Chapter 12 Radiation Protection

12.1 Ensuring That Occupational Radiation Exposures Are ALARA

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

Add the following at the beginning of this section.

STD SUP 12.1-1

The ALARA program is addressed in Appendix 12AA and Appendix 12BB.

12.1.1.3.1 **Compliance with Regulatory Guide 8.8**

Replace the first paragraph of this section with the following.

STD COL 12.1-4-A

Compliance with Regulatory Guide 8.8 is addressed in Appendix 12BB.

12.1.1.3.2 **Compliance with Regulatory Guide 8.10**

Replace this section with the following.

STD COL 12.1-1-A

Compliance with Regulatory Guide 8.10 is addressed in Appendix 12BB.

12.1.1.3.3 **Compliance with Regulatory Guide 1.8**

Replace this section with the following.

STD COL 12.1-2-A

Compliance with Regulatory Guide 1.8 is addressed in Appendix 12BB.

12.1.3 **Operational Considerations**

Replace this section with the following

STD COL 12.1-3-A The ALARA program implementation is addressed in Appendix 12BB.

12.1.4 COL Information

12.1-1-A Regulatory Guide 8.10

STD COL 12.1-1-A This COL item is addressed in Subsection 12.1.1.3.2 and Appendix 12BB.

12.1-2-A Regulatory Guide 1.8

STD COL 12.1-2-A This COL item is addressed in Subsection 12.1.1.3.3 and Appendix 12BB.

12.1-3-A Operational Considerations

STD COL 12.1-3-A This COL item is addressed in Subsection 12.1.3 and Appendix 12BB.

12.1-4-A Regulatory Guide 8.8

STD COL 12.1-4-A This COL item is addressed in Subsection 12.1.1.3.1 and Appendix 12BB.

12.2 Plant Sources

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

12.2.1.5 Other Contained Sources

Replace this section with the following.

STD COL 12.2-4-A In addition to the contained sources identified above, additional contained sources which contain by-product, source, or special nuclear materials may be maintained onsite. These contained sources are used as calibration, check, or radiography sources. These sources are not part of the permanent plant design, and their control and use are governed by plant procedures. The procedures consider the guidance provided in RG 8.8 to ensure that occupational doses from the control and use of the sources are as low as is reasonably achievable (ALARA).

Various types and quantities of radioactive sources are employed to calibrate the process and effluent radiation monitors, the area radiation monitors, and portable and laboratory radiation detectors. Check sources that are integral to the area, process, and effluent monitors consist of

small quantities of by-product material and do not require special handling, storage, or use procedures for radiation protection purposes. The same consideration applies to solid and liquid radionuclide sources of exempt quantities or concentrations which are used to calibrate or check the portable and laboratory radiation measurement instruments.

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.

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.

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 Table 12.2-18bR. Calculation of site-specific doses is discussed in Subsection 12.2.2.2.

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.

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. 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 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 are both included for conservatism. The total dose is the sum of these individual 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 total body dose and thyroid dose. The total body dose is 4.5 person-rem/yr as shown in Table 12.2-204. The thyroid dose is 23.5 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

1.113 were used as described in DCD References 12.2-7 and 12.2-4, respectively.

The liquid effluent pathway offsite dose calculation bases are provided in Table 12.2-20aR. The bases include values that are default parameters in RG 1.109 and other values that are Fermi 3 site-specific inputs.

Based on the annual liquid release offsite values in DCD Table 12.2-19b, the Fermi 3 annual liquid release concentrations were calculated based upon the criteria specified in DCD Section 12.2.2.3 and the Fermi 3 specific input values shown in Table 12.2-20aR.

The LADTAP II code is used to perform the liquid effluent dose analysis (DCD Reference 12.2-3). The results of the dose calculation are given in Table 12.2-20bR.

12.2.2.4.1 Compliance with 10 CFR 50, Appendix I, Section II.A

Table 12.2-202 demonstrates that offsite dose due to Fermi 3 radioactive liquid effluents comply with the regulatory dose limits in 10 CFR 50, Appendix I, Section II.A.

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

Population dose is determined for the liquid effluent releases from Fermi 3 for both total body dose and thyroid dose. The total body dose is 17.7 person-rem/yr as shown in Table 12.2-204. The thyroid dose is 21.1 person-rem/yr. Table A-1 of RG 1.110 lists several liquid radwaste augments for light water cooled nuclear power reactors. The ESBWR already contains all of these augments as part of the conceptual design for the Liquid Radwaste Management System. The conceptual design information is the plant specific design. Therefore, a cost benefit analysis of the liquid radwaste augments is not necessary because the augments discussed in RG 1.110 have already been incorporated into the ESBWR design. Therefore, Fermi 3 complies with 10 CFR 50, Appendix I, Section II.D.

12.2.2.4.3 Compliance with 10 CFR 20 Appendix B, Table 2, Column 2

Compliance with 10 CFR 20 Appendix B, Table 2, Column 2 is demonstrated in DCD Table 12.2-19b.

12.2.2.4.4 Compliance with 10 CFR 20.1301 and 20.1302

This section demonstrates that offsite doses due to Fermi 3, combined with offsite doses due to Fermi 2 comply with the regulatory limits in 10 CFR 20.1301 for doses to members of the public.

Using the Fermi 3-specific gaseous effluent release activities identified in Table 12.2-17R and the liquid effluent release activities identified in DCD Table 12.2-19b, 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 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 total 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.

Compliance with the annual dose limit in 10 CFR 20.1302 is demonstrated by showing that the calculated total effective dose equivalent to the individual likely to receive the highest dose does not exceed the annual dose limit.

12.2.4 COL Information

12.2-2-A Airborne Effluents and Doses

EF3 COL 12.2-2-A This COL item is addressed in Subsection 12.2.2.1 and Subsection 12.2.2.2, and Table 2.0-201.

12.2-3-A Liquid Effluents and Doses

EF3 COL 12.2-3-A This COL item is addressed in Subsection 12.2.2.4.

12.2-4-A Other Contained Sources

STD COL 12.2-4-A This COL item is addressed in Subsection 12.2.1.5.

12.2.5 References

12.2-201 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.”

12.2-202 U.S. Nuclear Regulatory Commission, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” NUREG-1437, May 1996.

Table 12.2-15R Airborne Sources Calculation [EF3 COL 12.2-2-A]

	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)
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
	RB/FB Ventilation Stack	Table 2.3-335
	TB Ventilation Stack	Table 2.3-339
	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

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	1.3E-06	3.6E-17	3.6E-12	5.00E-05	7.2E-08
Kr-85m	6.6E+05	1.8E+01	1.1E-02	3.1E-13	1.4E-10	1.00E-07	1.4E-03
Kr-85	5.2E+06	1.4E+02	9.1E-02	2.4E-12	2.1E-11	7.00E-07	3.1E-05
Kr-87	1.4E+06	3.9E+01	2.5E-02	6.8E-13	3.0E-12	2.00E-08	1.5E-04
Kr-88	2.1E+06	5.6E+01	3.6E-02	9.8E-13	5.4E-11	9.00E-09	6.0E-03
Kr-89	1.4E+07	3.7E+02	6.4E-01	1.7E-11	9.6E-11	1.00E-09	9.6E-02
Xe-131m	1.5E+05	4.1E+00	2.6E-03	7.1E-14	5.8E-12	2.00E-06	2.9E-06
Xe-133m	1.9E+02	5.2E-03	3.0E-06	8.2E-17	2.4E-12	6.00E-07	4.0E-06
Xe-133	4.1E+07	1.1E+03	3.8E+00	1.0E-10	1.1E-09	5.00E-07	2.1E-03
Xe-135m	2.2E+07	6.0E+02	7.8E+00	2.1E-10	2.1E-10	4.00E-08	5.3E-03
Xe-135	2.8E+07	7.5E+02	4.4E+00	1.2E-10	1.4E-10	7.00E-08	2.0E-03
Xe-137	2.8E+07	7.6E+02	1.7E+00	4.5E-11	6.8E-11	1.00E-09	6.8E-02
Xe-138	2.3E+07	6.3E+02	4.3E-01	1.2E-11	1.1E-10	2.00E-08	5.5E-03
I-131	8,4E+03	2.3E-01	3.5E-04	9.6E-15	2.1E-14	2.00E-10	1.0E-04
I-132	5.8E+04	1.6E+00	2.8E-03	7.7E-14	1.8E-13	2.00E-08	8.8E-06
I-133	4.2E+04	1.1E+00	2.1E-03	5.6E-14	1.3E-13	1.00E-09	1.3E-04

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	5.2E-03	1.4E-13	3.3E-13	6.00E-08	5.5E-06
I-135	5.9E+04	1.6E+00	2.9E-03	7.9E-14	1.9E-13	6.00E-09	3.1E-05
H-3	2.8E+06	7.6E+01	4.4E-02	1.2E-12	1.3E-12	1.00E-07	1.3E-05
C-14	5.3E+05	1.4E+01	9.2E-03	2.5E-13	2.5E-13	3.00E-09	8.3E-05
Na-24	5.4E+00	1.5E-04	8.6E-08	2.3E-18	2.3E-18	7.00E-09	3.3E-10
P-32	1.3E+00	3.5E-05	2.1E-08	5.6E-19	5.6E-19	5.00E-10	1.1E-09
Ar-41	1.4E+03	3.8E-02	2.4E-05	6.6E-16	6.6E-16	1.00E-08	6.6E-08
Cr-51	1.8E+02	4.7E-03	1.3E-05	3.6E-16	3.6E-16	3.00E-08	1.2E-08
Mn-54	1.5E+02	4.1E-03	6.2E-05	1.7E-15	1.7E-15	1.00E-09	1.7E-06
Mn-56	1.1E+01	3.0E-04	1.7E-07	4.7E-18	4.7E-18	2.00E-08	2.4E-10
Fe-55	4.7E+01	1.3E-03	7.5E-07	2.0E-17	2.0E-17	3.00E-09	6.7E-09
Fe-59	2.0E+01	5.4E-04	4.8E-06	1.3E-16	1.3E-16	5.00E-10	2.6E-07
Co-58	4.0E+01	1.1E-03	3.6E-06	9.8E-17	9.8E-17	1.00E-09	9.8E-08
Co-60	3.2E+02	8.7E-03	1.1E-04	3.0E-15	3.0E-15	5.00E-11	6.0E-05
Ni-63	4.7E+02	1.3E-06	7.5E-10	2.0E-20	2.0E-20	1.00E-09	2.0E-11
Cu-64	6.9E+00	1.9E-04	1.1E-07	3.0E-18	3.0E-18	3.00E-08	9.8E-11

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	9.6E-06	2.6E-16	2.6E-16	4.00E-10	6.5E-07
Rb-89	2.0E-01	5.4E-06	3.2E-09	8.6E-20	8.6E-20	2.00E-07	4.3E-13
Sr-89	1.5E+02	3.9E-03	2.5E-06	6.8E-17	7.2E-16	2.00E-10	3.6E-06
Sr-90	1.0E+00	2.7E-05	1.7E-08	4.7E-19	4.9E-17	6.00E-12	8.2E-06
Y-90	8.1E-02	2.2E-06	1.3E-09	3.5E-20	3.5E-20	9.00E-10	3.9E-11
Sr-91	6.7E+00	1.8E-04	1.1E-07	2.9E-18	1.4E-14	5.00E-09	2.8E-06
Sr-92	4.6E+00	1.2E-04	7.3E-08	2.0E-18	2.2E-14	9.00E-09	2.4E-06
Y-91	1.7E+00	4.6E-05	2.7E-08	7.3E-19	7.3E-19	2.00E-10	3.6E-09
Y-92	3.7E+00	1.0E-04	5.9E-08	1.6E-18	1.6E-18	1.00E-08	1.6E-10
Y-93	7.2E+00	1.9E-04	1.1E-07	3.1E-18	3.1E-18	3.00E-09	1.0E-09
Zr-95	4.4E+01	1.2E-03	1.2E-05	3.4E-16	3.4E-16	4.00E-10	8.6E-07
Nb-95	2.4E+02	6.5E-03	3.9E-06	1.0E-16	1.0E-16	2.00E-09	5.2E-08
Mo-99	1.7E+03	4.5E-02	2.7E-05	7.2E-16	5.3E-15	2.00E-09	2.7E-06
Tc-99m	2.2E+00	5.9E-05	3.5E-08	9.4E-19	5.7E-14	2.00E-07	2.9E-07
Ru-103	1.0E+02	2.8E-03	1.6E-06	4.4E-17	4.8E-17	9.00E-10	5.3E-08
Rh-103m	3.5E-03	9.5E-08	5.5E-11	1.5E-21	1.5E-21	2.00E-06	7.5E-16
Ru-106	1.4E-01	3.8E-06	2.2E-09	6.0E-20	6.0E-20	2.00E-11	3.0E-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	7.1E-14	1.9E-24	1.9E-24	1.00E-09	1.9E-15
Ag-110m	1.0E-01	2.8E-06	1.6E-09	4.4E-20	4.4E-20	1.00E-10	4.4E-10
Sb-124	5.3E+00	1.4E-04	1.1E-06	3.1E-17	3.1E-17	3.00E-10	1.0E-07
Te-129m	1.6E+00	4.3E-05	2.5E-08	6.8E-19	6.8E-19	3.00E-10	2.3E-09
Te-131m	5.5E-01	1.5E-05	8.7E-09	2.4E-19	2.4E-19	1.00E-09	2.4E-10
Te-132	1.4E-01	3.8E-06	2.2E-09	6.0E-20	1.0E-15	9.00E-10	1.1E-06
Cs-134	1.8E+02	4.9E-03	3.8E-05	1.0E-15	1.1E-15	2.00E-10	5.3E-06
Cs-136	1.5E+01	4.0E-04	2.4E-07	6.5E-18	3.0E-17	9.00E-10	3.3E-08
Cs-137	2.7E+02	7.3E-03	6.4E-05	1.7E-15	1.8E-15	2.00E-10	8.8E-06
Cs-138	8.5E-01	2.3E-05	1.3E-08	3.6E-19	3.1E-14	8.00E-08	3.9E-07
Ba-140	7.8E+02	2.1E-02	1.3E-05	3.5E-16	2.2E-15	2.00E-09	1.1E-06
La-140	1.3E+01	3.5E-04	2.1E-07	5.6E-18	5.6E-18	2.00E-09	2.8E-09
Ce-141	2.6E+02	7.1E-03	4.7E-06	1.3E-16	1.3E-16	8.00E-10	1.7E-07
Ce-144	1.3E-01	3.5E-06	2.1E-09	5.6E-20	7.3E-18	2.00E-11	3.6E-07
Pr-144	1.6E-04	4.3E-09	2.5E-12	6.8E-23	6.8E-23	2.00E-07	3.4E-16
W-187	1.3E+00	3.5E-05	2.1E-08	5.6E-19	5.6E-19	1.00E-08	5.6E-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	1.3E-06	3.6E-17	4.9E-14	3.00E-09	1.6E-05
Total (w/ H-3)	1.7E+08	4.6E+03	1.9E+01	5.1E-10	1.9E-09		1.9E-01
Total (w/o H-3)	1.7E+08	4.5E+03	1.9E+01	5.1E-10	1.9E-09		1.9E-01

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

	Calculation Bases	
EF3 COL 12.2-2-A	Meteorology χ/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
	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

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

		Fermi 3		
		Total Body	Thyroid	Skin
Location	**Pathway**	**Annual Dose (mrem/year)**		
Site Boundary (1131 m [0.7 mi] SSE)	Plume	1.05E-01	1.05E-01	2.53E-01
Site Boundary (SB) (919 m [0.57 mi] WNW) In direction of Residence, Garden, Meat Cow, Goat Milk, and Cow Milk (WNW)	Ground (SB)	2.57E-01	2.57E-01	3.01E-01
	Vegetable (SB)			
	Adult	1.08E-01	4.35E+00	4.18E-02
	Teen	1.36E-01	6.04E+00	7.02E-02
	Child	2.44E-01	1.17E+01	1.71E-01
	Meat Cow (SB)			
	Adult	2.39E-02	1.61E-01	1.69E-02
	Teen	1.82E-02	1.18E-01	1.42E-02
	Child	3.07E-02	1.84E-01	2.66E-02
	Inhalation (SB)			
	Adult	1.72E-03	1.45E-01	8.61E-04
	Teen	1.75E-03	1.89E-01	8.69E-04
	Child	1.54E-03	2.31E-01	7.67E-04
	Infant	9.24E-04	2.11E-01	4.41E-04
	Goat Milk (3704 m [2.3 mi])			
	Adult	8.42E-03	3.14E-01	1.85E-03
	Teen	1.01E-02	4.98E-01	3.35E-03
	Child	1.42E-02	9.92E-01	8.15E-03
	Infant	2.42E-02	2.41E+00	1.70E-02
	Cow Milk (3513 m [2.18 mi])			
	Adult	4.79E-03	2.54E-01	1.97E-03
	Teen	6.86E-03	4.04E-01	3.60E-03
	Child	1.28E-02	8.04E-01	8.80E-03
	Infant	2.37E-02	1.95E+00	1.83E-02
	Total (Includes Plume)			
	Adult	5.08E-01	5.59E+00	6.17E-01
	Teen	5.35E-01	7.61E+00	6.46E-01
	Child	6.65E-01	1.42E+01	7.69E-01
	Infant	4.11E-01	4.93E+00	5.90E-01

Notes:

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

Table 12.2-20aR Liquid Pathway Offsite Dose Calculation Bases [EF3 COL 12.2-3-A]

	Calculation Bases	
	Calculation Methodology	RG 1.109
	Computer Code Utilized	LADTAP II (NUREG/CR-4013)
	Individual Consumption/Exposure Rates	Table E-5 of RG 1.109
	Site Water Type	Freshwater
EF3 COL 12.2-3-A	Liquid Effluent Discharge Rate	400 liters/min (0.234 ft^3/sec)
EF3 COL 12.2-3-A	Shore-Width Factor	0.3
EF3 COL 12.2-3-A	Dilution Factor	115 – Minimum to discharge location (1) Additional dilution factors after discharge: 45 – Nearest Shoreline Northeast (1770 m [1.1 mi]) 67 – Nearest Shoreline South (1530 m [0.95 mi]) 77 – 3200 m (1.99 mi) South 100 – Distances greater than 3200 m (1.99 mi)
EF3 COL 12.2-3-A	Transit times from discharge to the receiving water body to exposure location	Drinking Water – 22.6 hours Fishing – 24 hours Aquatic Recreation – 10.6 hours
EF3 COL 12.2-3-A	Irrigation rate	None – lake water is not used for irrigation
EF3 COL 12.2-3-A	Fraction of year that leafy vegetables are grown	Not used in liquid pathway dose calculation
EF3 COL 12.2-3-A	Fraction of year that animals graze on pasture	Not used in liquid pathway dose calculation
EF3 COL 12.2-3-A	Fraction of daily feed that is pasture grass when the animal grazes on pasture	Not used in liquid pathway dose calculation
EF3 COL 12.2-3-A	Animal milk considered for milk pathway	Not used in liquid pathway dose calculation
EF3 COL 12.2-3-A	Liquid Pathway Offsite Annual Doses	Table 12.2-20bR

Notes:

1. Blowdown flowrate divided by discharge flow rate

Table 12.2-20bR Liquid Pathway Doses from Fermi 3 for MEI at Lake Erie

[EF3 COL 12.2-3-A]

	Fermi 3 Dose (mrem/yr)		
Pathway	**Total Body**	**Thyroid**	**Bone**
Fish	6.46E-03	1.51E-03	9.86E-02
Invertebrate	6.84E-04	1.33E-04	5.37E-03
Drinking	6.09E-04	1.82E-02	7.11E-04
Shoreline (includes water recreation)	1.21E-04	1.21E-04	1.21E-04
Total	7.66E-03	1.82E-02	1.05E-01
Age group receiving maximum dose	Adult	Infant	Child

Notes:

1. Bone of the child is the organ receiving the maximum dose.
2. There are no infant doses for the fish and invertebrate pathways because infants do not consume these foods.
3. 1 mrem = 0.01 mSv

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
Total Body (mrem/yr)	Site Boundary (1131 m [0.70 mi] SSE)	6.65E-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	1.42E+01	15

1 mrad = 0.01 mGy
1 mrem = 0.01 mSv

Table 12.2-202 Comparison of Annual Doses to MEI from Liquid Effluents

[EF3 COL 12.2-3-A]

Type of Dose	Location	Fermi 3	10 CFR 50 Limit
Total Body (mrem/yr)	Lake Erie	7.66E-03	3
Thyroid (mrem/yr)	Lake Erie	1.82E-02	10
Bone (mrem/yr)	Lake Erie	1.05E-01	10

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]

Type of Dose	Fermi 3 (ESBWR)			Fermi 2	Site Total(1)	40 CFR 190 Limit
	Liquid	Gaseous	Total			
Total Body (mrem/yr)	0.008	0.66	0.67	4.68	5.35	25
Thyroid (mrem/yr)	0.018	14.2	14.2	2.66	16.86	75
Bone (mrem/yr)	0.105	1.81	1.92	0.052	1.97	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

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)	17.7
Bone (Liquid)	124.7
Thyroid (Liquid)	21.1
Total Body (Gaseous)	4.5
Max Organ – Thyroid (Gaseous)	23.5

1 rem = 0.01 Sv

12.3 Radiation Protection

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

12.3.1.3 Radiation Zoning

Replace the last sentence with the following.

STD COL 12.3-3-H Access to "Very High Radiation Areas" is discussed in Section 12.5.

12.3.4 Area Radiation and Airborne Radioactivity Monitoring Instrumentation

Replace the last bullet with the following.

STD COL 12.3-2-A The radiation instrumentation that monitors airborne radioactivity is classified as nonsafety-related. Airborne radiation monitoring operational considerations, such as the procedures for operation and calibration of the monitors, as well as the placement of the portable monitors, are discussed in Section 12.5.

12.3.7 COL Information

12.3-2-A Operational Considerations

STD COL 12.3-2-A This COL item is addressed in Subsection 12.3.4.

12.3-3-H Controlled Access

STD COL 12.3-3-H This COL item is addressed in Subsection 12.3.1.3.

12.4 Dose Assessment

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

12.4.7.1 Annual Doses to Construction Workers

EF3 SUP 12.4-1 Doses to construction workers are addressed in Section 4.5 of the Environmental Report contained in COLA Part 3.

12.5 Operational Radiation Protection Program

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

12.5.3 Operational Considerations

Replace this section with the following.

STD COL 12.5-1-A
STD COL 12.5-2-A
STD COL 12.5-3-A

The operational program for radiation protection is addressed in Appendix 12BB.

12.5.4 COL Information

12.5-1-A Equipment, Instrumentation, and Facilities

STD COL 12.5-1-A This COL item is addressed in Appendix 12BB.

12.5-2-A Compliance with 10 CFR 50.34(f)(2)(xxvii) and NUREG-0737 Item III.D.3.3

STD COL 12.5-2-A This COL item is addressed in Appendix 12BB.

12.5-3-A Radiation Protection Program

STD COL 12.5-3-A This COL item is addressed in Appendix 12BB.

12.6 Minimization of Contamination and Radwaste Generation

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

12.6.1 Minimization of Contamination to Facilitate Decommissioning

Add the following at the end of this section.

STD SUP 12.6-1

In addition to design features, measures are implemented in operating procedures to minimize contamination. Appendix 12BB establishes contamination control measures to ensure compliance with 10 CFR 20.1406. Practical measures to prevent the spread of contamination are employed, including:

- Engineering controls, such as portable ventilation or filtration units to reduce concentrations of radioactivity in air or fluids, are used where practical
- Criteria for selecting tools, material, and equipment for use in contaminated areas include minimizing the use of porous or other materials that are difficult to decontaminate
- Leaks and spills are contained promptly and repaired or cleaned up as soon as practical
- Containments, caches, and enclosures are used during maintenance, repairs, and testing, when practical, to contain spills or releases
- Contaminated tools and equipment are segregated from clean tools and equipment
- Potentially contaminated systems, equipment, and components are surveyed for the presence of contamination when opened or prior to removal
- Procedures ensure that equipment performs and is operated in accordance with the design requirements
- Temporary and permanent design modifications require compensatory measures be taken to prevent and limit the spread of contamination

Appendix 12A Calculation of Airborne Radionuclides

This section of the referenced DCD is incorporated by reference with no departures or supplements.

Appendix 12B Calculation of Airborne Releases

This section of the referenced DCD is incorporated by reference with no departures or supplements.

STD SUP 12.1-1

Appendix 12AA ALARA Program

NEI 07-08, Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures Are As Low As Is Reasonably Achievable (ALARA), which is currently under review by the NRC staff, is incorporated by reference. (Reference 12AA-201)

12AA.1 References

12AA-201 Nuclear Energy Institute (NEI), Generic FSAR Template Guidance for Ensuring that Occupational Radiation Exposures Are As Low As Is Reasonably Achievable (ALARA), NEI 07-08.

STD COL 12.1-1-A
STD COL 12.1-2-A
STD COL 12.1-3-A
STD COL 12.1-4-A
STD COL 12.5-1-A
STD COL 12.5-2-A
STD COL 12.5-3-A

Appendix 12BB Radiation Protection

NEI 07-03, Generic FSAR Template Guidance for Radiation Protection Program Description, which is currently under review by the NRC staff, is incorporated by reference with the following supplemental information. (Reference 12BB-201)

12.5.2.4 Radiation Protection Technicians

Delete the third paragraph.

12.5.3.1 Facilities

Delete the first and second paragraphs.

12.5.3.2 Monitoring Instrumentation and Equipment

Delete the third paragraph.

12.5.3.3 Personal Protective Clothing and Equipment

Delete the last sentence in the first paragraph.

12.5.4.2 Methods to Maintain Exposures ALARA

Delete the second paragraph.

12.5.4.4 Access Control

Isometric drawings of the Very High Radiation Areas (VHRA) are included in DCD Section 12.3.

Physical access controls include postings, barricades, physical barriers, and the use of locks that are keyed so only keys designated as VHRA can open the locks. Additionally, entry into a VHRA is allowed only with a specific (Special) radiation work permit.

12.5.4.12 Quality Assurance

Replace the bracketed text in the first paragraph with Section 17.5.

12BB.1 References

12BB-201 Nuclear Energy Institute (NEI), Generic FSAR Template Guidance for Radiation Protection Program Description, NEI 07-03.