermi 3 Annual Release		Fermi 3 Concentration		Fermi 2 + 3 Concentration	10 CFR 20 Concentration Limit	Fermi 2 + 3 Fraction of 10 CFR 20 Limit
Nuclide	MBq/yr	Ci/yr	Bq/m^3	μCi/ml	μCi/ml	μCi/ml	
I-134	1.1E+05	3.0E+00	5.6E-03	1.5E-13	3.4E-13	6.0E-08	5.7E-06
I-135	5.9E+04	1.6E+00	3.2E-03	8.6E-14	2.0E-13	6.0E-09	3.3E-05
H-3	2.8E+06	7.6E+01	5.5E-02	1.5E-12	1.6E-12	1.0E-07	1.6E-05
C-14	5.3E+05	1.4E+01	1.2E-02	3.2E-13	3.2E-13	3.0E-09	1.1E-04
Na-24	5.4E+00	1.5E-04	1.1E-07	2.9E-18	2.9E-18	7.0E-09	4.1E-10
P-32	1.3E+00	3.5E-05	2.6E-08	7.0E-19	7.0E-19	5.0E-10	1.4E-09
Ar-41	1.4E+03	3.8E-02	3.1E-05	8.3E-16	8.3E-16	1.0E-08	8.3E-08
Cr-51	1.8E+02	4.7E-03	1.4E-05	3.8E-16	3.8E-16	3.0E-08	1.3E-08
Mn-54	1.5E+02	4.1E-03	6.2E-05	1.7E-15	1.7E-15	1.0E-09	1.7E-06
Mn-56	1.1E+01	3.0E-04	2.2E-07	5.9E-18	5.9E-18	2.0E-08	2.9E-10
Fe-55	4.7E+01	1.3E-03	9.3E-07	2.5E-17	2.5E-17	3.0E-09	8.4E-09
Fe-59	2.0E+01	5.4E-04	4.8E-06	1.3E-16	1.3E-16	5.0E-10	2.6E-07
Co-58	4.0E+01	1.1E-03	3.8E-06	1.0E-16	1.0E-16	1.0E-09	1.0E-07
Co-60	3.2E+02	8.7E-03	1.1E-04	3.0E-15	3.0E-15	5.0E-11	6.0E-05
Ni-63	4.7E+02	1.3E-06	9.3E-10	2.5E-20	2.5E-20	1.0E-09	2.5E-11
Cu-64	6.9E+00	1.9E-04	1.4E-07	3.7E-18	3.7E-18	3.0E-08	1.2E-10

Table 12.2-17R Comparison of Airborne Release Concentrations with 10 CFR 20 Limit (Sheet 3 of 5) [EF3 COL 12.2-2.A]

	Fermi 3 Annual Release		Fermi 3 Concentration		Fermi 2 + 3 Concentration	10 CFR 20 Concentration Limit	Fermi 2 + 3 Fraction of 10 CFR 20 Limit
Nuclide	MBq/yr	Ci/yr	Bq/m^3	µCi/ml	µCi/ml	µCi/ml	
Zn-65	3.2E+02	8.6E-03	1.1E-05	3.0E-16	3.0E-16	4.0E-10	7.4E-07
Rb-89	2.0E-01	5.4E-06	4.0E-09	1.1E-19	1.1E-19	2.0E-07	5.4E-13
Sr-89	1.5E+02	3.9E-03	3.2E-06	8.6E-17	7.4E-16	2.0E-10	3.7E-06
Sr-90	1.0E+00	2.7E-05	2.2E-08	5.9E-19	5.0E-17	6.0E-12	8.3E-06
Y-90	8.1E-02	2.2E-06	1.6E-09	4.3E-20	4.3E-20	9.0E-10	4.8E-11
Sr-91	6.7E+00	1.8E-04	1.3E-07	3.6E-18	1.4E-14	5.0E-09	2.8E-06
Sr-92	4.6E+00	1.2E-04	9.1E-08	2.5E-18	2.2E-14	9.0E-09	2.4E-06
Y-91	1.7E+00	4.6E-05	3.4E-08	9.1E-19	9.1E-19	2.0E-10	4.6E-09
Y-92	3.7E+00	1.0E-04	7.3E-08	2.0E-18	2.0E-18	1.0E-08	2.0E-10
Y-93	7.2E+00	1.9E-04	1.4E-07	3.9E-18	3.9E-18	3.0E-09	1.3E-09
Zr-95	4.4E+01	1.2E-03	1.3E-05	3.4E-16	3.5E-16	4.0E-10	8.7E-07
Nb-95	2.4E+02	6.5E-03	4.8E-06	1.3E-16	1.3E-16	2.0E-09	6.5E-08
Mo-99	1.7E+03	4.5E-02	3.3E-05	9.0E-16	5.5E-15	2.0E-09	2.8E-06
Tc-99m	2.2E+00	5.9E-05	4.4E-08	1.2E-18	5.7E-14	2.0E-07	2.9E-07
Ru-103	1.0E+02	2.8E-03	2.0E-06	5.5E-17	5.9E-17	9.0E-10	6.5E-08
Rh-103m	3.5E-03	9.5E-08	6.9E-11	1.9E-21	1.9E-21	2.0E-06	9.4E-16
Ru-106	1.4E-01	3.8E-06	2.8E-09	7.5E-20	7.5E-20	2.0E-11	3.8E-09

Table 12.2-17R Comparison of Airborne Release Concentrations with 10 CFR 20 Limit (Sheet 4 of 5) [EF3 COL 12.2-2.A]

	Fermi 3 Annual Release		Fermi 3 Concentration		Fermi 2 + 3 Concentration	10 CFR 20 Concentration Limit	Fermi 2 + 3 Fraction of 10 CFR 20 Limit
Nuclide	MBq/yr	Ci/yr	Bq/m^3	µCi/ml	µCi/ml	µCi/ml	
Rh-106	4.5E-06	1.2E-10	8.9E-14	2.4E-24	2.4E-24	1.0E-09	2.4E-15
Ag-110m	1.0E-01	2.8E-06	2.0E-09	5.5E-20	5.5E-20	1.0E-10	5.5E-10
Sb-124	5.3E+00	1.4E-04	1.2E-06	3.1E-17	3.1E-17	3.0E-10	1.0E-07
Te-129m	1.6E+00	4.3E-05	3.2E-08	8.6E-19	8.6E-19	3.0E-10	2.9E-09
Te-131m	5.5E-01	1.5E-05	1.1E-08	2.9E-19	2.9E-19	1.0E-09	2.9E-10
Te-132	1.4E-01	3.8E-06	2.8E-09	7.5E-20	1.0E-15	9.0E-10	1.1E-06
Cs-134	1.8E+02	4.9E-03	3.8E-05	1.0E-15	1.1E-15	2.0E-10	5.4E-06
Cs-136	1.5E+01	4.0E-04	3.0E-07	8.2E-18	3.1E-17	9.0E-10	3.5E-08
Cs-137	2.7E+02	7.3E-03	6.4E-05	1.7E-15	1.8E-15	2.0E-10	8.9E-06
Cs-138	8.5E-01	2.3E-05	1.7E-08	4.6E-19	3.1E-14	8.0E-08	3.9E-07
Ba-140	7.8E+02	2.1E-02	1.6E-05	4.4E-16	2.3E-15	2.0E-09	1.2E-06
La-140	1.3E+01	3.5E-04	2.6E-07	7.0E-18	7.0E-18	2.0E-09	3.5E-09
Ce-141	2.6E+02	7.1E-03	5.8E-06	1.6E-16	1.7E-16	8.0E-10	2.1E-07
Ce-144	1.3E-01	3.5E-06	2.6E-09	7.0E-20	7.3E-18	2.0E-11	3.6E-07
Pr-144	1.6E-04	4.3E-09	3.2E-12	8.6E-23	8.6E-23	2.0E-07	4.3E-16
W-187	1.3E+00	3.5E-05	2.6E-08	7.0E-19	7.0E-19	1.0E-08	7.0E-11

Table 12.2-17R Comparison of Airborne Release Concentrations with 10 CFR 20 Limit (Sheet 5 of 5) [EF3 COL 12.2-2.A]

	Fermi 3 Annual Release		Fermi 3 Concentration		Fermi 2 + 3 Concentration	10 CFR 20 Concentration Limit	Fermi 2 + 3 Fraction of 10 CFR 20 Limit
Nuclide	MBq/yr	Ci/yr	Bq/m^3	μCi/ml	μCi/ml	μCi/ml	
Np-239	8.3E+01	2.2E-03	1.6E-06	4.5E-17	4.9E-14	3.0E-09	1.6E-05
Total (w/ H-3)	1.7E+08	4.6E+03	2.0E+01	5.3E-10	1.9E-09		1.9E-01
Total (w/o H-3)	1.7E+08	4.5E+03	2.0E+01	5.3E-10	1.9E-09		1.9E-01

Insert Table 12.2-17R

Nuclide	Fermi 3 Annual Release (MBq/yr)	(Ci/yr)	Fermi 3 Concentration (Bq/m^3)	(µCi/mL)	Fermi 2+3 (µCi/mL)	10 CFR 20 Concentration Limit (µCi/mL)	Fermi 2 + 3 Fraction of 10 CFR 20 Limit
Kr-83m	8.5E+01	2.3E-03	2.3E-06	6.3E-17	3.6E-12	5.00E-05	7.2E-08
Kr-85m	6.6E+05	1.8E+01	2.0E-02	5.3E-13	1.4E-10	1.00E-07	1.4E-03
Kr-85	5.2E+06	1.4E+02	1.6E-01	4.3E-12	2.3E-11	7.00E-07	3.3E-05
Kr-87	1.4E+06	3.9E+01	4.4E-02	1.2E-12	3.5E-12	2.00E-08	1.7E-04
Kr-88	2.1E+06	5.7E+01	6.3E-02	1.7E-12	5.5E-11	9.00E-09	6.1E-03
Kr-89	1.4E+07	3.7E+02	6.2E-01	1.7E-11	9.6E-11	1.00E-09	9.6E-02
Xe-131m	1.5E+05	4.1E+00	4.6E-03	1.2E-13	5.8E-12	2.00E-06	2.9E-06
Xe-133m	1.9E+02	5.2E-03	5.3E-06	1.4E-16	2.4E-12	6.00E-07	4.0E-06
Xe-133	4.1E+07	1.1E+03	2.8E+00	7.6E-11	1.0E-09	5.00E-07	2.1E-03
Xe-135m	2.2E+07	6.1E+02	4.5E+00	1.2E-10	1.2E-10	4.00E-08	3.0E-03
Xe-135	2.8E+07	7.5E+02	2.8E+00	7.7E-11	1.0E-10	7.00E-08	1.4E-03
Xe-137	2.8E+07	7.8E+02	1.5E+00	4.0E-11	6.3E-11	1.00E-09	6.3E-02
Xe-138	2.3E+07	6.3E+02	7.2E-01	1.9E-11	1.2E-10	2.00E-08	5.9E-03
I-131	8.7E+03	2.3E-01	3.7E-04	1.0E-14	2.1E-14	2.00E-10	1.0E-04
I-132	5.8E+04	1.6E+00	2.7E-03	7.3E-14	1.7E-13	2.00E-08	8.6E-06
I-133	4.3E+04	1.2E+00	2.0E-03	5.4E-14	1.3E-13	1.00E-09	1.3E-04
I-134	1.1E+05	2.8E+00	4.9E-03	1.3E-13	3.2E-13	6.00E-08	5.4E-06
I-135	5.9E+04	1.6E+00	2.8E-03	7.4E-14	1.8E-13	6.00E-09	3.1E-05
H-3	2.8E+06	7.2E+01	7.7E-02	2.1E-12	2.2E-12	1.00E-07	2.2E-05
C-14	5.3E+05	1.4E+01	1.6E-02	4.4E-13	4.4E-13	3.00E-09	1.5E-04
Na-24	5.9E+00	1.6E-04	1.6E-07	4.4E-18	4.4E-18	7.00E-09	6.3E-10
P-32	1.5E+00	4.1E-05	4.1E-08	1.1E-18	1.1E-18	5.00E-10	2.2E-09

Nuclide	Fermi 3 Annual Release (MBq/yr)	(Ci/yr)	Fermi 3 Concentration (Bq/m^3)	(μCi/mL)	Fermi 2+3 (μCi/mL)	10 CFR 20 Concentration Limit (μCi/mL)	Fermi 2 + 3 Fraction of 10 CFR 20 Limit
Ar-41	1.4E+03	3.8E-02	4.3E-05	1.2E-15	1.2E-15	1.00E-08	1.2E-07
Cr-51	2.7E+02	7.2E-03	1.9E-05	5.0E-16	5.0E-16	3.00E-08	1.7E-08
Mn-54	3.0E+02	8.2E-03	7.3E-05	2.0E-15	2.0E-15	1.00E-09	2.0E-06
Mn-56	1.2E+01	3.2E-04	3.3E-07	8.9E-18	8.9E-18	2.00E-08	4.5E-10
Fe-55	5.1E+01	1.4E-03	1.4E-06	3.8E-17	3.8E-17	3.00E-09	1.3E-08
Fe-59	4.1E+01	1.1E-03	6.0E-06	1.6E-16	1.6E-16	5.00E-10	3.2E-07
Co-58	8.0E+01	2.2E-03	5.6E-06	1.5E-16	1.5E-16	1.00E-09	1.5E-07
Co-60	6.6E+02	1.8E-02	1.3E-04	3.5E-15	3.5E-15	5.00E-11	7.1E-05
Ni-63	5.2E-02	1.4E-06	1.4E-09	3.9E-20	3.9E-20	1.00E-09	3.9E-11
Cu-64	7.5E+00	2.0E-04	2.1E-07	5.6E-18	5.6E-18	3.00E-08	1.9E-10
Zn-65	6.2E+02	1.7E-02	2.3E-05	6.1E-16	6.1E-16	4.00E-10	1.5E-06
Rb-89	2.0E-01	5.4E-06	5.5E-09	1.5E-19	1.5E-19	2.00E-07	7.5E-13
Sr-89	3.1E+02	8.3E-03	9.3E-06	2.5E-16	9.0E-16	2.00E-10	4.5E-06
Sr-90	1.9E+00	5.0E-05	5.4E-08	1.5E-18	5.0E-17	6.00E-12	8.4E-06
Y-90	8.9E-02	2.4E-06	2.5E-09	6.6E-20	6.6E-20	9.00E-10	7.4E-11
Sr-91	7.5E+00	2.0E-04	2.1E-07	5.6E-18	1.4E-14	5.00E-09	2.8E-06
Sr-92	4.9E+00	1.3E-04	1.4E-07	3.7E-18	2.2E-14	9.00E-09	2.4E-06
Y-91	1.9E+00	5.1E-05	5.2E-08	1.4E-18	1.4E-18	2.00E-10	7.1E-09
Y-92	3.8E+00	1.0E-04	1.0E-07	2.8E-18	2.8E-18	1.00E-08	2.8E-10
Y-93	8.1E+00	2.2E-04	2.2E-07	6.0E-18	6.0E-18	3.00E-09	2.0E-09
Zr-95	9.2E+01	2.5E-03	1.5E-05	4.2E-16	4.2E-16	4.00E-10	1.1E-06
Nb-95	5.0E+02	1.4E-02	1.4E-05	3.8E-16	3.8E-16	2.00E-09	1.9E-07
Mo-99	3.4E+03	9.3E-02	9.5E-05	2.6E-15	7.2E-15	2.00E-09	3.6E-06
Tc-99m	2.4E+00	6.5E-05	6.6E-08	1.8E-18	5.7E-14	2.00E-07	2.9E-07
Ru-103	2.1E+02	5.8E-03	5.9E-06	1.6E-16	1.6E-16	9.00E-10	1.8E-07
Rh-103m	3.8E-03	1.0E-07	1.0E-10	2.8E-21	2.8E-21	2.00E-06	1.4E-15
Ru-106	1.6E-01	4.3E-06	4.4E-09	1.2E-19	1.2E-19	2.00E-11	6.0E-09
Rh-106	5.2E-06	1.4E-10	1.4E-13	3.9E-24	3.9E-24	1.00E-09	3.9E-15
Ag-110m	1.7E-01	4.6E-06	4.7E-09	1.3E-19	1.3E-19	1.00E-10	1.3E-09

Nuclide	Fermi 3 Annual Release (MBq/yr)	(Ci/yr)	Fermi 3 Concentration (Bq/m^3)	(µCi/mL)	Fermi 2+3 (µCi/mL)	10 CFR 20 Concentration Limit (µCi/mL)	Fermi 2 + 3 Fraction of 10 CFR 20 Limit
Sb-124	1.1E+01	3.0E-04	1.4E-06	3.9E-17	3.9E-17	3.00E-10	1.3E-07
Te-129m	1.8E+00	4.9E-05	5.0E-08	1.3E-18	1.3E-18	3.00E-10	4.5E-09
Te-131m	6.0E-01	1.6E-05	1.7E-08	4.5E-19	4.5E-19	1.00E-09	4.5E-10
Te-132	1.5E-01	4.1E-06	4.1E-09	1.1E-19	1.0E-15	9.00E-10	1.1E-06
Cs-134	3.7E+02	1.0E-02	4.9E-05	1.3E-15	1.4E-15	2.00E-10	6.8E-06
Cs-136	3.1E+01	8.3E-04	8.6E-07	2.3E-17	4.6E-17	9.00E-10	5.1E-08
Cs-137	5.5E+02	1.5E-02	8.0E-05	2.2E-15	2.2E-15	2.00E-10	1.1E-05
Cs-138	8.5E-01	2.3E-05	2.3E-08	6.3E-19	3.1E-14	8.00E-08	3.9E-07
Ba-140	1.6E+03	4.4E-02	4.6E-05	1.2E-15	3.1E-15	2.00E-09	1.6E-06
La-140	1.4E+01	3.8E-04	3.9E-07	1.0E-17	1.0E-17	2.00E-09	5.2E-09
Ce-141	5.5E+02	1.5E-02	1.7E-05	4.5E-16	4.6E-16	8.00E-10	5.7E-07
Ce-144	1.6E-01	4.3E-06	4.4E-09	1.2E-19	7.3E-18	2.00E-11	3.7E-07
Pr-144	1.8E-04	4.9E-09	5.0E-12	1.3E-22	1.3E-22	2.00E-07	6.7E-16
W-187	1.4E+00	3.8E-05	3.9E-08	1.0E-18	1.0E-18	1.00E-08	1.0E-10
Np-239	9.0E+01	2.4E-03	2.5E-06	6.7E-17	4.9E-14	3.00E-09	1.6E-05
Total (w/ H-3)	1.7E+08	4.6E+03	1.3E+01	3.6E-10	1.8E-09		1.8E-01
Total (w/o H-3)	1.7E+08	4.5E+03	1.3E+01	3.6E-10	1.8E-09		1.8E-01

Table 12.2-18aR Offsite Dose Calculation Bases [EF3 COL 12.2-2-A]

	Calculation Bases	
EF3 COL 12.2-2-A	Meteorology X/Qs	Table 12.2-15R
EF3 COL 12.2-2-A	Meteorology D/Qs	Table 12.2-15R
	Airborne Release Source Term	DCD Table 12.2-16 and Table 12.2-206
	Calculation Methodology	RG 1.109
	Computer Code Utilized	GASPAR II (NUREG/CR-4653)
	Individual Consumption Rates	Table E-5 of RG 1.109
	Misc. Calculation Inputs (other than RG 1.109 default values):	
EF3 COL 12.2-2-A	Midpoint of plant operating life	20 years
EF3 COL 12.2-2-A	Fraction of year that leafy vegetables are grown	0.33
EF3 COL 12.2-2-A	Fraction of year that animals graze on pasture	0.58 for milk cows 0.67 for goats
EF3 COL 12.2-2-A	Fraction of daily feed that is pasture grass when the animal grazes on pasture	1 for cows 1 for goats
	Animal milk considered for milk pathway	Cow and Goat
EF3 COL 12.2-2-A	Annual Average Doses from Airborne Releases	

Table 12.2-18bR Gaseous Pathway Doses to the MEI [EF3 COL 12.2-2-A]

Location	Pathway		Fermi 3 Whole Body	Fermi 3 Thyroid	Fermi 3 Skin
			Annual Dose (mrem/year)		
Site Boundary (1131 m [0.7 mi] SSE)	Plume		1.0E-01	1.05E-01	2.53E-01
	Ground (SB)		2.57E-01	2.57E-01	3.01E-01
	Vegetable (SB)				
		Adult	1.08E-01	4.50E+00	4.18E-02
		Teen	1.37E-01	6.24E+00	7.02E-02
		Child	2.44E-01	1.21E+01	1.71E-01
	Meat Cow (SB)				
		Adult	2.39E-02	1.66E-01	1.69E-02
		Teen	1.82E-02	1.22E-01	1.42E-02
		Child	3.07E-02	1.89E-01	2.66-02
	Inhalation (SB)				
		Adult	1.73E-03	1.47E-01	8.61E-04
		Teen	1.76E-03	1.91E-01	8.69E-04
Site Boundary (SB) (919 m [0.57 mi] WNW)		Child	1.54E-03	2.34E-01	7.67E-04
		Infant	9.28E-04	2.13E-01	4.41E-04
In direction of Residence, GArden, Meat Cow, Goat Milk, and Cow Milk (WNW)	Goat Milk (3704 m [2.3 mi])				
		Adult	8.41E-03	3.25E-01	1.85E-03
		Teen	1.01E-02	5.15E-01	3.35E-03
		Child	1.43E-02	1.03E+00	8.15E-03
		Infant	2.43E-02	2.49E+00	1.70E-02
	Cow Milk (3513 m [2.18 mi])				
		Adult	4.81E-03	2.63E-01	1.97E-03
		Teen	6.89E-03	4.17E-01	3.60E-03
		Child	1.28E-02	8.31E-01	8.80E-03
		Infant	2.38E-02	2.02E+00	1.83E-02
	Total (Includes Plume)				

Insert Table 12.2-18bR

Table 12.2-18bR Gaseous Pathway Doses to the MEI [EF3 COL 12.2-2-A]

			Fermi 3		
			Whole Body	Thyroid	Skin
Location	Pathway		Annual Dose (mrem/year)		
		Adult	5.09E-01	5.76E+00	6.17E-01
		Teen	5.36E-01	7.85E+00	6.46E-01
		Child	6.66E-01	1.47E+01	7.69E-01
		Infant	4.11E-01	5.08E+00	5.90E-01

Notes:

1. There are no infant doses for the vegetables and meat cow pathways because infants do not consume these foods.
2. I mrem = 0.01 mSv.

Insert Table 12.2-18bR

Location	Pathway	Annual Dose (mrem/yr)			
		Total Body	Thyroid	Bone	Skin
Site Boundary (769 m [0.48 mi] NNW)	**Plume**	1.42E-01	1.42E-01	1.42E-01	3.35E-01
Site Boundary (769 m [0.48 mi] NW)	**Radioiodines and Particulates:**				
	Ground	6.96E-01	6.96E-01	6.96E-01	8.16E-01
	Inhalation				
	Adult	3.88E-03	2.43E-01	2.44E-03	1.49E-03
	Teen	3.70E-03	3.16E-01	3.38E-03	1.50E-03
	Child	2.94E-03	3.85E-01	4.53E-03	1.33E-03
	Infant	1.69E-03	3.51E-01	3.06E-03	7.63E-04
	Total (Iodine & Particulates)				
	Adult	7.00E-01	9.39E-01	6.98E-01	8.17E-01
	Teen	7.00E-01	1.01E+00	6.99E-01	8.18E-01
	Child	6.99E-01	1.08E+00	7.01E-01	8.17E-01
	Infant	6.98E-01	1.05E+00	6.99E-01	8.17E-01
Residence (957 m [0.59 mi]) + Garden (960 m [0.60] mi NW)	**Radioiodines and Particulates:**				
	Ground	4.95E-01	4.95E-01	4.95E-01	5.81E-01
	Vegetable				
	Adult	1.73E-01	3.89E+00	4.18E-01	5.38E-02
	Teen	2.07E-01	5.41E+00	6.96E-01	9.03E-02
	Child	3.37E-01	1.05E+01	1.68E+00	2.20E-01
	Inhalation				
	Adult	2.81E-03	1.85E-01	1.74E-03	1.14E-03
	Teen	2.72E-03	2.40E-01	2.41E-03	1.16E-03
	Child	2.23E-03	2.93E-01	3.23E-03	1.02E-03
	Infant	1.29E-03	2.68E-01	2.20E-03	5.87E-04
	Total (Iodine & Particulates)				
	Adult	6.71E-01	4.57E+00	9.15E-01	6.36E-01
	Teen	7.05E-01	6.15E+00	1.19E+00	6.72E-01
	Child	8.34E-01	1.13E+01	2.18E+00	8.02E-01
	Infant	4.96E-01	7.63E-01	4.97E-01	5.82E-01
Meat Cow (4754 m [2.95 mi] NNW)	**Radioiodines and Particulates:**				
	Ground	1.07E-02	1.07E-02	1.07E-02	1.26E-02
	Cow Meat				
	Adult	1.61E-03	4.93E-03	6.67E-03	1.29E-03
	Teen	1.27E-03	3.72E-03	5.62E-03	1.09E-03
	Child	2.22E-03	6.02E-03	1.05E-02	2.05E-03
	Inhalation				
	Adult	1.31E-04	8.69E-03	6.62E-05	7.40E-05

Location	Pathway	Annual Dose (mrem/yr)			
		Total Body	Thyroid	Bone	Skin
	Teen	1.32E-04	1.13E-02	9.16E-05	7.46E-05
	Child	1.14E-04	1.37E-02	1.23E-04	6.59E-05
	Infant	6.68E-05	1.25E-02	8.54E-05	3.79E-05
	Total (Iodine & Particulates)				
	Adult	1.25E-02	2.43E-02	1.75E-02	1.39E-02
	Teen	1.21E-02	2.57E-02	1.64E-02	1.37E-02
	Child	1.31E-02	3.04E-02	2.13E-02	1.47E-02
	Infant	1.08E-02	2.32E-02	1.08E-02	1.26E-02
Milk Cow (3363 m [2.09 mi] WNW)	**Radioiodines and Particulates:**				
	Ground	2.90E-02	2.90E-02	2.90E-02	3.40E-02
	Cow Milk				
	Adult	8.56E-03	2.84E-01	1.76E-02	2.53E-03
	Teen	1.13E-02	4.52E-01	3.22E-02	4.64E-03
	Child	1.86E-02	9.00E-01	7.80E-02	1.13E-02
	Infant	3.28E-02	2.18E+00	1.46E-01	2.37E-02
	Inhalation				
	Adult	2.41E-04	1.61E-02	1.26E-04	1.31E-04
	Teen	2.42E-04	2.09E-02	1.74E-04	1.32E-04
	Child	2.08E-04	2.55E-02	2.32E-04	1.17E-04
	Infant	1.23E-04	2.32E-02	1.62E-04	6.71E-05
	Total (Iodine & Particulates)				
	Adult	3.78E-02	3.30E-01	4.67E-02	3.67E-02
	Teen	4.05E-02	5.01E-01	6.13E-02	3.88E-02
	Child	4.78E-02	9.55E-01	1.07E-01	4.54E-02
	Infant	6.19E-02	2.24E+00	1.76E-01	5.77E-02
Milk Goat (3554 m [2.21 mi] WNW)	**Radioiodines and Particulates:**				
	Ground	2.57E-02	2.57E-02	2.57E-02	3.01E-02
	Goat Milk				
	Adult	1.68E-02	3.48E-01	2.38E-02	2.39E-03
	Teen	1.86E-02	5.53E-01	4.32E-02	4.34E-03
	Child	2.24E-02	1.10E+00	1.05E-01	1.05E-02
	Infant	3.48E-02	2.67E+00	1.88E-01	2.19E-02
	Inhalation				
	Adult	2.17E-04	1.45E-02	1.12E-04	1.20E-04
	Teen	2.19E-04	1.88E-02	1.54E-04	1.21E-04
	Child	1.89E-04	2.30E-02	2.07E-04	1.07E-04
	Infant	1.11E-04	2.10E-02	1.44E-04	6.17E-05
	Total (Iodine & Particulates)				
	Adult	4.27E-02	3.88E-01	4.96E-02	3.26E-02
	Teen	4.45E-02	5.98E-01	6.91E-02	3.46E-02
	Child	4.83E-02	1.15E+00	1.30E-01	4.07E-02
	Infant	6.06E-02	2.72E+00	2.14E-01	5.21E-02

Table 12.2-201 Comparison of Annual Doses to the MEI from Gaseous Effluents

[EF3 COL 12.2-2-A]

Type of Dose	Location	Fermi 3	10 CFR 50 Limit
Gamma Air (mrad/yr)	Site Boundary (1131 m [0.70 mi] SSE)	1.62E-01	10
Beta Air (mrad/yr)	Site Boundary (1131 m [0.70 mi] SSE)	2.00E-01	20
Whole Body (mrem/yr)	Site Boundary (1131 m [0.70 mi] SSE)	6.66E-01	5
Skin (mrem/yr)	Site Boundary (1131 m [0.70 mi] SSE)	7.69E-01	15
Iodines and Particulates – Max Organ Thyroid (mrem/yr)	WNW Direction, Site Boundary (919 m [0.57 mi]) for Residence, Garden and Meat Cow 3704 m [2.3 mi} for Goat Milk 3513 m [2.18 mi]) for Cow Milk	1.47E+01	15

1 mrad = 0.01 mGy
1 mrem = 0.01 mSv

Insert Table 12.2-201

Insert Table 12.2-201

Type of Dose	Location	Fermi 3	10 CFR50 Limit
Gamma Air (mrad/yr)	Site Boundary (769 m [0.48 mi] NNW)	~~1.90E-01~~ 2.18E-01	10
Beta Air (mrad/yr)	Site Boundary (769 m [0.48 mi] NNW)	~~2.33E-01~~ 2.59E-01	20
Whole Body (mrem/yr) [Includes Plume Exposure]	Table 12.2-18bR	~~5.69E-01~~ 9.76E-01	5
Skin (mrem/yr) [Includes Plume Exposure]	Table 12.2-18bR	~~7.17E-01~~ 1.15E+00	15
Iodines and Particulates – Max Organ Thyroid (mrem/yr)	Table 12.2-18bR	~~1.08E+01~~ 1.13E+01	15

1 mrad = 0.01 mGy
1 mrem = 0.01 mSv

Table 12.2-203 Comparison of Site Doses to the MEI

[EF3 COL 12.2-2-A] [EF3 COL 12.2-3-A]

	Fermi 3 (ESBWR)				Site	40 CFR 190
Type of Dose	Liquid	Gaseous	Total	Fermi 2	Total[1]	Limit
Whole Body (mrem/yr)	0.006	0.67	0.68	4.68	5.36	25
Thyroid (mrem/yr)	0.026			2.66	17.39	75
Bone (mrem/yr)	0.088	1.81	1.90	0.052	1.95	25

Insert Table 12.2-203

Notes:

1. This site total dose includes the Fermi 3 total dose and the dose from Fermi 2.
2. 1 mrem = 0.01 mSv

Insert Table 12.2-203

Type of Dose	Fermi 3 (ESBWR) Liquid	Fermi 3 (ESBWR) Gaseous	Fermi 3 (ESBWR) Total	Fermi 2	Site Total (1)	40 CFR 190 Limit
Whole Body (mrem/yr)	0.006	~~0.569~~	~~0.58~~	4.68	~~5.26~~	25
Thyroid (mrem/yr)	0.026	~~10.8~~	~~10.83~~	2.66	~~13.49~~	75
Bone (mrem/yr)	0.088	~~1.29~~	~~1.38~~	0.05	~~1.43~~	25

Gaseous	Total	Site Total
0.976	0.98	5.66
11.3	11.33	13.99
2.18	2.27	2.32

Table 12.2-204 Collective Total Body (Population) Doses Within 50 Miles [EF3 COL 12.2-2-A] [EF3 COL 12.2-3-A]

Units in person-rem/yr

	Fermi 3
Total Body (Liquid)	14.9
Bone (Liquid)	104.2
Thyroid (Liquid)	30.1
Total Body (Gaseous)	~~4.5~~ 6.7
Max Organ – Thyroid (Gaseous)	~~24.1~~ 27.1

1 rem = 0.01 Sv

Table 12.2-205 Fermi 3 Normal Operational Iodine Radioisotopes in Reactor Water (Based on Fermi 3 ODCM) [EF3 COL 12.2-2-A]

Isotope	Decay Constant	Water Concentration	
		(MBq/gm)	µCi/gm)
I-131	3.59E-03	5.6E-05	1.5E-03
I-132	3.03E-01	5.3E-04	1.4E-02
I-133	3.33E-02	3.8E-04	1.0E-02
I-134	7.91E-01	9.7E-04	2.6E-02
I-135	1.05E-01	5.5E-04	1.5E-02

Table 12.2-206 Fermi 3 Annual Airborne Iodine Releases for Offsite Dose Evaluations (MBq) - Based on Reactor Water Iodine Concentrations in Table 12.2-205** [EF3 COL 12.2-2-A]

Nuclide	Reactor Building	Turbine Building	Radwaste Building	Mechanical Vacuum Pump	Turbine Seal	Offgas System	Drywell
I-131	9.4E+02	5.2E+03	3.4E+02	1.8E+03	4.7E+01		3.4E+02
I-132	8.5E+03	4.6E+04	3.0E+03				4.9E+01
I-133	6.2E+03	3.4E+04	2.2E+03		8.4E+01		3.3E+02
I-134	1.5E+04	8.4E+04	5.5E+03				3.4E+01
I-135	8.6E+03	4.7E+04	3.1E+03				1.4E+02

** The releases (as designated in the table column headings) from the building stacks are as follows:
Reactor Building/Fuel Building stack: "Reactor Building" and "Drywell"
Turbine Building stack: "Turbine Building", "Mechanical Vacuum Pump", "Turbine Seal", and "Offgas System"
Radwaste Building stack: "Radwaste Building"

Markup of Detroit Edison ER
(following 18 pages)

The following markup represents how Detroit Edison intends to reflect this RAI response in the next submittal of the Fermi 3 ER Revision 2. However, the same COLA content may be impacted by revisions to the ESBWR DCD, responses to other COLA RAIs, other COLA changes, plant design changes, editorial or typographical corrections, etc. As a result, the final COLA content that appears in a future submittal may be different than presented here.

3.5 Radioactive Waste Management System

This section describes the liquid, gaseous, and solid radioactive waste (radwaste) treatment systems and the instrumentation used to monitor the effluent release points. The information includes the origin, treatment, and disposal of all liquid, gaseous, and solid radioactive wastes generated by the station during normal operation including anticipated operational occurrences (e.g., refueling, purging, equipment downtime, maintenance). Low Level Mixed Waste is discussed in Subsection 3.6.3.4.

During normal operations of reactors, fission neutrons can activate nonradioactive materials normally present in the reactor coolant. Trace metals such as iron, cobalt, and manganese can become activated. Small amounts of fission-activated products within the fuel can enter the coolant by diffusing through the fuel cladding, or by escaping through fuel cladding leaks, if they occur. Thus, the reactor coolant normally carries materials with varying degrees of radioactivity. The sources of radioactivity and the source terms used for the design of the radioactive waste management systems are described in DCD Chapter 11 (Reference 3.5-1).

The radioactive waste management systems are designed to maintain releases of radioactive materials in effluents to "as low as reasonably achievable" levels in conformance with 10 CFR Parts 20 and 50, including the design objectives of 10 CFR 50 Appendix I. Brief descriptions of the radioactive waste management systems are provided in this section. More complete descriptions of the radioactive waste management systems design, including process flow diagrams, are included in DCD Sections 11.2, 11.3, and 11.4.

3.5.1 **Source Terms**

The sources of radioactivity that serve as input to the liquid, gaseous, and solid radioactive waste treatment systems for normal operation (including anticipated operational occurrences) are described in DCD Section 11.1. These sources include fission products (noble radiogas, radioiodines, and transuranic nuclides) and activation products (coolant, non-coolant, tritium, and Argon-41). ~~DCD~~ FSAR Section 12.2 provides additional information on plant sources of radioactivity.

The calculation model used to determine the activity of each radionuclide in the primary containment is based on the ANSI/ANS 18.1 source terms (Reference 3.5-2) with appropriate adjustment factors applied. The details of the model, including the fission product noble gas release rate used, are provided in DCD Section 11.1.

Regulatory Guide 1.112, Appendix A, provides a listing of data needed for radioactive source term calculations for Boiling Water Reactors. General data needed for calculation of the radioactive source term is provided in DCD Sections 11.1, 11.2, and 11.3. Additional information on condensate demineralization and condensate and gland seal air removal systems is provided

in DCD Sections 10.4.6 and 10.4.3, respectively. The ESBWR DCD concluded that the ESBWR conforms to Regulatory Guide 1.112 as shown in DCD Table 1.9-21 (Reference 3.5-1). There are no site-specific parameters that change that conclusion.

DCD Section 9.4 describes the building HVAC systems servicing the Fuel Building, Turbine Building, Radwaste Building, and Reactor Building, and includes process diagrams for each system. Detailed discussion of the potential sources of airborne activity to each of these systems is provided in DCD Section 12.2.3. This includes information on airborne sources from the fuel pool resulting from refueling activities.

During periods of high radioactivity, the Reactor Building and Fuel Building HVAC systems may direct exhaust to the Reactor Building HVAC purge exhaust filter unit. The Reactor Building purge exhaust filter units are equipped with prefilters, high efficiency particulate air (HEPA) filters and carbon filters for mitigating and controlling gaseous effluents from the Reactor Building or Fuel Building. DCD Table 9.4-11 provides design information for the Reactor Building purge exhaust filter units. The exhaust air is monitored for radiation prior to discharge to atmosphere through the RB/FB stack.

The Radwaste Building HVAC system directs exhaust air to exhaust filtration units. The system uses HEPA filtration of the exhaust air from the building prior to discharge to the atmosphere. The exhaust air is monitored for radiation prior to discharge to atmosphere through the RW stack. DCD Table 9.4-7 provides design information for the Radwaste Building HVAC system.

The Turbine Building HVAC system directs building exhaust air to filtration units. Exhaust air from low potential contamination areas is exhausted to the TB stack, where it is monitored for radioactive contamination. Exhaust air from high potential contamination areas is filtered using HEPA filters before being exhausted to the TB stack. Areas with high potential contamination have exhaust subsystems equipped with HEPA filtration units for localized air cleanup prior to mixing with the main ventilation exhaust. The Turbine Building combined ventilation exhaust is monitored for halogens, particulates and noble gas releases. Turbine Building exhaust air is directed to the TB stack where it is monitored for radiation prior to being discharged to the atmosphere.

Process radiation monitoring is provided for the systems described above. FSAR Section 11.5 describes the PRMS in further detail.

as supplemented by FSAR Table 12.2-206

The bounding ~~annualized~~ airborne radioactivity source terms for Fermi 3 are shown in DCD Table 12.2-16. The parameters used for determining the release characteristics are shown in ~~DCD Table 12.2-15.~~ The resulting bounding annualized release was used in determining the radiological impacts of operation. This analysis, resulting impact determinations, and evaluation showing conformance with 10 CFR 50, Appendix I design objectives are described in more detail in Section 5.4.

FSAR Table 12.2-15R

3.5.2.3 Solid Waste Management System

Certain amounts of radioactive materials are generated in solid form. The Solid Waste Management System (SWMS) collects, processes, packages, and temporarily stores these solid radioactive wastes for offsite shipment and permanent disposal.

The SWMS controls, collects, handles, processes, packages, and temporarily stores solid waste generated by the plant prior to shipping the waste offsite. These wastes include filter backwash

In lieu of onsite storage, Fermi 3 could enter into a commercial agreement with a third-party contractor that will process, store, own, and ultimately dispose of low-level waste generated as a result of Fermi 3 operations. Activities associated with the transportation, processing, and ultimate disposal of low level waste by the third-party contractor would necessarily comply with all applicable laws and regulations in order to assure public health and safety and protection of the environment. In particular, the third-party contractor would conduct its operations consistent with applicable Agreement State or NRC regulations (e.g., 10 CFR Part 20), which will assure that the radiological impacts from these activities would be small. Environmental impacts resulting from management of low-level wastes are expected to be bounded by the NRC's findings in 10 CFR 51.51(b) (Table S-3). Table S-3 assumes that solid, low-level waste from reactors will be disposed of through shallow land burial, and concludes that this kind of disposal will not result in the release of any significant effluent to the environment.

3.5.2.4 **Population Doses**

Population doses offsite were determined for airborne and liquid release pathways. A detailed discussion of the calculation methods and inputs is provided in Section 5.4.

Results of the analysis and conformance with 10 CFR 20 and 10 CFR 50, including the design objectives of 10 CFR 50, Appendix I are provided in Section 5.4.

3.5.3 **References**

3.5-1 GE-Hitachi Nuclear Energy, "ESBWR Design Control Document – Tier 2," Revision ~~6, August 2009.~~ 7, March 2010.

3.5-2 ANSI/ANS 18.1, "Source Term Specification," 1976.

3.5-3 EPRI Class B/C Waste Reduction Guide (November 2007).

3.5-4 EPRI Operational Strategies to Reduce Class B/C Wastes (April 2007).

(noble gas and other fission products) and FSAR Table 12.2-206 (iodines)

5.4 Radiological Impacts of Normal Operation

This section describes the radiological impacts of normal plant operation on members of the public, plant workers, and biota. A 50-mile region of interest is chosen for determining impacts to the general public although maximum impacts to individuals are calculated for the immediate plant environs. Subsection 5.4.1 describes the exposure pathways by which radiation and radioactive effluents could be transmitted from Fermi 3 to organisms living near the plant. Subsection 5.4.2 estimates the maximum doses to the public from the operation of Fermi 3. Subsection 5.4.3 evaluates the impacts of these doses by comparing them to regulatory limits. In addition, the impact of Fermi 3 in conjunction with Fermi 2 is compared to the corresponding regulatory limit. Subsection 5.4.4 considers the impact to non-human biota.

5.4.1 Exposure Pathways

DCD

Radioactive gases would be discharged to the environment during normal operation of Fermi 3. Fermi 3 is planned to be operated as a zero liquid effluent discharge plant. However, the analyses discussed herein conservatively assume that liquid effluents are discharged as part of normal operation. The released quantities have been estimated in ESBWR Tables 12.2-16 (gases) and 12.2-19b (liquids) (Reference 5.4-10). The impact of these releases and any direct radiation to individuals, population groups, and biota in the vicinity of Fermi 3 was evaluated by considering the most important pathways from the release to the receptors of interest. The major pathways are those that could yield the highest radiological doses for a given receptor. The relative importance of a pathway is based on the type and amount of radioactivity released, the environmental transport mechanism, and the consumption or usage factors of the receptor.

The exposure pathways considered and the analytical methods used to estimate doses to the maximally exposed individual (MEI) and to the population surrounding the new unit are based on Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50, Appendix I" (Reference 5.4-1) and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," (Reference 5.4-2). An MEI is a member of the public located to receive the maximum possible calculated dose. The annual dose to each nearby receptor indicated in Section 2.7 from the estimated releases from Fermi 3 was calculated, and the maximum of those was denoted the MEI. The use of the MEI allows comparisons with established dose criteria to the public.

5.4.1.1 Liquid Pathways

As noted above, Fermi 3 is designed for zero liquid effluent discharge during normal operation. However, the analyses discussed herein conservatively assume that liquid effluents are discharged as part of normal operation. For this analysis, the liquid effluents would be released through the Circulating Water (CIRC) blowdown line, approximately 1300 feet into Lake Erie. Dilution would occur due to mixing of the liquid effluent with the normal CIRC blowdown. Additional dilution would occur in Lake Erie. The dilution factors in Lake Erie are determined as part of the thermal analysis. The LADTAP II computer program (Reference 5.4-4) was used to calculate these doses with parameters specific to Lake Erie. This program implements the radiological exposure models described in Regulatory Guide 1.109 for radioactivity releases in liquid effluent. The following exposure pathways are considered in LADTAP II:

- Ingestion of drinking water from Lake Erie
- Ingestion of aquatic organisms as food
- External exposure to contaminated sediments deposited along the shoreline (shoreline exposure)

Although less important, as determined by LADTAP II calculations, the swimming and boating exposure pathways are also considered in the analysis. The program also considers ingestion of food sources that use the affected water for irrigation. However, as discussed in Subsection 2.3.2, water from Lake Erie in the vicinity of Fermi 3 is not used for irrigation. The site-specific input parameters for the liquid pathway are presented in Table 5.4-1.

5.4.1.2 **Gaseous Pathways**

The GASPAR II computer program (Reference 5.4-11) was used to calculate the doses to offsite receptors (the general public within 50 miles and the nearest individual receptors in various directions) from Fermi 3. This program implements the radiological exposure models described in Regulatory Guide 1.109 to estimate the doses resulting from radioactive releases in gaseous effluent. The atmospheric dispersion component of the analysis was calculated with the XOQDOQ computer program (Reference 5.4-5). Dispersion and deposition factors were calculated from validated onsite meteorological parameters (wind speed, wind direction, stability class) for the combined years 2002 through 2007 ~~as described in Section 2.7.~~ and 1985 through 1989)

Section 2.7 describes the meteorological data, gives the dispersion and deposition factors, and gives the locations of the individual receptors (distance and direction) relative to Fermi 3.

The following exposure pathways are considered in GASPAR II:

- External exposure to contaminated ground
- External exposure to gases in air
- Inhalation of airborne activity
- Ingestion of contaminated meat and milk
- Ingestion of contaminated garden vegetables

The spatial distribution of population was discussed in Section 2.5. The agricultural production for the 50 miles surrounding the site was developed from information in Section 2.2. The input parameters for the gaseous pathway are presented in Table 5.4-3.

5.4.1.3 **Direct Radiation from Fermi 3**

The primary objective of radiation shielding is to protect operating personnel and the general public from radiation emanating from the reactor, power conversion systems, radwaste process systems and auxiliary systems.

Figure 4.5-2 shows the locations of thermoluminescent dosimeter (TLD) measurements at Fermi 2. Measurements show that the direct dose levels at the site boundary are at background levels.

Shielding in Fermi 3 is provided to protect the general public outside the controlled area. The direct dose contribution from Fermi 3 is provided at two distances in DCD Table 12.2-21. The DCD annual dose at 800 meters is 5.93E-04 mrem/year. The distance from Fermi 3 to the site boundary is at least 890 meters. Therefore, the value from DCD Table 12.2-21 is conservative. This annual dose is considered to be negligible.

(Reactor Building centerline)

5.4.2 Radiation Doses to Members of the Public (Individuals)

Doses to MEIs residing near Fermi 3, from liquid and gaseous effluents are estimated using the methodologies and parameters specified in Subsection 5.4.1. Collective doses to the general public from Fermi 3 are described in Subsection 5.4.3.

Doses from the ISFSI to Fermi 3 construction workers are discussed in Section 4.5. These dose values are representative of doses anticipated during Fermi 3 operations.

It is noted that radiation is naturally present in the environment. It comes from outer space (cosmic), the ground (terrestrial), and even from our own bodies. It is present in the air breathed, the food and water consumed, and in the construction materials used to build homes. The average annual radiation exposure from natural sources to an individual in the United States is about 300 mrem (Reference 5.4-3).

5.4.2.1 Liquid Pathway Doses

Based on the parameters shown in Table 5.4-1, the LADTAP II computer program was used to calculate the important doses to the MEI via the following activities:

- Drinking contaminated water
- Eating fish and invertebrates caught in Lake Erie
- Shoreline exposure

The liquid activity releases (source terms) for each radionuclide in the discharge are described in Subsection 3.5.1. The MEI for the total body dose is determined to be an adult. The maximum organ dose occurs to the bone for a child. The maximum annual doses to the total body and organs from all pathways for all age groups calculated by the LADTAP program are presented in Table 5.4-4.

5.4.2.2 Gaseous Pathway Doses

Based on the parameters in Table 5.4-3, the GASPAR II computer program was used to calculate doses to the MEI child, who represents the bounding age group for total body and all organs. GASPAR determined that a child was the MEI because of the greater sensitivity of that age group to internal exposure from vegetables and meat. The gaseous activity releases (source terms) for each radionuclide are described in Subsection 3.5.1. The annual pathway components for the total

The NW direction provides the limiting dose for residents and consumption of vegetables.

ground exposure.

body, thyroid, and other organ doses calculated by the GASPAR computer program for this individual are presented in Table 5.4-5.

As part of the analysis, several sensitivities were performed to applicable account for potentially limiting combinations of atmospheric dispersion, deposition and ingestion pathways. The ~~SSE~~ NNW direction provides the limiting plume dose. The ~~WNW~~ direction at the site boundary provides the limiting dose for ~~non-milk iodine and particulate sources.~~ ~~This is conservative relative to the doses at the actual residences, vegetable gardens and meat cows.~~ The WNW direction ~~at the actual locations~~ provides the dose contribution due to milk consumption. ~~In this case the cow and goat milk both included for conservatism.~~ The total dose is the sum of these individual contributions.

As shown in Table 5.4-5, the annual total body dose to the MEI is ~~0.67~~ 0.98 mrem to a child, and the maximum annual thyroid dose of ~~14.7~~ 11.3 mrem to a child. Experience at Fermi 2 (Reference 5.4-6) indicates that these calculations are likely very conservative.

The NNW direction provides the limiting dose due to meat consumption.

5.4.2.3 **Summary**

The maximum doses due to the liquid and gaseous effluents are summarized in Table 5.4-5. As shown, all results are well within the 10 CFR 50, Appendix I limits. Therefore, the impacts are SMALL and no mitigation actions are necessary.

5.4.3 **Impacts to Members of the Public (Individual and Collective Dose to the Public and Comparison with Regulations)**

The radiological impacts to individuals and population groups from liquid and gaseous effluents are presented using the methodologies and parameters specified in Subsection 5.4.1. Table 5.4-5 estimates the total body and organ doses to the MEI from liquid effluents and gaseous releases from Fermi 3 for analytical endpoints prescribed in 10 CFR 50, Appendix I. The MEI receptor age group and location are those described in Subsection 5.4.2. As Table 5.4-5 indicates, the predicted doses are below Appendix I limits. These results are discussed in Subsection 5.4.2.3, above.

The total site liquid and gaseous effluent doses from Fermi 2 plus Fermi 3 would be well within the regulatory limits of 40 CFR 190 (Table 5.4-8). As indicated in NUREG-1555, demonstration of compliance with the limits of 40 CFR 190 is considered to be in compliance with the 0.1 rem limit of 10 CFR 20.1301.

Table 5.4-6 and Table 5.4-7 show the total body dose to the population within 50 miles that would be attributable to Fermi 3. Based on the information in these tables, the total whole body dose due to liquid and gaseous effluents from Fermi 3 is ~~19.4~~ 21.6 person-rem/year. As discussed above, the average annual radiation exposure from natural sources to an individual in the United States is about 300 mrem (Reference 5.4-3). Multiplying this by the population of 7,713,709 (Table 5.4-1), results in 2,300,000 person-rem/year. Thus, the dose from Fermi 3 is less than 0.001 percent of that received by the population from natural causes. Impacts to members of the public from operation of Fermi 3 would be SMALL and would not warrant mitigation.

Occupational exposure to Fermi 3 workers from Fermi 3 sources are described in the ESBWR DCD (Reference 5.4-12), Section 12.4. After consideration of shielding provided by the Fermi 3 facilities, occupational exposure from other sources on-site are relatively insignificant. As described in the Fermi 3 FSAR, Appendix 12AA, occupational exposure at Fermi 3 will be maintained as low as reasonably achievable (ALARA).

5.4.4 **Impacts to Biota Other than Members of the Public**

Subsection 2.4.1 and Subsection 2.4.2 identify the relevant species within the site area. Radiation exposure pathways to biota are expected to be the same as those to humans, i.e., inhalation, external (from ground, airborne plume, water submersion, and shoreline), drinking water and ingestion. These pathways were examined to determine if they could result in doses to biota significantly greater than those predicted for humans from operation of Fermi 3. This assessment used surrogate species that provide representative information about the various dose pathways potentially affecting broader classes of living organisms. The gaseous pathway doses for muskrats, raccoons, herons and ducks were taken as equivalent to human doses for the inhalation (child), plume (adult), and twice the ground (adult) pathways, conservatively adjusted based on the assumption that the affected biota are located at 0.25 miles from the facility. The doubling of doses from ground deposition reflects the closer proximity of these organisms to the ground. Doses to those same species plus fish, invertebrate and algae are calculated by the LADTAP II computer program.

Estimated dose to two of the surrogates (duck and muskrat) are slightly greater than the criteria in 40 CFR 190.

criteria

Doses to biota from liquid and gaseous effluents from Fermi 3 are shown in Table 5.4-9. The total dose is taken as the sum of the internal and external dose. Annual doses to ~~all~~ of the surrogates meet the ~~requirements~~ of 40 CFR 190. The Bald Eagle, a species of significance known to inhabit the site, is represented by the surrogate species of Table 5.4-9. The Heron is a representative surrogate for the Bald Eagle.

five

Use of exposure guidelines, such as 40 CFR 190, which apply to members of the public in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. The International Council on Radiation Protection states that "...if man is adequately protected then other living things are also likely to be sufficiently protected," and uses human protection to infer environmental protection from the effects of ionizing radiation (Reference 5.4-7 and Reference 5.4-8). This assumption is appropriate in cases where humans and other biota inhabit the same environment and have common routes of exposure. It is less appropriate in cases where human access is restricted or pathways exist that are much more important for biota than for humans.

Species in most ecosystems experience dramatically higher mortality rates from natural causes than man, as witnessed by their lesser life spans. From an ecological viewpoint, population stability is considered more important to the survival of the species than the survival of individual organisms. Thus, higher dose limits could be permitted. In addition, no biota has been discovered that show significant changes in morbidity or mortality due to radiation exposures predicted from nuclear power plants.

An international consensus has been developing with respect to permissible dose exposures to biota. The International Atomic Energy Agency (IAEA) (Reference 5.4-9) evaluated available evidence including the "Recommendations of the International Commission on Radiological

NUREG 155, Section 5.4.4, indicates that if the doses are approximately the same order of magnitude as the criteria in 40 CFR 190, no further review is necessary. Thus, as the results for the duck and muskrat are of the same order of magnitude as 40 CFR 190, the results are considered to be acceptable.

5.4-6 Detroit Edison, "Fermi 2 – 2006 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2006 through December 31, 2006.

5.4-7 International Council on Radiation Protection, "Recommendations of the International Commission on Radiological Protection," Publication 26, 1977.

5.4-8 International Council on Radiation Protection, "Recommendations of the International Commission on Radiological Protection," Publication 60, 1991.

5.4-9 International Atomic Energy Agency, "Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards," Report Series No. 332, 1992.

5.4-10 GE-Hitachi Nuclear Energy, "ESBWR Design Control Document – Tier 2," Revision ~~6, August 2009.~~ 7, March 2010.

5.4-11 U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, "GASPAR II Technical Reference and User Guide," NUREG/CR-4653, March 1987.

Table 5.4-3 Gaseous Pathway Input Parameters

Parameter	Value
Release Source Term	Refer to Subsection 3.5.1
Agricultural Production within 50 mile radius Meat Production Milk Production Vegetable Production (grain, tomatoes, potatoes)	Developed from Section 2.2 1.919E+07 kg/year 6.043E+08 liter/year 9.689E+09 kg/year
Fraction of the year that leafy vegetables are grown	0.33
Fraction of a maximum individual's vegetable intake from own garden	0.76
Fraction of the year milk cows are on pasture	0.58
Fraction of milk cow feed intake from pasture while on pasture	1.0
Fraction of year goats are on pasture	0.67
Fraction of goat feed intake from pasture while on pasture	1.0
Fraction of year meat cows are on pasture	0.58
Fraction of meat cow feed intake from pasture while on pasture	1.0
Consumption/Usage Rates	Table 5.4-2
Population Distribution 50-mile Population	Refer to Section 2.5 7,713,709 (1)
Distance and Direction to Receptors and Associated Atmospheric Dispersion Factors	Refer to Section 2.7
Humidity	~~10.98~~ g/m³

11

Notes:
1. Estimated population for the year 2060, from Section 2.5

Table 5.4-4 Liquid Pathway Doses for Maximally Exposed Individual

Dose (mrem/yr)							
Skin [1]	**Bone [2]**	**Liver [1]**	**Total Body [3]**	**Thyroid [4]**	**Kidney [1]**	**Lung ~~[1]~~[2]**	**GI-LLI [3]**
1.19E-04	8.77E-02	1.00E-02	6.48E-03	2.63E-02	2.49E-03	1.11E-03	8.40E-03

Notes:
1. Total of all pathways for Teen
2. Total of all pathways for Child
3. Total of all pathways for Adult
4. Total of all pathways for Infant

Table 5.4-5 Comparison of Annual Maximally Exposed Individual Doses with 10 CFR 50, Appendix I Limits

Type of Dose	Annual Dose Fermi 3	Annual Dose Limit
Liquid Effluents		
Total Body (mrem/yr)	0.006 (1)	3
Max Organ – Bone (mrem/yr)	0.088 (2)	10
Gaseous Effluents		
Total External Body (mrem/yr)	0.98 ~~0.67~~	5
Skin (mrem/yr)	1.15 ~~0.77~~	15
Beta Air Dose (mrem/yr)	0.26 ~~0.20~~	20
Gamma Air Dose (mrem/yr)	0.22 ~~0.16~~	10
Max Organ – Thyroid (mrem/yr) Child	11.3 ~~14.7~~	15

Notes:
1. Total dose from all pathways for an adult
2. Total dose from all pathways for a child

Table 5.4-7 50-mile Population Doses from Gaseous Effluents

Pathway	Dose person-rem/yr
Plume	
Total Body	~~0.96~~
Max Organ – Skin	~~2.94~~
Ground	
Total Body	~~1.06~~
Max Organ – Skin	~~1.24~~
Inhalation	
Total Body	~~0.08~~
Max Organ – Thyroid	~~4.80~~
Vegetable	
Total Body	~~1.86~~
Max Organ – Bone	~~8.39~~
Cow Milk	
Total Body	~~0.56~~
Max Organ – Thyroid	~~15.0~~
Meat Cow	
Total Body	~~0.03~~
Max Organ – Bone	~~0.12~~
50-Mile Total Dose	
Total Body	~~4.5~~
Max Organ – Thyroid	~~24.1~~

1.20
3.58
2.25
2.63
0.07
5.13
2.39
10.1
0.75
16.1
0.03
0.14
6.7
27.1

Table 5.4-8 Comparison of Maximally Exposed Individual Doses with 40 CFR 190 Criteria

Insert Table 5.4-8 here.

Type of Dose	Fermi 3 (ESBWR)			Fermi 2	Site Total (1)	40 CFR 190 Limit
	Liquid	Gaseous	Total			
Total Body (mrem/yr)	0.006	[illegible]	[illegible]	4.68	5.36	25
Thyroid (mrem/yr)	0.026	14.7	14.7	2.66	17.39	75
Bone (mrem/yr)	0.088	1.81	1.90	0.05	1.95	25

Notes:
1. This site total dose includes the Fermi 3 total dose and the dose from Fermi 2.
2. 1 mrem = 0.01 mSv

Insert Table 5.4-8

	Fermi 3 (ESBWR)				Site Total	40 CFR 190
Type of Dose	Liquid	Gaseous	Total	Fermi 2	(1)	Limit
Total Body (mrem/yr)	0.006	~~0.569~~	~~0.58~~	4.68	~~5.26~~	25
Thyroid (mrem/yr)	0.026	~~10.8~~	~~10.83~~	2.66	~~13.49~~	75
Bone (mrem/yr)	0.088	~~1.29~~	~~1.38~~	0.05	~~1.43~~	25

Gaseous	Total	Site Total
0.976	0.98	5.66
11.3	11.33	13.99
2.18	2.27	2.32

Table 5.4-9 Doses to Biota from Liquid and Gaseous Effluents

Biota	Dose (mrem per year) Liquid Effluents	Gaseous Effluents [1]	Total	40 CFR 190 Limit
Fish	2.31	0	2.31	25
Invertebrate	7.65	0	7.65	25
Algae	11.9	0	11.9	25
Muskrat	14.8	~~7.04~~ 11.15	~~21.8~~ 25.95	25
Raccoon	0.43	~~7.04~~ 11.15	~~7.47~~ 11.58	25
Heron	6.87	~~7.04~~ 11.15	~~13.9~~ 18.02	25
Duck	14.8	~~7.04~~ 11.15	~~21.8~~ 25.95	25

Notes:

1. Dose from gaseous effluents determined based on whole body inhalation dose for child + whole body ground and plume exposure at 0.25 miles from the facility. Ground exposures increased by a factor of two to account for ground proximity.

FR 30028), "vicinity" is the area within one mile of the plant site boundary. "Prompt Fatality Risks" are defined as the sum of risks which the average individual residing in the vicinity of the plant is exposed to as a result of normal daily activities (driving, household chores, occupational activities, etc). For this evaluation, the sum of prompt fatality risks was taken as the U.S. accidental death risk value of 37.7 deaths per 100,000 people per year (Reference 7.2-2).

7.2.4.2 **Societal Risk Goal**

The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from its operation should not exceed one-tenth of one percent (0.1 percent) of the sum of the cancer fatality risks resulting from all other causes. As defined in the Safety Goal Policy Statement (51 FR 30028), "near" is within 10 miles of the plant. The cancer fatality risk was taken as 191.4 deaths per 100,000 people per year based upon National Center for Health Statistics data for 2001–2004 (Reference 7.2-2).

7.2.4.3 **Radiation Dose Goal**

The probability of an individual exceeding a whole body dose of 25 rem at a distance of 0.5 mile from the reactor shall be less than one in a million per reactor year.

7.2.5 **Conclusions**

The total calculated dose-risk to the 50-mi population from airborne releases from an ESBWR reactor at the Fermi site would be 0.032 person-rem per reactor year (Table 7.2-1). This value is less than the population risk for all current reactors that have undergone license renewal, and less than that for the five reactors analyzed in NUREG-1150 (Reference 7.2-7).

Seventy-five percent of the Fermi 3 dose-risk is from late phase pathway exposures, especially groundshine and ingestion. The Fermi 3 early phase dose-risk, 0.0071 person-rem per reactor year, can be compared with the GEH generic calculation of 24-hour dose-risk (which does not include late phase exposure) of 0.017 person-rem per reactor year (Reference 7.2-3); GEH did not calcualte late phase consequences.

Comparisons with the existing nuclear reactor fleet (Subsection 7.2.3.2) indicate that risk from the surface-water pathway is SMALL. Under the severe accident scenarios, surface-water is primarily contaminated by atmospheric deposition. The ESBWR atmospheric pathway doses are significantly lower than those of the current nuclear fleet. Therefore, it is reasonable to conclude that the doses from the surface-water pathway at the Fermi site would be consistently lower than those reported in Subsection 7.2.3.2 for the current fleet.

The risks of groundwater contamination from a severe ESBWR accident (see Subsection 7.2.3.3) would be much less than the risk from currently licensed reactors. Additionally, interdiction could substantially reduce the groundwater pathway risks.

21.6

For comparison, as reported in Subsection 5.4.3, the whole body dose from the Fermi site normal ~~airborne~~ releases is predicted to be ~~22.2~~ 21.6 person-rem annually. As previously described, dose-risk is dose times frequency. Normal operations have a frequency of one. Therefore, the dose-risk for normal operations is ~~22.5~~ 21.6 person-rem per reactor year. Comparing this value to the severe accident dose-risk of 0.032 person-rem per reactor year indicates that the dose risk from severe accidents is ~~approximately 0.1~~ less than 0.2 percent of the dose-risk from normal operations.

The probability-weighted risk of early and late cancer fatalities from a severe accident at the Fermi site in the surrounding 50-mile population projected for 2060 of 7.7 million is reported as ~~1.8~~ 2.0 x 10^{-5} fatalities per reactor year in Table 7.2-1. For a 60-year reactor operating life, this population cancer fatality risk becomes ~~1.1~~ 1.2 x 10^{-3}.

The probability of an individual dying from any cancer from any cause is approximately 0.23 for men and 0.20 for women over a lifetime (Reference 7.2-1). This implies that more than 1.5 x 10^{6} members of the 50-mile population will die of cancer.

The cancer fatality risk from a severe accident at Fermi 3 to the 50-mile population is then less than 10^{-7} percent of the background risk, which is much less than the societal risk goal of 0.1 percent of the background risk.

The results from the analysis discussed in this section are used in Section 7.3 to determine if there are any cost-beneficial design alternatives that should be considered to mitigate the impacts described herein.

7.2.6 **References**

7.2-1 American Cancer Society, "Lifetime Probability of Developing or Dying from Cancer," http://www.cancer.org/docroot/CRI/content/CRI_2_6x_Lifetime_Probability_of_Developing_or_Dying_From_Cancer.asp, accessed 1 May 2008.

7.2-2 Centers for Disease Control, "Deaths: Final Data for 2004," National Vital Statistics Reports, Volume 55 Number 19, August 21, 2007.

7.2-3 GE Energy, "ESBWR Probabilistic Risk Assessment," NEDO-33201, Revision 4, June 2009.

7.2-4 GE-Hitachi Nuclear Energy, "ESBWR Design Control Document - Tier 2," Revision 6, August 2009.

7.2-5 U.S. Nuclear Regulatory Commission, "SECPOP 2000: Sector Population Land Fraction, and Economic Estimation Program," NUREG/CR-6525, August 2003.

7.2-6 U.S. Nuclear Regulatory Commission, "Liquid Pathway Generic Study: Impacts of Accidental Radioactive Releases to the Hydrosphere from Floating and Land-Based Nuclear Power Plants," NUREG-0440, February 1978.

7.2-7 U.S. Nuclear Regulatory Commission, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, June 1989.

7.2-8 U.S. Nuclear Regulatory Commission, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, Volumes 1 and 2, May 1996.

Attachment 4
NRC3-10-0040

Supplemental Response to RAI letter related to Fermi 3 ER

RAI Question HH5.4.4-1

NRC RAI HH5.4.4-1

Provide dose estimates for biota (including the bald eagle) inside the site boundary (0.25 mi from Fermi 3 emission sources).

Supporting Information

Biota doses are presented in Table 5.4-9 (Dose to Biota from Liquid and Gaseous Effluents) but the assumptions used with the LADTAP computer code to estimate dose to biota from liquid effluents are not provided. It is assumed that biota would be at the site boundary to calculate the dose from gaseous effluent but biota could be inside the site boundary and very near the proposed Fermi Unit 3.

According to ESRP Section 5.4.4, "the biota to be considered in this evaluation should include those in the pathways identified in ESRP 5.4.1, those appearing on the endangered/threatened species lists, and others of significance." ER Section 2.4.1.2.1, page 2-330 states that two bald eagle nests were observed on the Fermi site in May 2008. Dose calculations for the bald eagle should be made because the species is protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.

Supplemental Response

In the original response to ER RAI HH5.4.4-1 in Detroit Edison letter NRC3-09-0015 (ML093090165), dated October 30, 2009, the biota dose estimates were based on ESBWR DCD Rev. 5. Based on discussion with NRC staff on November 16, 2009, it was determined that the biota dose estimate needed to be updated to incorporate DCD Rev. 6 information. A supplemental response to ER RAI HH5.4.4-1 was submitted in Detroit Edison letter NRC3-10-0005 (ML100541329), dated February 15, 2010. Subsequently, an additional supplemental response to ER RAI HH5.4.4-1 was submitted in Detroit Edison letter NRC3-10-0015 (ML100960474), dated March 30, 2010, to describe changes made to the biota dose calculation as a result of changes to the long term, routine X/Q and D/Q values.

The gaseous source term presented in DCD Rev. 7 Table 12.2-16 with the radioiodine concentrations in new FSAR Table 12.2-206 and the previously communicated changes to the atmospheric dispersion estimates presented in Detroit Edison Letter NRC3-10-0033 (ML102180224), dated July 25, 2010, were utilized to provide updated estimates for the dose to the MEI, population, and biota.

The estimated total dose to biota from gaseous releases, liquid effluents, and direct radiation for five of the surrogate species are less than exposure criteria in 40 CFR 190 (25 mrem/yr). The estimated total dose for the muskrat and the duck are 25.95 mrem/yr, or slightly greater than the criteria in 40 CFR 190. It is noted, as described in ER Section 5.4.4, that the heron is considered as the representative surrogate for the bald eagle and the estimated total biota dose to the heron is

18 mrem/yr; less than the criteria in 40 CFR 190. The biota dose estimate includes conservatisms in the calculation, most notably, the assumption that the biota is located at the limiting location for both gaseous and liquid releases although these are two distinctly different locations. That is, the contribution from the liquid release is in the vicinity of the discharge pipe to the East of the site in Lake Erie. The contribution from the gaseous release is towards the NNW and NW directions. These two locations were selected to provide a conservative result.

As described in ER Section 5.4.4, using exposure guidelines, such as 40 CFR 190, which apply to members of the public, is considered conservative when evaluating calculated doses to biota. NUREG-1555, Section 5.4.4, "Impacts to Biota Other Than Members of the Public," Section III.(2), second bullet, states:

> "If the doses are of approximately the same order of magnitude or less than the dose criteria, in 40 CFR 190, no further review is necessary."

Although the estimated biota dose results for Fermi 3 exceed the dose criteria in 40 CFR 190, the results are approximately the same order of magnitude. Therefore, the results are considered to be acceptable and the impact continues to be SMALL.

<u>Proposed COLA Revision</u>

Proposed revision to ER Section 5.4 is shown on the markup provided with ER RAIs HH5.4.2-1 and HH5.4.3-3 (Attachment 3).