

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



10 CFR 52.79

May 21, 2010  
NRC3-10-0022

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

References:

- 1) Fermi 3  
Docket No. 52-033
- 2) Letter from Jerry Hale (USNRC) to Jack M. Davis (Detroit Edison), "Request for Additional Information Letter No. 30 Related to the SRP Section 12.03 – 12.04 for the Fermi 3 Combined License Application," Dated April 12, 2010

Subject: Detroit Edison Company Response to NRC Requests for Additional  
Information Letter No. 30

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In Reference 2, the NRC requested additional information to support the review of certain portions of the Fermi 3 Combined License Application (COLA). The response to the Request for Additional Information (RAI) associated with Reference 2, SRP Section 12.03 – 12.04, is provided as Attachment 1 of this letter. Information contained in this response will be incorporated into a future COLA submission as described in the attachments.

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 21st day of May 2010.

Sincerely,

A handwritten signature in black ink, appearing to read "Peter W. Smith".

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

Attachments: 1) Response to RAI Letter No. 30, RAI Question No. 12.03-12.04-5

cc: 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 Environmental Quality, Radiological Protection and Medical  
Waste Section (w/o attachments)

Attachment 1 to  
NRC3-10-0022  
Page 1

**Attachment 1**  
**NRC3-10-0022**

**Response to RAI Letter No. 27**  
**(eRAI Tracking No. 4553)**

**RAI Question No. 12.03-12.04-5**

**NRC RAI 12.03-12.04-5**

*In the response to RAI 12.03-12.04-3 (Letter NRC3-09-002, dated August 25, 2009), DTE proposed to include a summary of construction activities and bases of dose calculations in the FSAR Revision 2. In addition, the response referenced Sections 4.5 of COL application Part 3 (the Fermi 3 Environmental Report) as containing additional information on the basis, models, assumptions, and input data used to determine the estimated doses to construction workers. The Environmental Report, however, is a separate stand alone document and it is not part of the FSAR. Therefore, the staff cannot base its determination of reasonable assurance on material contained in the Environmental Report.*

*In order for the staff to make a determination of reasonable assurance that the FSAR contains sufficient information related to the bases, models, assumptions, and input data used in the assessment and calculation of construction worker dose, it is the staff's position that the applicant modify FSAR Section 12.4.7.1 to include supplemental information equivalent to what is contained in the Fermi 3 Environmental Report (COLA Part 3, Section 4.5) relating to construction worker dose estimates. FSAR Section 12.4.7.1 should be modified to include the following:*

- 1) *The calculated annual person-Sievert construction worker dose.*
- 2) *The bases, models, assumptions, and input data used to calculate construction worker dose.*
- 3) *A description of any dose reduction measures identified or taken as a result of the construction worker dose assessment process.*
- 4) *A discussion of how the guidance in RG 8.19 was used to perform the construction worker dose assessment. If RG 8.19 was not used, the FSAR should describe the specific alternative methods used.*
- 5) *A discussion of whether construction workers will be considered to be Members of the Public or occupational workers during construction of Fermi 3, and a description of how DTE will demonstrate compliance with the applicable requirements of 10 CFR 20 Subpart C or Subpart D.*
- 6) *A discussion of plans for radiological monitoring of the Fermi 3 construction site to verify construction worker dose estimates and to ensure that construction worker doses do not exceed the applicable limits. In the response to RAI 12.03-12.04-3, DTE provided a discussion of why the TLD location T-48 was chosen as the most representative location for estimating construction worker dose estimates. Although TLD location T-48 is located closer to the closest to the Fermi 3 power block, TLD location T-47 is located closer to Fermi 2.*

- 7) *Provide a justification as to why DTE should not base its estimated construction worker dose estimates on a TLD reading that is based on the average reading for these two TLD locations for the year with the highest TLD annual dose.*

*Provide a markup of the proposed FSAR changes in the response.*

### **Response**

FSAR Section 12.4.7.1 will be updated to include Fermi 3 construction worker dose estimates, bases, models, assumptions, and input data, as shown in the following markups. The analysis presented in COLA Part 3, Section 4.5, has been included in the FSAR Section 12.4.7.1 markups. Additionally, the annual construction worker dose estimate has been updated to incorporate an average contribution associated with TLDs 47 and 48, as represented in the attached FSAR Section 12.4.7.1 markups. The following paragraphs address each request of RAI 12.03-12.04-5 as identified in the RAI.

*1) The calculated annual person-Sievert construction worker dose.*

The collective construction worker dose estimate for the period of peak construction at Fermi 3 is expected to be less than 2.8 person-Sievert (280 person-rem) annually. Analysis details are presented below.

*2) The bases, models, assumptions, and input data used to calculate construction worker dose.*

The construction worker dose analyses include sources from Fermi 2, the anticipated Fermi 2 ISFSI, and the anticipated decommissioned Fermi 1 site. The analysis combines dose estimates from each source, calculated at the point of highest potential exposure relative to the planned Fermi 3 construction site ( i.e. the Fermi 3 construction worker is assumed to occupy the location of greatest exposure, at each source simultaneously, for the entire working year consisting of 2080 hours). Each potential source for Fermi 3 construction workers is evaluated as discussed below.

### **Fermi 2**

The contributions to construction worker dose from Fermi 2 sources were evaluated based on information reported annually to the NRC as part of the Fermi 2 Radioactive Effluent Release and Radiological Environmental Operating Report. Measured and reported data from Fermi 2 is available for gaseous and liquid effluents, as well as direct radiation sources. Reports from the years 1999 through 2008 were utilized in the Fermi 3 construction worker dose analysis. This 10 year period provides sufficient data to be representative of plant conditions. The most limiting annual dose rates, from the ten year period analyzed, were used for the Fermi 3 construction worker dose estimates.

### ***Gaseous Effluents***

The Fermi 2 Annual Radioactive Effluent Release and Radiological Environmental Operating Reports for 1999 through 2008 provide both the airborne effluent doses for

the most highly exposed individual living near the plant, as well as the maximum potential dose to a visitor to Fermi 2 due to all radioactive effluents, including noble gases. Because of the proximity of this location to the expected Fermi 3 construction site, the dose rates due to gaseous effluents calculated at the Visitor's Center are representative of the dose rates to which the construction workers would be exposed. The annual doses at the Visitor's Center were calculated based on an exposure time of 4 hours/year. Dividing these annual doses by four results in an hourly dose rate which is representative of what a construction worker could expect to receive, and can then be used to extrapolate the dose rate to construction workers on an annual basis (2080 hours) due to gaseous effluent from Fermi 2. The dose to a Fermi 3 construction worker from Fermi 2 gaseous effluents for a full work year of 2080 hours is estimated to be less than 1.6 mrem.

#### *Liquid Effluents*

Liquid radioactive effluents from Fermi 2 may be released to Lake Erie via the circulating water reservoir blowdown line. The Fermi 3 construction site is well removed from the Fermi 2 blowdown line. There have been no liquid radioactive effluent releases from Fermi 2 from 1999 through 2008, the time period used to estimate Fermi 2 contribution to Fermi 3 construction worker dose. As such, the dose estimate from liquid effluents is negligible.

#### *Direct Radiation*

The direct radiation dose estimates from Fermi 2 are based on TLD stations that are in the proximity of the Fermi 3 construction area, relative to Fermi 2. The dose measured by these TLDs includes background radiation, and the analysis presented accounts for background radiation as estimated using remote TLD data. In determining the annual construction worker dose estimate, the worker is assumed to be located in the area between the TLD 47 and 48 stations for the entire year. The average of the two TLD stations provides a conservative estimate based on duration of exposure and distance to the source. The dose to a Fermi 3 construction worker from Fermi 2 direct radiation for a full work year of 2080 hours is estimated to be less than 56.3 mrem.

#### Fermi 2 ISFSI

The contribution to construction worker dose from the Fermi 2 ISFSI source was evaluated based on potential ISFSI loading and distance from Fermi 3 construction activities. The ISFSI for Fermi 2 is located approximately 820 feet from the nearest construction area for Fermi 3. The dry casks of the Fermi 2 ISFSI will be loaded with fuel that has cooled between 14 and 29 years. Industry practice for cask fuel loading is to load the oldest fuel on the perimeter and the newest fuel in the middle. This loading provides additional shielding and lowers the dose rate. The analysis presents a conservative estimate, taking the collection of dry casks to be utilized at the Fermi 2 ISFSI as a single point source, assuming a uniform loading of spent fuel with a 15 year cooling period in each dry cask, and utilizing the 820 foot distance to the nearest

construction area for Fermi 3. The dose to a Fermi 3 construction worker from the Fermi 2 ISFSI for a full work year of 2080 hours is estimated to be less than 13.8 mrem.

Fermi 1

The anticipated decommissioned Fermi 1 source is evaluated based on regulatory limits for decommissioned sites. Fermi 1 will be decommissioned before the construction of Fermi 3. In accordance with the limits established in 10 CFR 20.1402, the dose from Fermi 1 can not exceed 25 mrem/yr. The dose to a Fermi 3 construction worker from Fermi 1 for a full work year of 2080 hours is estimated to be significantly less than 25 mrem.

Fermi 3 Construction Worker Dose Estimate

Based on the analysis presented above, combining the estimated dose from all sources, for a Fermi 3 construction worker, assuming a 2080 hour work year, and accounting for background radiation, the exposure to a Fermi 3 construction worker is conservatively estimated to be less than 96.6 mrem/yr. This estimate represents less than 1.6 mrem/yr associated with Fermi 2 gaseous effluents, less than 56.3 mrem/yr associated with Fermi 2 direct radiation, less than 25 mrem/yr associated with Fermi 1, and less than 13.8 mrem/yr associated with the Fermi 2 ISFSI. The collective construction worker dose estimate for the period of peak construction at Fermi 3 which includes 2900 workers is expected to be less than 2.8 person-Sievert (280 person-rem) annually. FSAR Section 12.4.7.1 will be updated to describe the bases, models, assumptions, and input data used to calculate the construction worker dose.

*3) A description of any dose reduction measures identified or taken as a result of the construction worker dose assessment process.*

The exposure to the Fermi 3 construction work force will be less than presented in the analysis above. Dose reduction measures were not considered in the estimates. The analysis assumes the greatest potential source, at the shortest distance, for the longest period of time, with no shielding present. The following factors will contribute to lower construction worker dose exposures.

The estimate assumes that the decommissioned Fermi 1 site contributes 25 mrem/yr to Fermi 3 construction workers. The Fermi 1 dose contribution of 25 mrem/yr is based on the regulatory limit for a decommissioned site under 10 CFR 20.1402. The actual contribution is expected to be much less. The Fermi 2 TLD location T-54 is the closest TLD location to the Fermi 1 site, and when subtracting background radiation, the highest value measured between 1999 and 2008, for an occupancy duration of 2080 hours, was 5.4 mrem/yr. As it is not possible to distinguish Fermi 1 radiation from Fermi 2 radiation, it is reasonable to conclude that in its current state the existing Fermi 1 radiation dose is currently less than 5.4 mrem/yr. This is approximately five times less than the value used in the construction worker dose estimate.

The calculated construction worker dose estimate assumes that the Fermi 2 ISFSI, Fermi 2 direct dose, Fermi 2 gaseous effluent, and Fermi 1 dose all occur at a single point.

Therefore, the calculated dose is based on the assumption that the construction worker spends all 2080 hours at each source simultaneously, which is not physically possible due to the distance separating the sources. Therefore, in order to spend all 2080 hours at any one of the source points, the distance from the other points would be increased. Further, as the actual distances to Fermi 3 structures are greater than those used in the calculation, the time spent by construction workers at the source locations would be reduced.

The Fermi 2 ISFSI dose calculation assumes that all casks are located at a single point, and does not take credit for cask to cask shielding. Additional conservatism is included in the ISFSI dose calculation by assuming that all fuel in the casks is from the same year. Industry practice for cask fuel loading is to load the oldest fuel on the perimeter and the newest fuel in the middle. The loading provides additional shielding and lowers the dose rate. Further, excavation and construction of the Fermi 3 structures would provide additional shielding from all direct dose sources.

In determining the direct radiation estimate for Fermi 3 construction worker dose, the TLD-48 station closest to the Fermi 3 power block provides a more accurate estimation. This TLD represents a more likely Fermi 3 construction work force exposure instead of the maximal individual exposure discussed above. Use of TLD 48 is conservative as the TLD station is closer to the source than Fermi 3 structures, shielding provided as structures are constructed has not been accounted for, and the duration of exposure at the location is assumed to be a full working year for the entire Fermi 3 peak construction work force. The total body Fermi 2 direct dose estimate for the Fermi 3 construction worker using TLD-48 data is 32.0 mrem/yr, a 43% reduction in the Fermi 2 direct dose estimate presented above.

Fermi 2 currently uses Hydrogen Water Chemistry (HWC) to control the production of corrosion products to mitigate stress corrosion cracking. The use of HWC increases N-16 production which results in high energy gamma rays that contribute to the direct radiation measured at the TLD locations in close proximity to Fermi 2. The use of noble metal chemistry could significantly reduce the direct radiation from Fermi 2 to the Fermi 3 construction workforce. Using the TLD records from the second half of 1997 as a reference (prior to full implementation of Fermi 2 HWC program), the direct dose contribution to the Fermi 3 work force, as estimated from the average of TLDs 47 and 48 and accounting for background radiation, is only 9.3 mrem/yr. The use of noble metal chemistry at Fermi 2, currently planned for March 2011 implementation, may reduce the direct dose Fermi 2 contributions to Fermi 3 construction workers by up to 83%.

*4) A discussion of how the guidance in RG 8.19 was used to perform the construction worker dose assessment. If RG 8.19 was not used, the FSAR should describe the specific alternative methods used.*

The guidance of Regulatory Guide 8.19 (RG 8.19) describes a method acceptable to the NRC Staff for performing an assessment of collective occupational radiation dose as part of the ongoing review process involved in designing a light-water-cooled power reactor (LWR) so that occupational doses will be as low as reasonably achievable (ALARA).

The guidance for ALARA and the principles of RG 8.19 were considered through the use of historical operational data from Fermi 2, industry experience with ISFSI design, and regulatory requirements for Fermi 1 to evaluate the construction worker dose by using the operational experience from existing plants.

*5) A discussion of whether construction workers will be considered to be Members of the Public or occupational workers during construction of Fermi 3, and a description of how DTE will demonstrate compliance with the applicable requirements of 10 CFR 20 Subpart C or Subpart D.*

The dose estimate is based on direct sources, gaseous effluents, and liquid effluents for a construction worker that spends 2080 hours on site each year. Under 10 CFR 20.1301, annual dose to members of the public shall not exceed 0.1 rem (100 mrem) for licensed operating plants; therefore, the calculated dose of 96.6 mrem/yr for maximal exposure of an individual construction worker is below the threshold requirement for individual dose monitoring. Based on the calculated maximum dose to an individual construction worker, the Fermi 3 construction workers are considered members of the general public.

Radiation monitoring of the Fermi 3 construction workers as members of the general public, and compliance with the requirements of 10 CFR 20 Subpart D, is controlled per the requirements of the Fermi 2 Radiological Effluent Monitoring Plan (REMP).

*6) A discussion of plans for radiological monitoring of the Fermi 3 construction site to verify construction worker dose estimates and to ensure that construction worker doses do not exceed the applicable limits. In the response to RAI 12.03-12.04-3, DTE provided a discussion of why the TLD location T-48 was chosen as the most representative location for estimating construction worker dose estimates. Although TLD location T-48 is located closer to the closest to the Fermi 3 power block, TLD location T-47 is located closer to Fermi 2.*

Based on the calculated maximum dose to an individual construction worker, the Fermi 3 construction workers are considered members of the general public. Radiation monitoring of the Fermi 3 construction workers as members of the general public is controlled per the requirements of the Fermi 2 Radiological Effluent Monitoring Plan (REMP).

*7) Provide a justification as to why DTE should not base its estimated construction worker dose estimates on a TLD reading that is based on the average reading for these two TLD locations for the year with the highest TLD annual dose.*

As discussed above, an average of TLDs 47 and 48 were used to estimate the direct dose contribution of the Fermi 2 plant on Fermi 3 construction workers. The direct radiation dose estimates from Fermi 2 are based on TLD stations that are in the proximity of the Fermi 3 construction area, relative to Fermi 2. In determining the annual construction worker dose estimate the worker is assumed to be located in the area between the TLD 47 and 48 stations for the entire working year. The average of the two TLD stations provides a conservative estimate based on duration of exposure and distance to the source.

**Proposed COLA Revision**

Proposed changes to FSAR Section 12.4.7.1 which incorporate analysis presented in COLA Part 3, Section 4.5, are attached. Proposed changes to ER Section 4.5 to revise the direct dose estimate based on an average of TLDs 47 and 48 are attached.

**Markup of Detroit Edison COLA**  
(following 14 pages)

The following markup represents how Detroit Edison intends to reflect this RAI response in a future submittal of the Fermi 3 COLA. 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.

## 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

Add Insert "1" here

~~Doses to construction workers are addressed in Section 4.5 of the Environmental Report (ER) contained in COLA Part 3 and associated impacts are determined to be SMALL. As described in Section 4.5 of the ER, the dose estimates are determined based on the following.~~

~~The dose to the construction worker includes dose due to operation of Fermi 2 and estimated dose from the planned Fermi Independent Spent Fuel Storage Installation (ISFSI).~~

~~External dose estimates are determined based on TLD readings that are located closest to the Fermi 3 power block construction area relative to Fermi 2. Conservative TLD readings used are based on several years of data.~~

~~Effluent release data for Fermi 2 used for dose calculations is based on several years of data as reported in the Fermi 2 Annual Radioactive Effluent Release Reports. Conservative values are used based on several years of data.~~

~~The estimated peak number of construction workers is 2000.~~

~~The resultant projected maximum dose estimate for an individual construction worker is less than the limits for public dose specified in 10 CFR 20.1301.~~

~~There are also some contributions to dose for Fermi 3 construction workers from the decommissioned Fermi 1 site. To meet the limits established in 10 CFR 20.1402, the maximum dose to a construction worker from the decommissioned Fermi 1 must not exceed 25 mrem per year. Conservatively including this additional dose with the dose estimated in ER Section 4.5 still results in estimated construction worker dose that is well within the limits for the members of the public.~~

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## 12.5 Operational Radiation Protection Program

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

Insert "1"

During the construction of Fermi 3, workers could be exposed to several potential sources of radiation. This section identifies the potential sources of radiation and estimates the doses that workers may receive during the construction of Fermi 3 due to the operation of Fermi 2.

Three types of sources are considered: direct radiation, gaseous effluents, and liquid effluents. Tables 12.4-203 and 12.4-204 provide a comparison of these calculated doses and show that the limits in 10 CFR 20.1301 and 40 CFR 190 for members of the public are satisfied.

Dose rates at the construction site are estimated based on dose rate measurements and calculations. Although construction workers will occupy a large area over the course of the construction period, dose rates to an individual construction worker are conservatively estimated based on the assumption that the worker is closest to all radiation sources without respect to the actual proximity of the sources relative to each other. The bases, assumptions and methods used to calculate the construction worker dose is given below with the maximum annual dose to an individual construction worker of 96.6 mrem/yr.

Construction workers are considered to be members of the public and radiological monitoring is handled per requirements of the Fermi 2 Radiological Effluent Monitoring Program (REMP). The Fermi site will be continually monitored during the construction period under the Fermi 2 REMP and appropriate actions taken to ensure that doses to the construction workers remain ALARA.

### **Direct Radiation**

The direct radiation dose rates from Fermi 2 are based on an average of the highest annual measurement at the two TLD stations that are closest to the Fermi 3 power block area relative to Fermi 2 from 1999 to 2008, T-47 and T-48. This 10 year period provides sufficient data to be representative of plant conditions. The dose measured by these TLDs includes background radiation, the analysis presented accounts for background radiation as estimated using remote TLD data. In determining the direct radiation dose rates, it is assumed that the worker is located in the area between the two TLD stations for the entire year. Given that workers move about the construction area over the course of a year, and that all Fermi 3 structures are located farther than TLD station T-48, the use of the average of the two TLD stations is a conservative selection for determining the maximum individual construction worker dose. The maximum estimated total body dose rate to a Fermi 3 construction worker due to operation of Fermi 2 is 56.3 mrem/yr. Further, no credit is taken for any shielding provided as structures are constructed.

Depending on the construction schedule for Fermi 3, a potential source of direct radiation could be an independent spent fuel storage installation (ISFSI) constructed for Fermi 2. The ISFSI dose contribution to a Fermi 3 construction worker is calculated at a distance of 820 feet from the ISFSI pad for an exposure period of 2080 hours. The distance of 820 feet is based on the closest Fermi 3 structures. The estimated dose for a 2080 hour exposure period at a distance of 820 feet from the ISFSI pad is approximately 13.8 mrem/yr.

Fermi 1 will be decommissioned before the construction of Fermi 3. In accordance with the limits established in 10 CFR 20.1402, the dose from Fermi 1 can not exceed 25 mrem/yr. It is expected that the dose from Fermi 1 will be significantly less than 25 mrem/yr.

### **Gaseous Effluents**

The Fermi 2 Annual Radioactive Effluent Release and Radiological Environmental Operating Reports for 1999 through 2008 (Reference 12.4-201 through Reference 12.4-210) provide both the airborne effluent doses for the most highly exposed individual living near the plant, as well as the maximum potential dose to a visitor to Fermi 2 due to all radioactive effluents, including noble gases. Due to the proximity of this location to the expected Fermi 3 construction site, the dose rates due to gaseous effluents calculated at the Visitor's Center are representative of the dose rates to which the construction workers would be exposed. The annual doses at the Visitor's Center were calculated based on an exposure time of 4 hours/year. Dividing these annual doses by four results in an hourly dose rate which is representative of what a construction worker could expect to receive, and can then be used to extrapolate the dose rate to construction workers on an annual basis (2080 hours) due to gaseous effluent from Fermi 2. Using this dose rate, the maximum exposed organ (thyroid) dose of 10.4 mrem/yr and a maximum whole body dose of 1.6 mrem/yr for the annual dose from Fermi 2 gaseous releases.

### **Liquid Effluents**

Liquid radioactive effluents from Fermi 2 may be released to Lake Erie via the circulating water reservoir blowdown line. However, there have been no liquid radioactive effluent releases from Fermi 2 since 1994 (Reference 12.4-211). As such, the dose estimate from liquid effluents is negligible.

Table 12.4-201 provides a summary of the maximum annual dose to a construction worker by source. Table 12.4-202 provides a summary of the collective annual construction worker dose. Table 12.4-203 provides a comparison of the maximum construction worker dose with the dose to the public limits in 10 CFR 20.1301. Table 12.4-204 provides a comparison of the construction worker dose from gaseous effluent discharges with the public dose limits in 40 CFR 190. Table 12.4-205 provides a comparison with the 10 CFR 50 Appendix I criteria for effluent doses. The direct radiation estimates do not take credit for shielding provided by any intervening Fermi 3 structures during construction or for activities that occur below grade. The direct radiation dose estimates also assume that the doses are not reduced as the distance from the source increases. The conservative assumptions for the direct radiation doses allow for assurance that the dose to individual construction workers is in compliance with 10 CFR 20 Subpart D. The Fermi 2 REMP will monitor radiation at the site to confirm dose to construction workers is in compliance with 10 CFR 20 Subpart D.

#### **12.4.9 References**

- 12.4-201 Detroit Edison, "Fermi 2 – 1999 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 1999 through December 31, 1999."
- 12.4-202 Detroit Edison, "Fermi 2 – 2000 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2000 through December 31, 2000."
- 12.4-203 Detroit Edison, "Fermi 2 – 2001 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2001 through December 31, 2001."
- 12.4-204 Detroit Edison, "Fermi 2 – 2002 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2002 through December 31, 2002."
- 12.4-205 Detroit Edison, "Fermi 2 – 2003 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2003 through December 31, 2003."
- 12.4-206 Detroit Edison, "Fermi 2 – 2004 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2004 through December 31, 2004."
- 12.4-207 Detroit Edison, "Fermi 2 – 2005 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2005 through December 31, 2005."
- 12.4-208 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."
- 12.4-209 Detroit Edison, "Fermi 2 - 2007 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2007 through December 31, 2007."
- 12.4-210 Detroit Edison, "Fermi 2 - 2008 Annual Radiological Environmental Operating Report for the period of January 1, 2008 through December 31, 2008."
- 12.4-211 Detroit Edison, "Fermi 2 - 2008 Annual Radioactive Effluent Release Report for the period of January 1, 2008 through December 31, 2008."

Insert "2"

Table 12.4-201 Maximum Annual Dose to a Construction Worker by Source (mrem)

	<b>Direct</b>						<b>Total<sup>1</sup></b>
Critical Organ	<b>Fermi 2</b>	<b>Direct ISFSI</b>	<b>Fermi 1</b>	<b>Gaseous</b>	<b>Liquid</b>		
Whole Body	56.3	13.8	25	1.6	N/A		96.6

Notes:

1. The Total dose calculation for Whole Body exposure may not match the sum of the individual dose values due to rounding.
2. 1 mrem = 0.01 mSv

Table 12.4-202 Collective Annual Construction Worker Dose by Source (person-rem)<sup>1</sup>

	<b>Direct</b>					<b>Total</b>
Whole Body	<b>Fermi 2</b>	<b>Direct ISFSI</b>	<b>Fermi 1</b>	<b>Gaseous</b>	<b>Liquid</b>	
Whole Body	163.2	39.9	72.5	4.5	N/A	280

Notes:

1. The collective annual doses are based on 2900 worker working 2080 hours.
2. 1 mrem = 0.01 mSv

Table 12.4-203 Comparison of Construction Worker Dose to Public Dose Limits Specified in 10 CFR 20.1301

<b>Type of Dose</b>	<b>Annual Dose Limits</b>	<b>Construction Worker Dose</b>
Total effective dose equivalent per year	100 mrem	96.6 mrem
Maximum dose in any hour	2 mrem	0.128 mrem

Notes:

1. 1 mrem = 0.01 mSv

Table 12.4-204 Comparison of Construction Worker Dose from Gaseous Effluent to Public Dose Limits Specified in 40 CFR 190<sup>1</sup>

<b>Type of Dose</b>	<b>Annual Dose Limits</b>	<b>Construction Worker Dose</b>
Whole body dose	25 mrem	1.6 mrem
Thyroid dose <sup>2</sup>	75 mrem	10.4 mrem

Notes:

1. 10 CFR 20 requires that the dose to an individual from radioactive effluents also meet 40 CFR 190 limits.
2. The thyroid dose is identified as the maximum exposed organ; therefore the other organ dose would be less than the thyroid dose.
3. 1 mrem = 0.01 mSv

Table 12.4-205 Comparison with 10 CFR 50 Appendix I Criteria for Effluent Dose

	<b>Annual Dose (mrem)</b>	
	<b>Annual Limit</b>	<b>Estimated Dose</b>
Whole body dose from liquid effluents	3	Negligible <sup>1</sup>
Organ dose from liquid effluents	10	Negligible <sup>1</sup>
Whole body dose from liquid effluents	5	1.6
Organ dose from all effluents	15	10.4

Notes:

1. Per Reference 12.4-211, there have been no liquid effluent releases at Fermi 2 since 1994.
2. 1 mrem = 0.01 mSv

## 4.5 Radiation Exposure to Construction Workers

This section evaluates the potential radiological dose impacts to construction workers at Fermi 3 resulting from the operation of Fermi 2.

### 4.5.1 Site Layout

Fermi 3 is located to the southwest of Fermi 2. Fermi 2 is expected to be operating normally during the construction period for Fermi 3. Construction support areas such as offices, parking, warehouses, and laydown areas are also located to the south and west of the new facility location.

Figure 4.5-1 shows the construction areas relative to the Fermi 2 power block and associated facilities.

### 4.5.2 Radiation Sources

Construction workers at a new facility on the site could be exposed to radiation from a range of sources associated with the normal operation of Fermi 2. These include direct radiation, radiation from gaseous effluents, and radiation from liquid effluents.

Figure 4.5-1 shows the location of the primary sources of radiation from Fermi 2 relative to the construction areas, as discussed below.

#### 4.5.2.1 Direct Radiation Sources

A large portion of the radiation dose to construction workers is expected to be due to the "skyshine" (gamma radiation that scatters in the atmosphere and is reflected back to the ground) from the nitrogen-16 (N-16) source present in the operating Fermi 2 main turbine steam cycle. Hydrogen Water Chemistry (HWC) is employed at Fermi 2 in order to control the production of corrosion products and thereby mitigate intergranular stress corrosion cracking of susceptible components. The Fermi 2 Updated Final Safety Analysis Report (UFSAR), Table 11.1-5, indicates an N-16 specific activity of 100  $\mu\text{Ci/g}$  in the steam for normal water chemistry, and 600  $\mu\text{Ci/g}$  for HWC (Reference 4.5-1). The N-16 activity present in the main steam lines, turbines, and moisture separators provides an air-scattered radiation dose contribution to locations outside Fermi 2 structures as a result of the high energy gamma rays which N-16 emits as it decays.

Other sources at the Fermi 2 with the potential for a direct radiation dose contribution to construction workers are the condensate storage tanks and the onsite low level waste storage facility. The minimal activity within the tanks and the concrete shielding used in the design of the onsite storage facility results in a negligible dose rate at the site boundary (Reference 4.5-1, Section 12.1.1.2). Therefore, these sources of direct radiation are deemed negligible in comparison with the skyshine doses when considering the dose to construction workers.

Depending on the construction schedule undertaken for Fermi 3, a potential source of direct radiation could be an independent spent fuel storage installation (ISFSI) constructed for Fermi 2. ~~Currently, there is no ISFSI at the Fermi site, but there are plans to construct an ISFSI using a Holtec HI-STORM system.~~ The ISFSI dose contribution to a Fermi 3 construction worker is calculated at a distance of 820 feet from the ISFSI pad for an exposure period of 2080 hours. The

distance of 820 feet is based on the closest Fermi 3 structures. The estimated dose for a 2080 hour exposure period at a distance of 820 feet from the ISFSI pad is approximately 13.8 mrem/yr.

Fermi 1 will be decommissioned before the construction of Fermi 3. In accordance with the limits established in 10 CFR 20.1402, the dose from Fermi 1 can not exceed 25 mrem/yr. It is expected that the dose from Fermi 1 will be significantly less than 25 mrem/yr.

#### **4.5.2.2 Radiation from Gaseous Effluents**

Fermi 2 is designed with the provision for releasing airborne effluents via three gaseous effluent release points to the environment. These are the radwaste building vent, the reactor building vent, and the turbine building vent (Reference 4.5-1, Section 11.3.7). The reactor building vent is the primary release point and includes exhaust from the offgas system, turbine gland seal system, and the reactor building ventilation. The turbine building vent contains low activity exhaust resulting from small leaks from the turbine, condenser and other components in the turbine building. The radwaste building vent contains low activity exhaust resulting from small leaks from laboratory fume hoods, tank vents, and contaminated cubicles. The expected radiation sources (nuclides and activities) for the primary gaseous effluents are listed in the Fermi 2 UFSAR, Table 11.3-1 (Reference 4.5-1).

#### **4.5.2.3 Radiation from Liquid Effluents**

Fermi 2 releases radioactive liquid effluents via the circulating water reservoir blowdown line. The minimum dilution flow is approximately 10,000 gpm (Reference 4.5-1, Section 11.2.8). The annual expected maximum dose to an individual resulting from Fermi 2 liquid effluents is presented in the Fermi 2 UFSAR (Reference 4.5-1, Appendix 11A). When effluents are released, they discharge directly to Lake Erie via the circulating water reservoir blowdown line. Lake Erie provides further dilution through natural mixing characteristics in the vicinity of the discharge. From Figure 4.5-1, it is clear that construction activities for a new facility would be well removed from the release point for liquid effluents.

#### **4.5.3 Measured and Calculated Radiation Dose Rates**

Measured and reported data from Fermi 2 is available for gaseous and liquid effluents, as well as direct radiation sources. This information is reported annually to the NRC as part of the Radioactive Effluent Release and Radiological Environmental Operating Report. Reports from the years 1999 through 2008 were utilized in the preparation of this section (Reference 4.5-2 through Reference 4.5-9 and Reference 4.5-11 through Reference 4.5-13).

##### **4.5.3.1 Dose Rate from Direct Radiation Sources**

Fermi 2 measures radiation doses at various locations on the site using thermoluminescent dosimeters (TLDs). As shown on Figure 4.5-2, TLDs T47, T48, T54, and T64 are the TLDs closest to the expected construction areas for the Fermi 3 site. The location of TLD 47 represents the maximum radiation exposure a construction worker is expected to encounter, TLD T48 is representative of the near edge of the Fermi 3 construction site (southwest of the Fermi 2 plant buildings), TLD T54 is representative of the far edge of the Fermi 3 construction site, and TLD T64 is representative of the location of the ~~planned ISFSI construction~~ site due west of Fermi 2.

Measurements from these TLDs are used to determine the expected direct radiation dose to construction workers.

Table 4.5-1 collects ten years of radiation dose rate data for the four TLDs of interest. As explained in the footnotes of the table, the dose rates from the Radioactive Effluent Release and Radiological Environmental Operating Reports are expressed in units of radiation exposure (Roentgen) and represent one year (365 days x 24 hours/day = 8760 hours) of exposure time. In order to compare the expected dose rates to the dose limits prescribed in 10 CFR 20, conversion of these dose rates into mrem/yr is necessary.

The most limiting annual dose rates at the four TLDs of interest were 410.31 milliroentgen/yr, recorded at TLD T47 in 2008 and 194.96 milliroentgen/yr, recorded at TLD T48 in 2008 (Reference 4.5-12). TLD T47 and TLD T48 are approximately 525 ft and 1000 ft from the centerline of the Fermi 2 Turbine Building, respectively (Reference 4.5-9). Conversion of these radiation exposures into a dose equivalent in tissue is accomplished by multiplying by 0.95 (Reference 4.5-10). Conversion results in an annual dose rate of 389.79 mrem/yr at T47 and 185.21 mrem/yr at T48. The annual dose measured at these TLDs was accumulated over an exposure time of 8760 hours. It is assumed that construction workers will work standard 8-hour shifts. Applying this work rate to 5 days per week, 52 weeks per year, yields 2080 hours per year. Therefore, the annual dose to a construction worker due to direct radiation at the Fermi 3 construction site is approximately 92.6 mrem/yr at TLD T47 and 44.0 mrem/yr at TLD T48. While the dose rate measured at TLD T47 is the most bounding of the four TLD locations, this location overestimates the average dose rate a construction worker would incur on the Fermi 3 construction site. From Figure 4.5-1 and Figure 4.5-2, TLD T47 is located on the Protected Area fence south of the Fermi 2 Turbine Building, well removed from the eventual location of the Fermi 3 building structures. As such, the location of TLD T48 is more representative of the areas where the bulk of the construction activities will occur. ~~TLD T48 provides a more representative dose rate to a construction worker and is used to calculate the radiological impact to construction workers at the Fermi 3 site.~~

As a comparison, the most limiting annual dose at TLD T54 was 77.34 milliroentgen/yr in 2008 (Reference 4.5-12). TLD T54 is approximately 1530 ft from the centerline of the Fermi 2 Turbine Building (Reference 4.5-1). The estimated annual dose to a construction worker at TLD T54 is approximately 17.4 mrem/yr.

The most limiting annual dose at TLD T64 was 101.05 milliroentgen/yr in 2008 (Reference 4.5-12). TLD T64 is approximately 1340 ft from the centerline of the Fermi 2 Turbine Building (Reference 4.5-1). The estimated annual dose to a construction worker at TLD T64 is approximately 22.8 mrem/yr.

The dose measured by these TLDs includes background radiation. Based on remote TLDs background radiation is approximately 50 mrem per year. This corresponds to an annual radiation dose to a construction worker of approximately 12 mrem per year based on a 2080 working hours in a year. Subtracting the background radiation yields a direct dose from Fermi 2 as measured by ~~T48~~ of 32.0 mrem per year.

the average of TLD 47 and TLD 48 of 56.3

#### 4.5.3.3 Dose Rate from Liquid Effluents

The Annual Radioactive Effluent Release and Radiological Environmental Operating Reports for 1999 through 2008 (Reference 4.5-2 through Reference 4.5-9, Reference 4.5-11, and Reference 4.5-13) explicitly state that "there were no releases of liquid radioactive effluents," and furthermore that "there has not been a liquid radioactive discharge from Fermi 2 since 1994."

As such, the dose rate from liquid effluents is not expected to be a factor in the cumulative dose to construction workers.

#### 4.5.4 Construction Worker Dose Estimates

The overall estimate of dose to construction workers considers an occupational exposure period of 2080 hours per year, and a construction work force of approximately 2,900. All annualized dose estimates developed in this section are based on a 2080-hour year. Contributions from each type of source are developed below and a total estimated dose is provided in the conclusions.

##### 4.5.4.1 Dose Estimate from Direct Radiation Sources

56.3

As described in Subsection 4.5.3.1, a dose rate of ~~32.0~~ mrem/yr for the Fermi 3 construction area is used to estimate the annual dose to construction workers from N-16 skyshine radiation. Fermi 2 utilizes hydrogen water chemistry, which results in elevated skyshine doses.

A dose rate of 13.8 mrem/yr for the Fermi 3 construction area is used to estimate the annual dose to construction workers from Fermi 2 ISFSI radiation. A dose rate of 25 mrem/yr for the Fermi 3 construction area is used to estimate the annual dose to construction workers from the decommissioned Fermi 1 site radiation.

As described in Subsection 4.5.2.1, the contribution to the total dose estimate for construction workers from the condensate storage tanks and the onsite storage facility are negligible.

##### 4.5.4.2 Dose Estimate from Gaseous Effluents

Table 4.5-6 provides the estimated bounding dose of 10.4 mrem/yr to a maximally exposed organ (thyroid) and whole body dose of 1.6 mrem/yr from gaseous effluents.

##### 4.5.4.3 Dose Estimate from Liquid Effluents

Liquid radioactive effluents from Fermi 2 can be released to Lake Erie via the circulating water reservoir blowdown line. However, there have been no liquid radioactive effluent releases from Fermi 2 since 1994. As such, the dose estimate from liquid effluents is negligible.

#### 4.5.5 Summary and Conclusions

The annual dose to an individual construction worker from all three pathways is summarized in Table 4.5-4 and compared to the public dose criteria in 10 CFR 20.1301 and 40 CFR 190 in Table 4.5-5 and Table 4.5-6, respectively. Because the calculated doses meet the public dose criteria of 10 CFR 20.1301 and 40 CFR 190, the workers would not need to be classified as radiation workers and no shielding or other protective measures are required. Table 4.5-7 shows that the doses also meet the design objectives of 10 CFR 50, Appendix I, for gaseous and liquid effluents.

The maximum annual collective dose to the construction work force (2900 workers) is estimated to be ~~240~~ person-rem.

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It is concluded that annual construction worker doses attributable to the operation of Fermi 2 for the Fermi 3 construction areas would be SMALL because it would be a fraction of 10 CFR 20 and 10 CFR 50 Appendix I limits. Thus, monitoring of individual construction workers will not be required. Construction workers will be treated as if they were members of the general public in unrestricted areas.

#### 4.5.6 References

- 4.5-1 Detroit Edison, "Fermi 2 Updated Final Safety Analysis Report, UFSAR."
- 4.5-2 Detroit Edison, "Fermi 2 – 1999 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 1999 through December 31, 1999."
- 4.5-3 Detroit Edison, "Fermi 2 – 2000 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2000 through December 31, 2000."
- 4.5-4 Detroit Edison, "Fermi 2 – 2001 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2001 through December 31, 2001."
- 4.5-5 Detroit Edison, "Fermi 2 – 2002 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2002 through December 31, 2002."
- 4.5-6 Detroit Edison, "Fermi 2 – 2003 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2003 through December 31, 2003."
- 4.5-7 Detroit Edison, "Fermi 2 – 2004 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2004 through December 31, 2004."
- 4.5-8 Detroit Edison, "Fermi 2 – 2005 Annual Radioactive Effluent Release and Radiological Environmental Operating Report for the period of January 1, 2005 through December 31, 2005."
- 4.5-9 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."
- 4.5-10 Turner, J.E., "Atoms, Radiation, and Radiation Protection," Pergamon Press, 1986.

**Table 4.5-4 Annual Dose to a Construction Worker by Source (mrem)**

	Fermi 2	Direct ISFSI <sup>1</sup>	Fermi 1	Gaseous	Liquid	Total <sup>2</sup>		
Critical Organ	-	-	-	10.4	N/A	10.4		
Whole Body	32.0	56.3 <sup>3</sup>	13.8	25	1.6	N/A	72.3	96.6

Notes:

1. The ISFSI and decommissioned Fermi 1 site only contribute to the direct dose.
2. The Total dose calculation for Whole Body exposure may not match the sum of the individual dose values due to rounding.
3. The Fermi 2 dose is an average of TLD 47 and TLD 48 to represent the maximum dose to any single construction worker.

**Table 4.5-5 Comparison of Construction Worker Dose to Public Dose Limits Specified in 10 CFR 20.1301**

Type of Dose	Annual Dose Limits	Estimated Dose
Total effective dose equivalent per year	100 mrem	96.6 <del>72.3</del> mrem
Maximum dose in any hour	2 mrem	<< 1 mrem

**Table 4.5-7 Comparison with 10 CFR 50 Appendix I Criteria for Effluent Doses**

	Annual Dose (mrem)	
	Annual Limit	Estimated Dose
Whole body dose from liquid effluents	3	Negligible <sup>1</sup>
Organ dose from liquid effluents	10	Negligible <sup>1</sup>
Whole body dose from gaseous effluents	5	1.6
Organ dose from all effluents	15	10.4

Notes:

4.5-13

1. Per Reference 4.5-2 through Reference 4.5-9, there have been no liquid effluent releases at Fermi 2 since 1994.