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

10 CFR 52.79

February 8, 2010
NRC3-10-0003

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. 21 Related to the SRP Sections 2.3.1, 2.3.2, 2.3.3, 2.3.4 and 2.3.5 for the Fermi 3 Combined License Application," dated December 23, 2009

Subject: Detroit Edison Company Response to NRC Request for Additional Information Letter No. 21

In the referenced letter, the NRC requested additional information to support the review of certain portions of the Fermi 3 Combined License Application (COLA). The responses to these Requests for Additional Information (RAIs) are provided as Attachments 1 through 31 of this letter. Information contained in these responses will be incorporated into a future COLA submission as described in the RAI response.

As described in the response to RAI 02.03.04-3 in Attachment 29, Detroit Edison expects to supplement this response and provide updates to affected information in the Fermi 3 COLA either in conjunction with the next COLA revision or as a supplemental response to RAI 02.03.04-3. The next Fermi 3 COLA revision is scheduled to be submitted by March 25, 2010. If a supplemental response to this RAI is necessary, it will also be submitted by that date.

The response to RAI 02.03.04-4 contains electronic files submitted on CD as separate enclosure.

The file format and names on the enclosed CDs do not comply with the requirements for electronic submission in NRC Guidance Document, "Guidance for Electronic Submissions to the NRC," dated June 25, 2009; the files are not ".pdf" formatted. The NRC Staff requested the files

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be submitted in their native formats required by the software in which they are utilized to support review of the Final Safety Analysis Report.

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 8th day of February 2010.

Sincerely,

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

Attachments:
1) Response to RAI Letter No. 21 (Question No. 02.03.01-1)
2) Response to RAI Letter No. 21 (Question No. 02.03.01-2)
3) Response to RAI Letter No. 21 (Question No. 02.03.01-3)
4) Response to RAI Letter No. 21 (Question No. 02.03.01-4)
5) Response to RAI Letter No. 21 (Question No. 02.03.01-5)
6) Response to RAI Letter No. 21 (Question No. 02.03.01-6)
7) Response to RAI Letter No. 21 (Question No. 02.03.01-7)
8) Response to RAI Letter No. 21 (Question No. 02.03.01-8)
9) Response to RAI Letter No. 21 (Question No. 02.03.01-9)
10) Response to RAI Letter No. 21 (Question No. 02.03.01-10)
11) Response to RAI Letter No. 21 (Question No. 02.03.01-11)
12) Response to RAI Letter No. 21 (Question No. 02.03.01-12)
13) Response to RAI Letter No. 21 (Question No. 02.03.01-13)
14) Response to RAI Letter No. 21 (Question No. 02.03.01-14)
15) Response to RAI Letter No. 21 (Question No. 02.03.02-1)
16) Response to RAI Letter No. 21 (Question No. 02.03.02-2)
17) Response to RAI Letter No. 21 (Question No. 02.03.02-3)
18) Response to RAI Letter No. 21 (Question No. 02.03.02-4)
19) Response to RAI Letter No. 21 (Question No. 02.03.02-5)
20) Response to RAI Letter No. 21 (Question No. 02.03.02-6)
21) Response to RAI Letter No. 21 (Question No. 02.03.03-1)
22) Response to RAI Letter No. 21 (Question No. 02.03.03-2)
23) Response to RAI Letter No. 21 (Question No. 02.03.03-3)
24) Response to RAI Letter No. 21 (Question No. 02.03.03-4)
25) Response to RAI Letter No. 21 (Question No. 02.03.03-5)
26) Response to RAI Letter No. 21 (Question No. 02.03.03-6)
27) Response to RAI Letter No. 21 (Question No. 02.03.03-7)
28) Response to RAI Letter No. 21 (Question No. 02.03.04-2)

29) Response to RAI Letter No. 21 (Question No. 02.03.04-3)
30) Response to RAI Letter No. 21 (Question No. 02.03.04-4)
31) Response to RAI Letter No. 21 (Question No. 02.03.05-2)

cc: Jerry Hale, NRC Fermi 3 Project Manager (w/o attachments, w CD for RAI 02.03.04-4)
Chandu Patel, NRC Fermi 3 Project Manager (w/o attachments)
Ilka Berrois, NRC Fermi 3 Project Manager (w/o attachments)
Bruce Olson, NRC Fermi 3 Environmental Project Manager (w/o attachments)
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
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-1

NRC RAI 02.03.01-1

Please revise the FSAR as necessary to be more specific when using the term "storms."

In FSAR Subsection 2.3.1.2.1, "Wind Conditions," as well as in other subsections, the low pressure area movements are referred to as "storm tracks." This is somewhat ambiguous, as "storm" could be interpreted also as a thunderstorm, tropical depression, tropical storm, or hurricane.

Response

In FSAR Section 2.3 the term "storm track" is used to describe the mean track of surface low pressure systems which affect the meteorological conditions at the Fermi site. The term "track of surface low pressure systems" will be used in FSAR Section 2.3 in lieu of the term "storm track" consistent with the definition of storm track as presented in the Glossary of Meteorology published by the American Meteorological Society. In addition, the term "storm" will be used in FSAR Section 2.3 in lieu of the phrase "surface low pressure systems".

Proposed COLA Revision

Throughout FSAR Section 2.3 the term "storm track" will be replaced with "track of surface low pressure systems" and the term "storm" will be replaced with "surface low pressure systems" as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 10 page(s))

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

the lake, with its greater heat capacity, moderates low temperatures along the shoreline. During late December, ice typically forms over the lake and decreases its influence on the coastal areas (Reference 2.3-208). The ice cover during most years thaws by the middle of March, which prolongs cooler temperatures through parts of the spring season for the Fermi region.

surface low pressure

The meteorological conditions in the Fermi region are also influenced by the ~~mean storm track, which brings a~~ high frequency of ~~storm~~ systems and cloudiness during the late fall and winter, as well as early spring (Reference 2.3-209). During the later half of spring and summer, the ~~storm~~ track shifts north of the region and the Fermi region experiences an increase in sunshine ~~and warmer~~ monthly temperatures.

of surface low pressure systems

mean

precipitation

Surface low pressure

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of surface low pressure systems

Overall precipitation amounts vary slightly from month to month throughout the year (Reference 2.3-201). During the winter, the ~~storm~~ track is positioned over or just south of the Fermi region and increases the frequency of ~~storm systems~~ (Reference 2.3-209). ~~Storm~~ systems come from the west, northwest and southwest during the winter and bring the possibility of rain, freezing rain, sleet, and snow. Heavy snows are possible throughout the winter and can result in significant accumulations. During the summer, the ~~storm track~~ track shifts north of the region, however monthly rainfall values are higher than any other season. The number of days per month with thunderstorms is approximately 6 days during June, July, and August, which is higher than any other months (Reference 2.3-201). Thunderstorms during the summer bring the potential of heavy rainfall and severe weather.

of surface low pressure systems

mean

2.3.1.2 Normal, Mean, and Extreme Climatological Conditions

This section discusses 30-year normals, as well as long-term means and historical extremes for temperature, water vapor, precipitation, and wind that characterize the meteorological conditions in the region surrounding the Fermi site.

Table 2.3-202 contains long-term normals, means and extremes for Detroit Metropolitan Airport in Detroit, located approximately 27.4 km (17 mi) north-northwest of the Fermi site. Table 2.3-203 and Table 2.3-204 exhibit long-term meteorological information for Flint and Toledo. Flint and Toledo are located 119.1 km (74 mi) to the north-northwest and 61.2 km (38 mi) southwest of the Fermi site, respectively.

The purpose of this section is to demonstrate that the long-term data reported at the three NWS first-order meteorological stations, as well as the four COOP stations are representative of the short- and long-term climate characteristics of the region surrounding the Fermi site. Subsection 2.3.1.2.1 through Subsection 2.3.1.2.4 provide more detailed discussions of specific meteorological parameters of interest.

of surface low pressure systems

2.3.1.2.1 Wind Conditions

Based upon 39 years of wind data at Detroit Metropolitan Airport, the annual prevailing wind direction is 240 degrees or southwest (Reference 2.3-201). Monthly prevailing winds in Detroit are generally southwest during all months except during the spring when they are northwest. At Flint and Toledo the annual prevailing wind direction is also southwest (Reference 2.3-202, Reference 2.3-203), but both stations have different monthly variations when compared to Detroit. Monthly winds for Toledo, like Detroit, are southwest during all but the spring season when they become east-northeast. Monthly wind directions for Flint are also southwest during the majority of the year, however winds become westerly during February and March, east-northeasterly during April, and more southerly during May. The differences in the late winter and spring prevailing wind directions between Detroit and the Flint and Toledo stations can be attributed to the transition of the ~~storm~~ track to the north. During this transition the path of ~~storm~~ systems greatly varies, and wind patterns across the region can be different. The variation in the path of the ~~storms~~, as well as the general weakening of the jet stream, can explain the complexity of wind directions at the three first-order stations during the late winter and spring months.

surface low pressure systems

mean

surface low pressure

During the most recent 23-year period, the annual mean wind speed for Detroit Metropolitan Airport is 15.9 km/hr (9.9 mph) (Reference 2.3-201). In comparison, Flint and Toledo have slightly lower annual mean wind speeds, 15 km/hr (9.3 mph) and 14.6 km/hr (9.1 mph), respectively (Reference 2.3-202, Reference 2.3-203). Seasonally, the highest seasonal mean wind for all three stations is during the winter and spring months as shown in Table 2.3-202 through Table 2.3-204. The lowest seasonal mean wind speed occurs during the summer months for Detroit (13 km/hr [8.4 mph]), Flint (12.4 km/hr [7.7 mph]), and Toledo (11.6 km/hr [7.2 mph]). The highest monthly mean wind speed for Detroit occurs in January with a value of 18.7 km/hr (11.6 mph). Flint and Toledo also have their highest monthly mean wind speed during January; however, their mean

of surface low pressure systems

surface low pressure

mean

of surface low pressure systems

values are slightly lower (17.4 km/hr [10.8 mph]). During January the ~~storm~~ track is positioned near the Fermi region, which increases the frequency of ~~storm~~ systems, and therefore wind speeds. The lowest monthly ~~mean~~ wind speed for the three first-order stations is during August when the ~~storm~~ track migrates well north of the region. The overall variation of monthly wind speeds is consistent for the three first-order stations, and therefore these values represent values characteristic of locations in the Fermi region.

Extreme winds for design basis purposes are discussed in Subsection 2.3.1.3.1.2. Wind data summaries for the Fermi onsite meteorological station are discussed in Subsection 2.3.2.1.5 and Subsection 2.3.2.1.6.

2.3.1.2.2 Temperature

Table 2.3-205 presents normal annual temperatures for the three NWS first-order and four COOP stations in the Fermi region during the period 1971-2000. The daily normal temperature for the stations are generally uniform with only minor differences apparent between the two COOP stations closer to the shoreline of Lake Erie and the other stations located further inland or stationed near metropolitan cities. The slight difference in the daily normal temperatures across the Fermi region can be explained by looking at the daily maximum and minimum temperatures. Stations that are closer to the shoreline, specifically Monroe and Windsor, have a slightly higher minimum temperature due to the heat content of Lake Erie. While the other NWS first-order and COOP stations are also influenced by the effects of Lake Erie, Monroe and Windsor are closer to the shoreline and further from metropolitan areas, as a result have slightly higher mean daily minimum temperatures and lower daily maximum temperatures. The observation stations at Detroit Metropolitan Airport are also influenced by the heat island effect that is created by large metropolitan areas. The heat island effect likely explains how the daily minimum temperature for Detroit Metropolitan Airport is warmer than the Monroe and Windsor stations.

During the summer months of June, July, and August, daily mean maximum and minimum temperatures at Detroit Metropolitan Airport average 27.2°C (81°F) and 15.5°C (60°F), respectively (Reference 2.3-201). In comparison, at Flint and Toledo summer mean daily maximum temperatures are 26.6°C (80°F) and 27.7°C (82°F), respectively, while mean daily minimum temperatures are 13.3°C (56°F) and 15°C (59°F), respectively (Reference 2.3-202, Reference 2.3-203). Table 2.3-206 contains climatological extreme maximum and minimum temperatures for the NWS first-order and COOP stations (Reference 2.3-202, Reference 2.3-203, Reference 2.3-205, Reference 2.3-210 through Reference 2.3-214). The highest daily maximum temperature recorded at Detroit Metropolitan Airport was 40°C (104°F) in June of 1988; however, a temperature of 40.5°C (105°F) was recorded in July of 1934 at the nearby Detroit City Airport (Reference 2.3-201, Reference 2.3-211). The highest temperature recorded at Toledo and Flint is 40.5°C (105°F) and 38.3°C (101°F), respectively, occurring in July of 1936 and 1995, respectively (Reference 2.3-202, Reference 2.3-213). The highest temperature recorded at the NWS COOP sites is 42.2°C (108°F), occurring at the Adrian 2 NNE observation station during July of 1934 (Reference 2.3-210).

During the winter months, the variation of the mean daily minimum temperature is higher between the stations, while the mean daily maximum temperature remains nearly uniform across the region. Mean daily maximum temperatures during the winter at Detroit Metropolitan Airport and Toledo are 1.1°C (34°F), while Flint, which is further north, averages a temperature of -1.1°C (30°F) (Reference 2.3-201 through Reference 2.3-203). The mean daily minimum temperatures for Detroit Metropolitan Airport and Toledo are -6.7°C (20°F) and -7.2°C (19°F), respectively. Flint, which is further inland and influenced less by the Great Lakes, has a mean daily minimum temperature of -8.9°C (16°F) during the winter season. The major ~~storm~~ track of surface low pressure systems during wintertime is over the Fermi region, which allows frequent episodes of arctic air (Reference 2.3-209). During a normal winter, there are 45.6 days where the maximum temperature fails to rise above freezing (Reference 2.3-201). However, the Canadian air masses that usher in arctic air to the Fermi region pass over Lake Michigan, which adds heat and moisture to the air mass. The lake effect produced by the Great Lakes produces an excess of cloudiness during the winter and a moderation of the extreme arctic temperatures. Table 2.3-206 summarizes the extreme minimum temperatures recorded at the NWS first-order and COOP station around the Fermi region. The coldest temperature recorded was -32.2°C (-26°F) at the Adrian 2 NNE station during January of 1892 (Reference 2.3-210). The extreme low values of nature of precipitation year round. The highest monthly precipitation for Detroit (9.0 cm [3.55 inches]) and Toledo (9.7 cm [3.80 inches]) occurs during June, while it is during September for Flint (9.6 cm [3.76 inches]). The lowest monthly precipitation occurs in February for the three first-order stations when monthly amounts between 3.4 and 4.8 cm (1.35 and 1.88 inches) are common.

Maximum 24-hour and Monthly Precipitation

Table 2.3-206 displays the maximum 24-hour precipitation amounts recorded for the NWS first-order and COOP stations in the region of the Fermi site. Excessive amounts of precipitation have fallen at all of the observation stations in a 24-hour period. The highest amount of precipitation in a 24-hour period is 15.3 cm (6.04 inches), occurring at Flint during September of 1950 (Reference 2.3-202). For all meteorological stations the 24-hour precipitation amounts occurred between the months of May through September. Table 2.3-206 also contains the maximum monthly precipitation amounts for the meteorological stations surrounding the Fermi site. All maximum amounts of precipitation for the NWS stations occurred between the months of June through August. The highest extreme monthly rainfall occurred at Flint during August of 1975 when 28.0 cm (11.04 inches) was reported (Reference 2.3-202). Earlier it was mentioned that the ~~storm~~ track during the summer months retreats well north of southeast Michigan. While the frequency of ~~weather~~ systems decreases during the summer season, the intensity of precipitation from thunderstorms contributes to the higher precipitation amounts during the summer months in the Fermi region.

of surface low pressure systems

mean

surface low pressure

Snow and Ice

Surface low pressure

~~Storm~~ systems during the wintertime can bring a combination of rain, freezing rain, sleet and snow. During a typical year frozen precipitation is possible starting in October and ending in May. Table 2.3-205 presents normal annual snowfall amounts for the meteorological stations surrounding the Fermi site. Normal annual snowfall distributions for the three first-order stations indicate that annual snowfall increases for stations located farther north.

The threat of heavy snowfall is present throughout the wintertime for the Fermi region. Maximum 24-hour snowfall amounts are listed in Table 2.3-206 for each meteorological station. The highest snowfall amount in a particulate matter to be realized. The minor nature of the effects of the new cooling towers on visibility and air quality, including potential for increases in ambient temperature and moisture, icing, fogging, and salt deposition, are discussed in further detail in Subsection 2.3.2.2.

2.3.1.3.7.3 **Air Stagnation**

The main components of air stagnation are light winds and weak vertical mixing. Light winds can also be associated with weak or poor horizontal mixing of the atmosphere which has the general effect of leading to restrictive horizontal and vertical dispersion and thus air stagnation (Reference 2.3-246). Along with wind speed, wind direction plays a key roll in horizontal mixing as winds with non-persistent directions can also lead to poor dispersion, especially under light wind speeds when the air may re-circulate. Finally, temperature inversions are also associated with little to no vertical mixing of the atmosphere and, therefore, air stagnation. Analyses of inversions are discussed in Subsection 2.3.2.1.8 while the persistence of wind speeds and directions are covered in Subsection 2.3.2.1.6.

Air stagnation episodes typically occur when high pressure systems (anti-cyclones) have a strong influence on the regional weather for four days or more. These systems often lead to generally light winds and little vertical mixing due to a general sinking of the air in their vicinity. The region surrounding the Fermi site can expect approximately 10 days per year of air stagnation, or two episodes per year (Reference 2.3-246). The mean duration of each air stagnation episode typically is three to four days.

mean

of surface low pressure systems

Air stagnation conditions primarily occur during the second half of the summer and early fall seasons that runs from July through September. This is a result of the migration of the ~~storm~~ track to areas well north of the Fermi site, which creates weaker pressure and temperature gradients, and therefore weaker wind circulations during this period. Wang & Angell confirm that air stagnation episodes in the region surrounding the Fermi site begin to occur in June and July (Reference 2.3-246). The number of air stagnation episodes reaches a maximum during August before decreasing in magnitude during September and October. During the fall season the ~~storm~~ track moves south and positions itself over southeastern Michigan and increases the

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of surface low pressure systems

surface low pressure systems

frequency of ~~storms~~ and monthly wind speeds, therefore decreasing the possibility of air stagnation (Reference 2.3-209).

EF3 COL 2.0-8-A

2.3.2 Local Meteorology

Measurements from the Fermi onsite meteorological tower, located approximately one-quarter mile from the Fermi 3 reactor building, will be used in this section to characterize the local meteorology conditions at the Fermi site. The onsite meteorological tower (the details of which are contained in Subsection 2.3.3) collects wind speed, wind direction, dew-point temperature, precipitation, and the ambient temperature at the 10-m (33-ft) and 60—m (197-ft) levels. The meteorological monitoring system uses the vertical temperature difference (ΔT) between the 10- and 60-m levels to compute the atmospheric stability. The hourly averages of wind speed and direction, as well as the estimated atmospheric stability collected from the onsite tower are archived in a digital format that meets the format described in Appendix A of Regulatory Guide 1.23. Hourly data from the most recent five years (2003 through 2007) was obtained in order to perform the analysis of the local meteorology of the Fermi site. Data recovery rates for all meteorological parameters collected at the Fermi onsite meteorological station are greater than 94 percent. Wet-bulb temperature, relative humidity, and the occurrence of fog and visibility are not collected at the Fermi onsite meteorological station; however, data from the nearby Detroit Metropolitan Airport has been used to supplement Fermi site data. Extreme values of temperature, rainfall, and snowfall have also been obtained for several COOP stations within a 80.5-km (50-mile) radius of the Fermi site since those parameters are better representative from a regional perspective.

2.3.2.1 Normal, Mean, and Extreme Values

Regional normal, mean, and extreme values of temperature, wind, moisture and precipitation were discussed in Subsection 2.3.1.1. In order to demonstrate that the long-term data reported at the NWS first-order meteorological stations are representative of the Fermi site, this section provides a more comprehensive analysis of these parameters in comparison with the conditions at the Fermi site.

2.3.2.1.1 Temperature

with the summer season, while the lowest dew-point temperature of -29.9°C (-21.8°F) occurred during the winter season. The last column in Table 2.3-212 shows that mean monthly diurnal variations in dew-point vary the least during the summer and early fall when mean dew-point temperatures are the highest.

2.3.2.1.3 **Precipitation**

The Fermi onsite meteorological station measures rainfall and the liquid equivalent of snowfall on a daily basis. During the process of analyzing the Fermi site precipitation data, it was discovered that the precipitation sensor malfunctioned several times during the 2003-2007 period, resulting in much higher annual precipitation amounts than observed at surrounding observation stations. For this reason, precipitation records for Detroit Metropolitan Airport will be used in this section to describe the precipitation characteristics of the Fermi site. Detroit Metropolitan Airport is the nearest first-order station that has a long period-of-record for reporting precipitation. Normal annual and monthly rainfall values were discussed in Subsection 2.3.1.2.4 and summarized in Table 2.3-202 and Table 2.3-205. These tables indicate that the Fermi region is annually characterized as having consistent precipitation amounts during the year and routine wintertime snowfall. These values are reasonably uniform over the region as to indicate that these stations are representative of precipitation averages that would be observed at the site.

<u>Maximum 24-Hour and Monthly Precipitation</u>

Maximum 24-hour and monthly precipitation totals for the region are discussed in Subsection 2.3.1.2.4 and summarized in Table 2.3-206 for the NWS first-order and COOP stations presented in the Fermi region. The highest 24-hour precipitation amount is 15.3 cm (6.04 inches), occurring during September 1950 at Flint (Reference 2.3-202). The highest monthly precipitation was also observed at Flint with an amount of 28.0 cm (11.04 inches) during August 1975. The maximum precipitation values are reasonably uniform across the area given that precipitation can be highly influenced by individual ~~storm events~~ which can be local in nature hitting one station and not another. It is therefore considered that the precipitation data are representative of precipitation extremes that might be observed at the site.

thunderstorms

Total Hours of Precipitation and 1-Hour Precipitation Rate Distribution

Hourly precipitation data for Detroit Metropolitan Airport was obtained from the NCDC for the most recent 5-year time period (2003-2007) to identify the precipitation intensity frequencies in the region surrounding the Fermi site (Reference 2.3-247). Detroit Metropolitan Airport is the closest NWS first-order station that has reliable precipitation records and as discussed above is representative of the precipitation trends at the Fermi site. Table 2.3-213 presents the distribution of hourly precipitation amounts in various intensity categories for each month during the 2003-2007 timeframe. Precipitation was recorded approximately 15.95 percent of the time during the 5-year period. January has the highest occurrence of hourly precipitation while September has the lowest. This corresponds with the location of the ~~storm~~ track, which is over the southeast Michigan during the winter and well north of the region during the summer and early fall seasons. Additionally, as expected, precipitation is most frequent in lighter intensity categories with the majority of hourly precipitation having accumulations less than 0.25 cm (0.10 inches).

mean

of surface low pressure systems

Maximum Precipitation Rate Distributions for 1-Hour Up To 24-Hours

In an effort to characterize possible heavy rainfall events at the Fermi site, probable maximum precipitation amounts for various durations and recurrence intervals were analyzed and are presented in Table 2.3-214. Maximum rainfall amounts were obtained from Reference 2.3-248 for recurrence intervals of 2 to 100 years and for durations of 1 to 24 hours. Estimates from U.S. Weather Bureau Technical Paper 40 (TP 40) were also obtained for this analysis, since updated literature does not provide amounts for 1-year recurrence intervals and durations of 1 to 24 hours (Reference 2.3-249).

For comparison, maximum observed precipitation amounts were obtained for Detroit City Airport from Reference 2.3-250 for the time period 1889-1961 and calculated for Detroit Metropolitan Airport during the time period 1962-2007 from Reference 2.3-247. These amounts are displayed in Table 2.3-215. The table shows that for all durations, higher maximum precipitation amounts were found during the older 1889-1961 period when compared to the more recent 1962-2007 period. In addition, observed amounts for all durations during the 1889-1961 time period are

Wind Roses-Detroit Metropolitan Airport

Figure 2.3-217 through Figure 2.3-229 contain the 10-m annual and monthly wind roses presenting the distribution of wind speed at 22.5 degree intervals for Detroit Metropolitan Airport during the 5-year period of 2003-2007 (Reference 2.3-229).

The annual wind rose plot in Figure 2.3-217 shows that winds at Detroit Metropolitan Airport predominantly blow from southwesterly directions. According to the annual 2006 LCD, the prevailing wind direction for Detroit Metropolitan Airport is from 240 degrees (west-southwesterly) (Reference 2.3-201). Monthly wind roses for Detroit Metropolitan Airport are presented in Figure 2.3-218 to Figure 2.3-229. The transition is apparent from dominant northwesterly and northerly winds during the spring months to southwesterly wind directions during the summer through fall months as the Bermuda High develops over the southeast United States and the ~~storm~~ track shifts north of the Fermi region. During May through September, the number of calm hours increase and the wind directions often become light and variable as the synoptic scale pressure gradient weakens, corresponding with the months having the highest number of air stagnation episodes (Reference 2.3-246). Detroit Metropolitan Airport considers calm hours as those with wind speeds less than three knots. As the ~~storm~~ track begins to move south and closer to southeastern Michigan during late the fall and winter, northwesterly and westerly wind directions become more frequent.

of surface low pressure systems

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of surface low pressure systems

Wind Roses-Fermi 10-m Level

Annual and monthly wind roses for the 10-m level at the Fermi site are depicted in Figure 2.3-230 through Figure 2.3-242. These figures show wind speeds and directions at 22.5 degree intervals by direction at the Fermi site for the 2003 through 2007 time period.

Figure 2.3-230 indicates that annually winds are southwesterly most often, occurring approximately 10 percent of the time. Winds with a northwesterly component are the second most common direction for the 10-m level at the Fermi site. Apparent is the increase of easterly and southeasterly winds annually at the Fermi site when compared to Detroit Metropolitan Airport at the same level. During the late spring, summer, and early fall, onshore lake breezes occur frequently at the Fermi site. The breezes form as air temperatures over land heat up faster than the air above the waters of Lake Erie. By afternoon a sharp temperature

Attachment 2
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-2

NRC RAI 02.03.01-2

Confirm the number of high wind events which FSAR Subsection 2.3.1.3.1.2 reports occurred in the five-county area between January 1, 1955, and December 31, 2007, and revise the FSAR as necessary.

a. *The staff counted 816 high wind events (50 knots or greater) for the five-county area in the NCDC online storm database as compared to 770 reported in the FSAR. Please confirm whether (1) the number of high wind events may be under-reported in the FSAR or (2) only 770 unique high wind events occurred, as some of the events counted by the staff may have occurred simultaneously in several of the five counties.*

b. *FSAR Subsection 2.3.1.3.1.2 states that 770 wind events were reported between 1955 and 2007. Please discuss whether the number of actual occurrences of high wind events during this period may be higher by virtue of the reporting periods of some of the stations used having begun much later than 1955. The first year of high wind event reports for each of the five counties begin in (year in parentheses): Lenawee (1979), Monroe (1969), Washtenaw (1957), Wayne (1956), and Lucas (1956).*

Response

a. Re-analysis of the National Climatic Center Database (NCDC) online storm database found that 816 wind high wind events were recorded between January 1, 1955 and December 31, 2007 in the five-county area surrounding the Fermi site: Lenawee, Monroe, Washtenaw, Wayne and the Ohio County of Lucas.

b. While not all five counties may have been actively reporting high wind events in the early years of the time period, the 1955-1959 period featured 1.6 high wind events per year. The subsequent 10-year periods of 1960-1969, 1970-1979, and 1980-1989 averaged 2.9, 2.4, and 4.2 high wind events per year respectively. An analysis of the high wind events on a decade by decade basis over the five-county area does not show a significant deviation over the first four decades. In fact, the variability in the average number of high wind events per decade over the first four decades may be explained by natural variability as the reporting counties each reported similar numbers of high wind events.

   Some of the reported high wind events likely occurred simultaneously in several of the five counties. While thunderstorms that have a cellular structure typically generate wind events that are isolated in nature, thunderstorms that have become linear along a squall line or cold front can produce wind events along an elongated path, which can be double counted.

Proposed COLA Revision

The number of recorded high wind events between January 1, 1955 and December 31, 2007 presented in FSAR Section, 2.3.1.3.1.2 for the five-county area will be changed from 770 total events to 816 total events as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 2 page(s))

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

from the NCDC database indicate that thunderstorms can produce wind speeds in excess of 160.9 km/hr (100 mph) at the Fermi site.

High Wind Events

Add Insert "1" Here

This section provides the frequency of occurrence of winds greater than 50 knots, in accordance with the Nuclear Regulatory Commission (NRC) Regulatory Guide 4.2. Storm reports that include wind speeds of 50 knots (91.7 km/hr [57 mph]) or greater occur with many types of weather phenomenon such as thunderstorms and tornadoes. Wind reports for thunderstorms and tornadoes were obtained from the NCDC online storm database for the following five-county area surrounding the Fermi site: Lenawee, Monroe, Washtenaw, Wayne and the Ohio County of Lucas.

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Between January 1, 1955 and December 31, 2007 there have been ~~770~~ reports of wind events that were 50 knots or greater in the five-county area (Reference 2.3-220). The highest wind speed reported was 90 knots (166.7 km/hr [103.6 mph]) in Wayne and Lucas Counties on July 22, 1960 and July 4, 1969. Many of the reports for high winds contained in the NCDC online storm database do not specify wind speeds and therefore may underestimate the count of wind events 50 knots or greater in the region of the Fermi site.

Between January 1, 1955 and December 31, 2007

~~In the same time period~~, 92 tornadoes were reported in the five-county area (Reference 2.3-220). All tornadoes are categorized as F0 or stronger on the Enhanced Fujita (EF) scale, thereby containing wind speeds greater than 50 knots (Reference 2.3-221). Additional discussion of tornadoes in the region surrounding the Fermi site is given in Subsection 2.3.1.3.1.3.

2.3.1.3.1.3 **Tornadoes and Waterspouts**

Waterspouts

Waterspouts are considered to be the counterpart of tornadoes, but over large bodies of water. Waterspouts are also much smaller than an average tornado and contain wind speeds that are typically less than 43 knots (80.5 km/hr [50 mph]). In the Fermi region, conditions favorable for waterspout formation are when a cool air mass passes over the warmer air above the waters of Lake Erie. The resulting instability can support the formation of waterspouts, most frequently during the late summer and fall season. A search for reported waterspouts in the NCDC online storm database resulted in eight occurrences off the shoreline of Lucas and

2.03.01-2 Insert 1:

While not all five counties may have been actively reporting high wind events in the early years of the time period, the 1955-1959 period featured 1.6 high wind events per year. The subsequent 10-year periods of 1960-1969, 1970-1979, and 1980-1989 averaged 2.9, 2.4, and 4.2 high wind events per year respectively. An analysis of the high wind events on a decade by decade basis over the five-county area does not show a significant statistical trend over the first four decades. In fact, the variability in the average number of high wind events per decade over the first four decades may be explained by natural variability as they each reported similar numbers of high wind events.

Furthermore, some of the reported high wind events likely occurred simultaneously in several of the five counties. High wind events can be caused by individual thunderstorms that have a cellular structure or by thunderstorms that have become linear along a squall line or cold front. A line of thunderstorms can cause wind damage along an elongated path, while the wind damage caused by cellular type thunderstorms is typically isolated in nature.

Attachment 3
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-3

NRC RAI 02.03.01-3

FSAR Table 2.0-201, Sheet 1 of 28, states under the evaluation for extreme wind exposure category that "The Fermi 3 site characteristic is Exposure Category C as this value cannot be exceeded."

Please explain this statement.

Response

The part of the statement that reads "as this value cannot be exceeded" would apply if the Fermi 3 site were classified as Exposure Category D. However, FSAR Section 2.3.1.3.1.2 identifies that the Fermi region is classified as Exposure Category C in accordance with SEI/ASCE 7-05 (FSAR Reference 2.3-218). The statement, "as this value cannot be exceeded" is incorrect and will be removed from FSAR Table 2.0-201, (Sheet 1 of 28).

Proposed COLA Revision

FSAR Table 2.0-201 (Sheet 1of 28), will be revised to remove the text "as this value cannot be exceeded." as shown on the proposed markup.

Markup of Detroit Edison COLA
(following 1 page(s))

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

Subject [16]	DCD Site Parameter Value [1][16]	Fermi 3 Site Characteristic	Evaluation
Part 1 – Evaluation of DCD Site Parameters			
Maximum Groundwater Level	0.61 m (2 ft) below plant grade		The DCD site parameter of maximum groundwater level of 0.61 m (2 ft) below plant grade is the same as the design groundwater level in DCD Table 3.4-1. The design plant grade elevation identified in DCD Table 3.4-1 is at 4650 mm, which corresponds to 179.6 m (589.3 ft) NAVD88 for the Fermi 3 site as described in Subsection 2.1.1. Therefore, the DCD site parameter value of 0.61 m (2 ft) below plant grade corresponds to a maximum groundwater level no higher than 179.0 m (587.3 ft) NAVD88 for the Fermi 3 site.
		1.2 m (3.9 ft) below design plant grade	The Fermi 3 site characteristic value for maximum groundwater level below design plant grade is 1.2 m (3.9 ft) in the power block area based on the assumed maximum groundwater elevation of 178.4 m (585.4 ft) NAVD 88 from Subsection 2.4.12 and by reference 2.4.5.2.2.2, and the design plant grade elevation of 179.6 m (589.3 ft) NAVD 88. Therefore, the Fermi 3 site characteristic value for maximum groundwater level below design plant grade falls within (is lower than) the DCD site parameter value.
Extreme Wind			
Seismic Category I and II Structures			
100-year Wind Speed (3-sec gust)[13]	67.1 m/s (150 mph)	42.9 m/s (96 mph), 3-second gust	The site characteristic value for basic wind speed is defined as the 3-second gust wind speed at 10 m (33 ft) above the ground that has a 1 percent annual probability of being exceeded (100-year mean recurrence interval). The site characteristic value for basic wind speed falls within (is lower than) the DCD site parameter value.
Exposure Category D			The DCD site parameter of extreme wind exposure category is determined using ASCE 7 (DCD Reference 2.0-2). Exposure category is determined by a number of variables including wind speed, building shape and location, and surface roughness. A DCD site parameter of Exposure Category D results in the most severe design wind pressures.
		Exposure Category C	The Fermi 3 site characteristic is Exposure Category C ~~as this value cannot be exceeded~~. The Fermi 3 site characteristic falls within (is less than) the DCD site parameter value for extreme wind exposure category, i.e., Exposure Category D.

Attachment 4
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-4

NRC RAI 02.03.01-4

Confirm the number of tornadoes which FSAR Subsection 2.3.1.3.1.2 reports occurred in the five county area between January 1, 1955 and December 31, 2007 and revise the FSAR as necessary.

a. *The staff counted 110 tornadoes for the five-county area in the NCDC online storm database as compared to 92 reported in the FSAR. Please confirm whether (1) the number of tornadoes may be under-reported in the FSAR or (2) only 92 unique tornadoes occurred, as some of the tornadoes counted by the staff may have occurred in several of the five counties. If the 110 tornados counted by the staff are unique, please revise the FSAR statistics on tornados per year and strike probabilities.*

b. *FSAR Subsection 2.3.1.3.1.2 states that 92 tornadoes were reported between 1955 and 2007. Please discuss whether the number of actual occurrences of tornadoes during this period may be higher by virtue of the reporting periods of some of the stations used having begun much later than 1955. The first year of tornado reports for each of the five counties begin in (year in parentheses): Lenawee (1956), Monroe (1963), Washtenaw (1962), Wayne (1956), and Lucas (1965).*

Response

a. FSAR Section 2.3.1.3.1.3 reported the occurrence of 92 tornadoes for the five-county area surrounding the Fermi site: Lenawee, Monroe, Washtenaw, Wayne and the Ohio County of Lucas, for the period between January 1, 1950 and December 31, 2007. Tornado reports were combined and therefore referenced as only a single tornado if the tornado reports indicated that the tornado tracked in a traceable direction between different counties or within the same county during a narrow time period and occurred within 45 minutes of one another. The 92 tornadoes reported in the FSAR Section 2.3.1.3.1.3 is a valid count of tornadoes within the five-county area between January 1, 1950 and December 31, 2007.

b. Analysis of tornado events does not suggest that the overall number of tornado events would be higher than reported during the 1950 to 1959 time period. During the 1950 to 1959 time period, an average of 1.20 tornadoes were reported per year in the five-county area. In comparison, the ten year periods of 1960-1969, 1970-1979, 1980-1989, 1990-1999, and 2000-2007 averaged 1.40, 2.30, 2.40, 1.40, and 0.63 tornadoes per year, respectively. Starting in 1950, the National Climatic Center Database (NCDC) online storm database shows the first year that a tornado was reported in each county to be: Lenawee (1954), Monroe (1953), Washtenaw (1951), Wayne (1953), and Lucas (1965). The 1965 date for Lucas County does stand out when compared with the other four counties listed above. Lucas County contains the city of Toledo, and has a high population density when compared to neighboring counties in Ohio. It would seem likely that if a tornado did occur between 1950 and 1964 that it would have been reported in Lucas County. The counties immediately west, southwest, and south of Lucas County each reported 2 total tornadoes between 1950 and 1964, indicating that tornadoes were being reported during this time period.

Proposed COLA Revision

None

Attachment 5
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-5

NRC RAI 02.03.01-5

Confirm the number of hail events which FSAR Subsection 2.3.1.3.1.4 reports occurred in the five county area between January 1, 1955, and December 31, 2007, and revise the FSAR as necessary.

FSAR Subsection 2.3.1.3.1.4 states that 571 hail events were reported between 1955 and 2007. Please discuss whether the number of actual occurrences of hail events during this period may be higher by virtue of the reporting periods of some of the stations used having begun much later than 1955. The first year of hail reports for each of the five counties begin in (year in parentheses): Lenawee (1963), Monroe (1963), Washtenaw (1957), Wayne (Sept.1955), and Lucas (June 1966).

Response

The National Climatic Data Center (NCDC) online storm database accessed in February of 2008 indicated 571 total severe hail events in five-county area surrounding the Fermi site, Lenawee, Monroe, Washtenaw, Wayne and the Ohio County of Lucas, during the period January 1, 1955 to December 31, 2007. A more recent analysis of the NCDC online storm database revealed that the number of severe hail events that occurred between January 1, 1955 and December 31, 2007 was updated in the NCDC online storm database to include four additional events in 2007. The NCDC online storm database was updated after the preparation of the FSAR and now identifies 576 severe hail events for the area surrounding the Fermi site for the period January 1, 1955 to December 31, 2007.

While not all five counties were actively reporting severe hail events between 1955 and 1959, there was an average of 2.0 severe hail events reported per year in the five-county area during this period. By comparison between 1960 and 1979, a period when all five counties were included in the reporting of severe hail events, an average of 1.9 severe hail events per year were reported over the same five-county area for the period between 1960 and 1969 and an average of 2.2 severe hail events per year were reported over the same five-county area for the period between 1970 and 1979. The frequency of occurrence of severe hail events during the decades 1960-1969 and 1970-1979 suggest that the overall number of severe hail events reported by a limited number of the counties in the five-county area between 1955 and 1959 is representative of the actual number of severe hail events during that period.

Therefore, the 576 severe hail events reported in the markup to FSAR Section 2.3.1.3.1.4 is representative for the five-county area surrounding the Fermi site between January 1, 1955 and December 31, 2007.

Proposed COLA Revision

FSAR Section 2.3.1.3.1.4 will be updated to report 576 severe hail events for the five-county area during the period January 1, 1955 through December 31, 2007 and the average number of severe hail events for the five-county area will be increased from 10.8 occurrences per year to 10.9 occurrences per year as shown in the proposed markup.

Markup of Detroit Edison COLA

(following 7 page(s))

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

Regulatory Guide 1.76 defines DBT characteristics for nuclear power plants that have a tornado strike probability greater than 1.0 X10-7. The calculated Fermi site tornado strike probability of 3.22 X10-4 exceeds the above probability threshold which requires Fermi 3 to meet the design requirements of Regulatory Guide 1.76. Table 1 from Regulatory Guide 1.76 presents the remaining six DBT characteristics for new reactors located in the United States whose tornado strike probabilities exceed the 1.0 X 10-7 threshold. According to Table 1, since the Fermi site is located in Region I, the DBT characteristics are as follows:

DBT Characteristics	**Fermi site (1)**	**ESBWR DCD (2)**
Maximum wind speed (mph)	230	330
Translational speed (mph)	46	70
Maximum rotational speed (mph)	184	260
Radius of maximum rotational speed (ft)	150	150
Pressure drop (psi)	1.2	2.4
Rate of pressure drop (psi/sec)	0.5	1.7

1. From Table 1 of Regulatory Guide 1.76
2. From DCD Table 2.0-1, Revision 4

The DBT characteristics for the Fermi site are bounded by the values cited in DCD Table 2.0-1 and are listed in the table above. In addition, the ESBWR DCD values are applied to the full building height of structures at the Fermi site for the spectrum of tornado-generated missiles specified in Table 2 of Regulatory Guide 1.76.

2.3.1.3.1.4 Hail

A study authored by Joseph T. Schaefer estimates that the 1 x 1 degree box surrounding the Fermi site averages 16.5 reports of severe hail (hail diameter ≥ 1.9 cm [0.75 inches]) per year (Reference 2.3-226). Schaefer's study examined hail reports from the period 1955-2002. In order to include the most recent five years, hail reports were obtained from the NCDC online storm database for the Michigan Counties of Lenawee, Monroe, Washtenaw, Wayne, and the Ohio County of Lucas. 576
10.9 The five-county area surrounding the Fermi site reported ~~571~~ severe hail events over a 53-year period of January 1, 1955 through December 31, 2007 producing an average of ~~10.8~~ occurrences of severe hail per year, which is somewhat lower than the findings by Schaefer

(Reference 2.3-220). However, the total area of the five-counties is less than that of the 1 x 1 degree box used by Schaefer, and thereby explains the difference among the two estimates.

576

Out of the ~~871~~ severe hail reports, 87 were reported as large hail (hail diameter ≥ 4.4 cm [1.75 inches]) (Reference 2.3-220). The largest hail report was 10.2 cm (4.00 inches), occurring in Wayne County on November 13, 1955 and Monroe County on March 27, 1991. Figure 2.3-202 shows the distribution of severe hail events for each month. The majority of hail events in the five-county area occur during the months of May, June, and July. During the 53-year period there were no reports of hail during the winter months of December and January. Figure 2.3-203 provides the distribution of severe hail events across each of the five counties. The counties surrounding Monroe County and the location of Fermi 3 contain higher occurrences of severe hail events. ~~In addition~~, the overall frequency of hail reports has steadily increased during the last few decades. It is reasonable to assume the increase may be explained by the improved technology of Doppler radars, cell phones, and the increased public awareness of reporting hail events (Reference 2.3-226).

Add Insert "1" Here

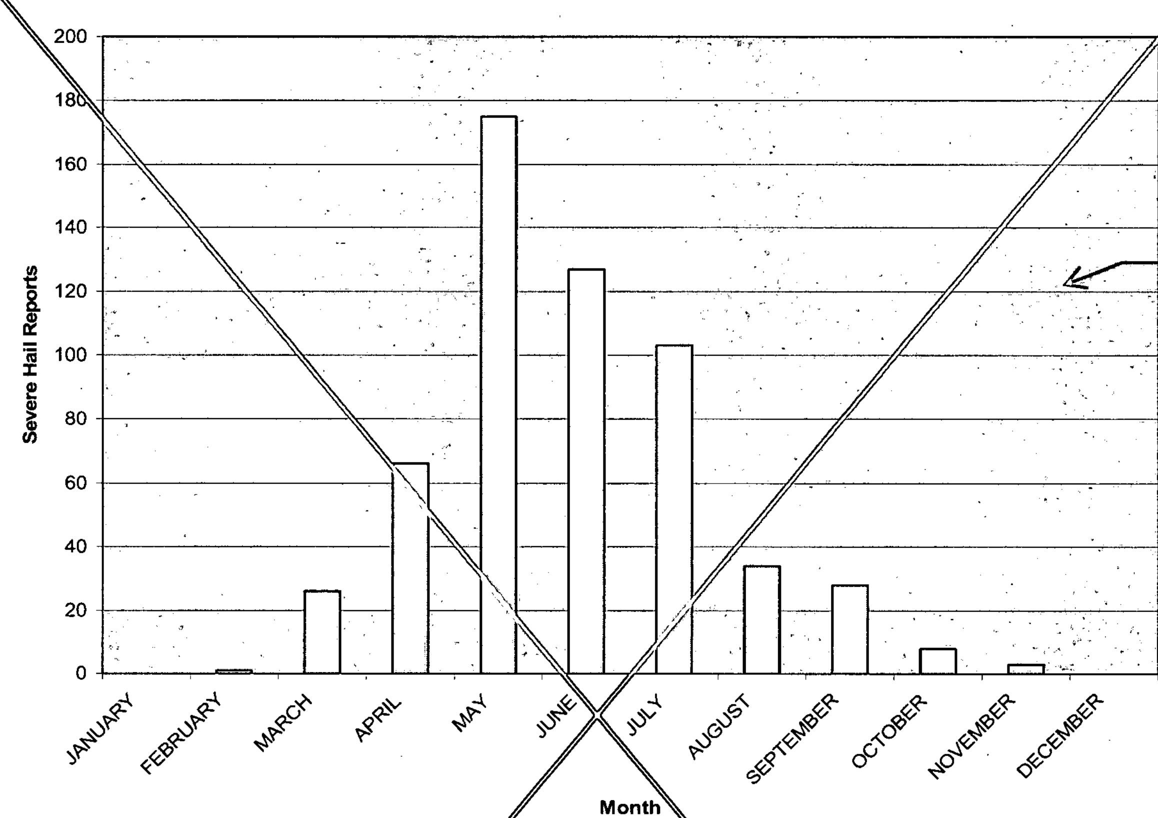
2.3.1.3.1.5 Drought

Monthly values of precipitation are nearly consistent throughout the year in the region surrounding the Fermi site; however, droughts do happen from time to time. A good way to analyze periods where droughts may have occurred is to analyze the extreme dry stretches over a period of time. In order to find the extreme dry periods, hourly precipitation data was analyzed for Detroit Metropolitan Airport during the period 1961-2007. During a stretch from June 17 through July 13, 1963 (644 hours or 26.8 days), the Detroit Metropolitan Airport recorded no measurable precipitation (Reference 2.3-227 through Reference 2.3-229). This was the longest dry stretch that occurred during the 1961-2007 time period. A useful tool that assesses the severity of drought conditions is the Palmer Drought Index (PDI) (Reference 2.3-230). According to an analysis performed by the NCDC, 10 extreme droughts (PDI values of less than -4.0) have occurred in Michigan between 1900 and February 2008 (Reference 2.3-231). One of the episodes of extreme drought corresponds with the longest dry stretch observed at Detroit Metropolitan Airport during June of 1963. Overall, the frequency of extreme droughts has decreased since 1940.

2.03.01-5 Insert 1:

While not all five counties were actively reporting severe hail events between 1955 and 1959, there was an average of 2.0 severe hail events reported per year in the five-county area during this period. By comparison between 1960 and 1979, a period when all five counties were included in the reporting of severe hail events, an average of 1.9 severe hail events per year were reported over the same five-county area for the period between 1960 and 1969 and an average of 2.2 severe hail events per year were reported over the same five-county area for the period between 1970 and 1979.

Figure 2.3-202 Total Reports of Severe Hail for the Five-County Area (1955-2007) [EF3 COL 2.0-7-A]

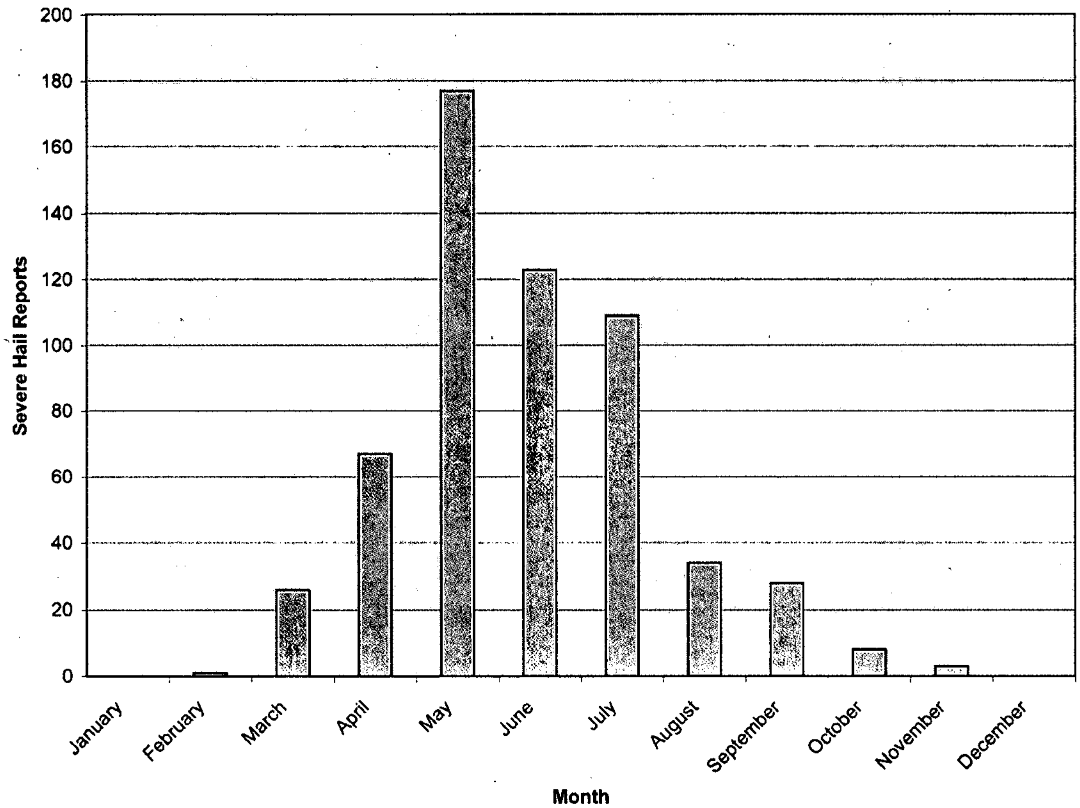


Add Insert "2" Here

Source: Reference 2.3-220

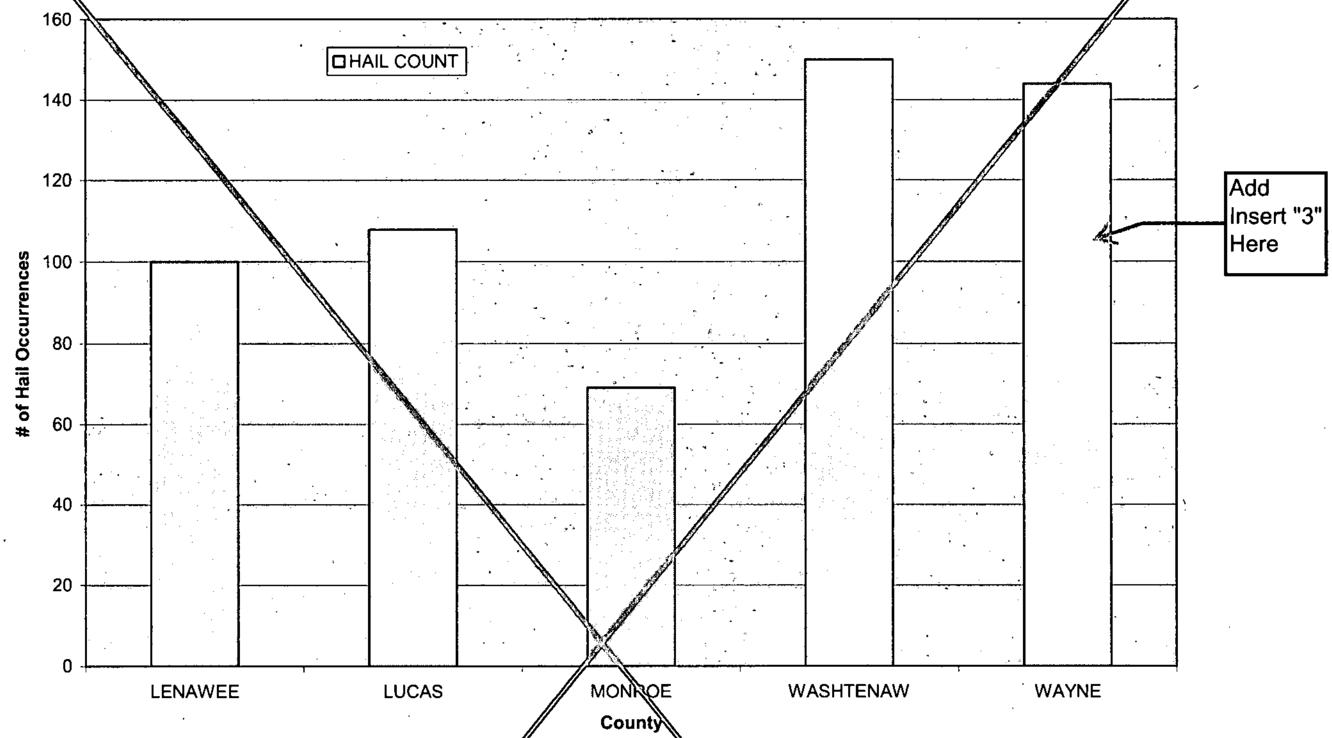
Insert "2"

Figure 2.3-202 Total Reports of Severe Hail for the Five-County Area (1955-2007) [EF3 COL 2.0-7-A]



Source: Reference 2.3-220

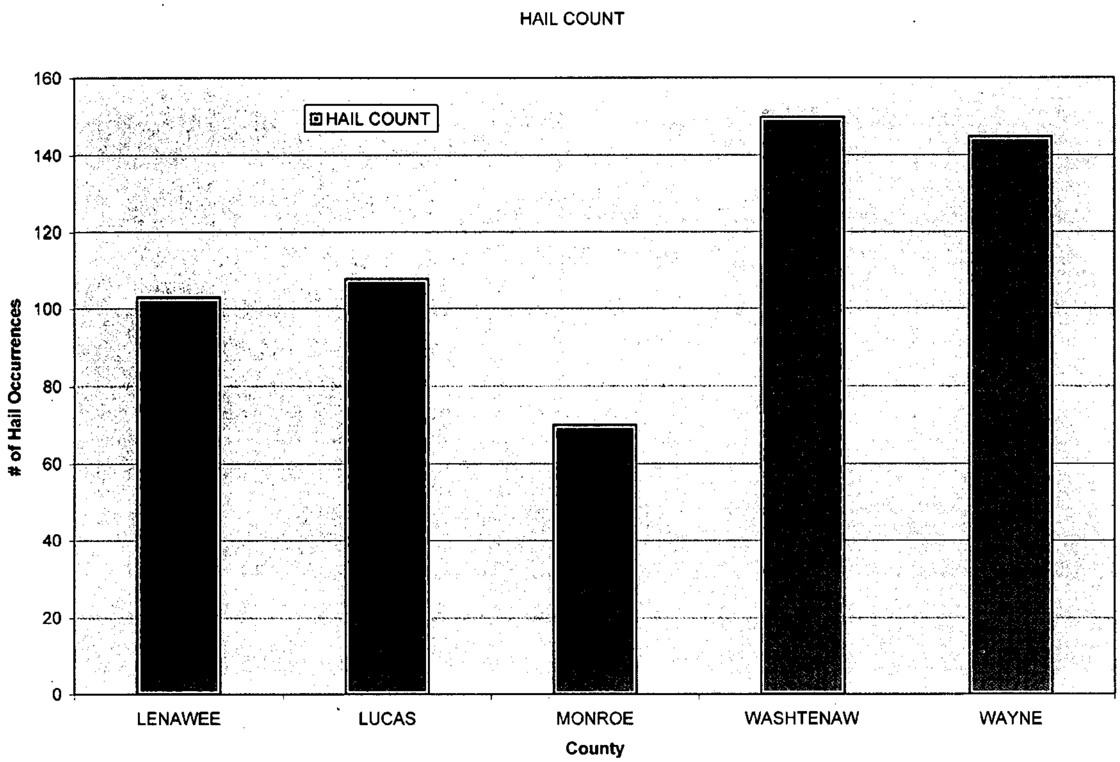
Figure 2.3-203 Total Hail Reports for the Five-County Area (1955-2007) [EF3 COL 2.0-7-A]



Source: Reference 2.3-220, Reference 2.3-224

Insert "3"

Figure 2.3-203 Total Hail Reports for the Five-County Area (1955-2007) [EF3 COL 2.0-7-A]



Source: Reference 2.3-220, Reference 2.3-224

Attachment 6
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-6

NRC RAI 02.03.01-6

Confirm the number of dust (sand) storm events which FSAR Subsection 2.3.1.3.2 and Tables 2.3-207 and 2.3-208 report occurred at Detroit Metropolitan Airport during the period 1961-1995 and revise the FSAR as necessary. The staff found one more dust (sand) storm (14:00 July 4, 1974) over the list presented in Tables 2.3-207 and 2.3-208.

Response

Re-review of the 1961-1995 meteorological data for Detroit Metropolitan Airport (FSAR References 2.3-227 and 2.3-228) identified that a single hour dust storm event on July 4, 1974 at Detroit Metropolitan Wayne County Airport was omitted from FSAR Tables 2.3-207 and 2.3-208.

Proposed COLA Revision

FSAR Tables 2.3-207 and 2.3-208 will be revised to add single hour dust storm event on July 4, 1974 at Detroit Metropolitan Wayne County Airport as shown in the attached markup.

Markup of Detroit Edison COLA
(following 2 page(s))

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

Table 2.3-207 Annual Summaries of Hours with Dust Reported for Detroit Metropolitan Airport During the Period 1961-1995 [EF3 COL 2.0-7-A]

Year	Annual Hours of Dust	Annual Frequency of Occurrence[2]
1961	0	--
1962	0	--
1963	1	0.01%
1964[1]	4	0.05%
1965	0	--
1966	2	0.02%
1967	0	--
1968	0	--
1969	0	--
1970	0	--
1971	0	--
1972	0	--
1973	0	--
1974	~~0~~ ← 1	-- ← 0.01%
1975	0	--
1976[1]	8	0.09%
1977	0	--
1978	0	--
1979	0	--
1980	0	--
1981	0	--
1982	0	--
1983	0	--
1984	7	0.08%
1985	4	0.05%
1986	0	--
1987	0	--
1988	0	--
1989	0	--
1990	0	--
1991	0	--
1992	0	--
1993	1	0.01%
1994	0	--
1995	0	--

Notes:

1. Calculations for leap years add an additional day to the calendar year.
2. Refers to percentage of total hours for the year.

Source: Reference 2.3-227, Reference 2.3-228

Table 2.3-208 Distribution for Duration of Discrete Dust Events at Detroit Metropolitan Airport (1961-1995) [EF3 COL 2.0-7-A]

	Duration of Discrete Events (Hours)								
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**10+**	**Annual Total of Occurrences**
1963	1								1
1964		2							2
1966		1							1
1976	1						1(1)		2
1984	1	1		1					3
1985				1					1
1993	1								1
Total Occurrences by Duration	~~4~~ 5	4	0	2	0	0	1	0	~~11~~ 12

Notes:

1. The longest stretch of consecutive hours with dust at Detroit Metropolitan Airport during the 1961-1995 time period is 7 hours, occurring in May of 1976.

Source: Reference 2.3-227, Reference 2.3-228

Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**10+**	**Annual Total of Occurrences**
1974	1								1

Attachment 7
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-7

NRC RAI 02.03.01-7

Clarify the terminology presented in FSAR Subsection 2.3.1.3.3, "Probable Maximum Annual Frequency of Occurrence and Duration of Freezing Rain."

The FSAR interchangeably uses the terms "freezing rain" and "freezing rain and ice pellets" to refer to ice events. Ice pellets are not freezing rain. In the discussion, it is sometimes confusing as to whether the two types of ice events are being spoken of separately, as a group, or interchangeably. The NCDC ice storm reports include freezing rain only. The FSAR refers to a "sub-freezing air mass near the surface," which more accurately should be called as a "sub-freezing air layer."

Response

The discussion in FSAR Section 2.3.1.3.3 about the frequency of occurrence and probable maximum duration of freezing rain events in the Fermi region will be revised to clarify the term "freezing rain" in referring to ice events and to use the term "sub-freezing air layer near the surface" in lieu of the original term "sub-freezing air mass near the surface."

Proposed COLA Revision

FSAR Section 2.3.1.3.3 and the title of FSAR Table 2.3-209 will be revised as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 3 page(s))

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

deviation of the data set for discrete dust events is large and such statistical calculations would underestimate the probable maximum duration of dust events at the Fermi site. For this reason, it can be conservatively stated that the probable maximum duration of dust events at the Fermi site is 7 hours, the longest duration of discrete events occurring during the 1961-1995 time period.

2.3.1.3.3 Probable Maximum Annual Frequency of Occurrence and Duration of Freezing Rain

Freezing rain is defined as an accretion of ice resulting from liquid precipitation striking a frozen surface (e.g., tree branches or power lines) and freezing. Typically the liquid droplets are supercooled droplets falling through ~~a~~ [an air] layer of sub-freezing temperatures, during their descent to the ground. The weight of the ice accretion on surface objects can become sufficient to cause damage to trees and power lines, as well as slow down or even halt transportation on ice covered roads and bridges. The surface air temperature during freezing rain events typically ranges between -3.9°C (25°F) and 0°C (32°F) (Reference 2.3-232). Ice pellets are also a common occurrence at the Fermi site during wintertime storms. Ice pellets are created when a snowflake melts during its descent to the ground, but then refreezes as it falls through a sub-freezing air ~~mass~~ [layer] near the surface.

Frequency of Occurrence

Cortinas et al. analyzed freezing rain and ice pellets events for the Fermi region during the period 1976-1990. In particular, freezing rain and ice pellet events are most common from December to March, although a few events have occurred in November and April. The Fermi site averages approximately 4-5 days per year when an observation of freezing rain has occurred, while ice pellets are reported four days per year (Reference 2.3-233).

Ice storm reports were obtained from the NCDC storm database in order to estimate the frequency of occurrence and duration of freezing rain events at the Fermi site. A total of 24 ~~ice~~ [freezing rain] events were reported in the five-county area surrounding the Fermi site during the period 1993-2007 (Reference 2.3-220). Table 2.3-209 displays the dates of the ~~ice~~ [freezing rain] events and the reported accumulations. In some cases amounts of freezing rain ~~and ice pellets~~ amounted to only a trace or were not available from the storm data records. From the data the frequency of freezing rain events during the 15-year period is 1.6 events per year (24 events/15 years). The high number of freezing ~~precipitation~~ rain events during the last 15 years provides an assessment of how frequent they are in the Fermi region.

Probable Maximum Annual Duration

In order to determine the duration of each ~~ice~~ freezing rain event that occurred in the five-county region surrounding the Fermi site, hourly temperature and precipitation data was obtained from Detroit Metropolitan Airport. To provide a conservative estimate of the duration for each event, only hours that reported measurable precipitation were counted. In addition, the precipitation type was ignored such that hours with rain are included. Table 2.3-209 provides the duration of each freezing rain event during the 1993-2007 time period. The ~~ice~~ freezing rain event with the longest duration occurred from January 30 into the afternoon of February 1, 2002 when 62 consecutive hours of precipitation was reported.

Using the method of moments as suggested by Wilks with the durations of ~~ice~~ freezing rain events listed in Table 2.3-209, the Gumbel probability distribution estimates a probable maximum annual duration of 72 hours for ~~ice~~ freezing rain events in the Fermi region (Reference 2.3-234). This provides a conservative estimate of the maximum duration for ~~ice~~ freezing rain events at Fermi 3.

2.3.1.3.4 Weight of Snow and Ice on Structures

It is important to determine the potential maximum weight of frozen precipitation on structures at the Fermi site for safety reasons. The following subsections will provide estimates for the weights of the 100-year return period snowpack and the 48-hour probable maximum winter precipitation (PMWP), as well as the 100-year probable maximum ice accretion for the Fermi site. Per guidance by NUREG-0800, winter precipitation loads to be considered in the design of the Fermi 3 reactor should be based on the weight of the 100-year return period snowpack at ground level plus the weight of the 48-hour PMWP. As mentioned previously, the Fermi site is located in a region that experiences frequent occurrences of ice, snow, and rain events on an annual basis. The possibility exists for many types of precipitation to fall on snow or ice accumulations from previous storms. Therefore, the following analysis will provide an estimate of the weight of the 48-hour PMWP in the form of rain in combination with the 100-year probable maximum ice accretion, as well as the 100-year snowpack. This estimate will provide a

Freezing Rain

Table 2.3-209 Summaries for ~~Ice~~ Events Occurring in the Five-County Area Surrounding the Fermi Site (1993-2007) [EF3 COL 2.0-7-A]

Event Date	Reported Accumulations (in.)	Duration (Hours)	Calculated Maximum Ice Accretion (in.)[2]
1/21/1993	0.40	36	0.96
3/4/1993 [1]	--	18	1.09
1/27/1994	0.25	25	1.68
2/27/1995	0.25	14	0.33
3/6/1995	0.25	27	1.09
4/10/1995	Trace	3	0.26
12/13/1995	0.25	9	0.44
3/13/1997	1.5-2.5	19	1.96
1/13/1998 [1]	--	7	0.12
1/2/1999 [1]	--	15	0.77
3/11/2000	Trace	7	0.15
12/11/2000	0.25	15	0.71
12/13/2000	Trace	12	0.36
1/29/2001	0.20	9	0.36
2/24/2001	0.25	25	1.08
1/30/2002	0.50	62	2.50
3/24/2002	Trace	13	0.27
3/26/2002	0.50	27	1.05
1/4/2004	Trace	24	0.27
1/26/2004	0.13	23	0.27
1/5/2005	0.75	33	0.47
1/14/2007	0.50	24	1.11
2/25/2007	0.50	18	0.31
3/1/2007	0.20	22	1.48

Notes:

1. Ice accumulations were not available for selected dates from the NCDC Storm Database.
2. 3 inches of ice accumulation occurred during the ~~ice storm~~ of January 26-27, 1967 across northern Ohio.

freezing rain event

Source: Reference 2.3-220, Reference 2.3-247

Attachment 8
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-8

NRC RAI 02.03.01-8

Clarify an apparent discrepancy in snowfall statistics reported in FSAR Subsection 2.3.1.3.4.2.

The FSAR states that the highest 24-hour snowfall was 62.2 cm (24.5 inches) during April of 1886 at Detroit City Airport whereas the highest 2- and 3-day snowfall occurred at the Flint recording station where 57.7 cm (22.7 inches) was reported during a 48-hour period. The reported 2- and 3-day snowfall maximum at Flint is inconsistent (i.e., lower) that the 24-hour snowfall maximum at Detroit City Airport.

Response

FSAR Sections 2.3.1.3.4.2 and 2.3.2.1.3 provide extreme snowfall statistics for the Fermi region. In order to find maximum snowfall events that occurred on timescales greater than 24-hours, 2- and 3-day snowfall data were obtained from the National Climatic Data Center (NCDC) online database. The stations in the region all began reporting after April 1886, the date southwest Michigan (attributed to Detroit City Airport in the database) recorded a snowfall of 24.5 inches, the highest 24-hour snowfall. Since the maximum 2- and 3-day snowfall obtained from the NCDC online database, is less than the maximum 24-hour snowfall, it is appropriate that the maximum 24-hour snowfall also be the maximum 2- and 3-day snowfall for the Fermi site.

Proposed COLA Revision

FSAR Section 2.3.2.1.3 will be revised accordingly as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 2 page(s))

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

equal to or greater than the 100-year recurrence interval values in Table 2.3-214.

Precipitation Wind Roses

Monthly and annual precipitation roses were created to correlate hourly precipitation with wind direction for the Fermi region during the 2003-2007 timeframe and are presented in Figure 2.3-204 through Figure 2.3-216. As shown in Figure 2.3-204, annually the majority of hourly precipitation events, regardless of intensity, occur when winds are from the east and east-northeast with secondary maximum occurring equally from the north and south directions. As can be seen in both Table 2.3-213 and Figure 2.3-204, a significant amount of the hourly precipitation events were less than 0.25 cm (0.10 inches). In addition, it appears from the annual precipitation rose that winds from the southwest and south-southwest yield the highest percentage of hourly rainfall events with intensities greater than 1.27 cm (0.50 inches).

Snowfall

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Mean annual snowfall, as well as 24-hour snowfall and maximum monthly values were discussed in Subsection 2.3.1.2.4. Table 2.3-205 and Table 2.3-206 present climatological normal and extreme values of snowfall, respectively, for the first-order and COOP stations in the region of the Fermi site. As indicated in these tables, annual amounts of snow vary greatly amongst the stations, and the region is characterized by heavy snow events. The highest 24-hour snowfall is 62.2 cm (24.5 inches) at the Detroit City Airport located north-northeast of the Fermi site, occurring during April 1886 (Reference 2.3-211). ~~The highest 2- and 3-day and maximum monthly snowfall is 56.6 and 148.6 cm (22.3 and 58.5 inches), respectively, which occurred at Flint and Ann Arbor, respectively (Reference 2.3-210, Reference 2.3-237).~~

2.3.2.1.4 Fog and Smog

Fog

Fog is reported at NWS first-order stations when the horizontal visibility is less than or equal to 9.7 km (6 mi) and the difference between the temperature and dew-point is 5°F or less. Detroit Metropolitan Airport is the nearest NWS station that routinely observes visibility and fog. Detroit Metropolitan Airport is located 27.4 km (17 mi) north-northwest of the Fermi site and has a similar elevation and relative proximity to Lake Erie.

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Maximum 2- and 3-day snowfall totals were also obtained for the Fermi region from the NCDC United States Snow Climatology online database. The highest 2- and 3-day snowfall reported from the database is 56.6 cm (22.3 inches) occurring at Flint (Reference 2.3-237). The Snow Climatology online database does not include snow records that would capture the maximum 24-hour snowfall that occurred in 1886. Since the maximum 2- and 3-day snowfall, obtained from Snow Climatology online database, is less than the maximum 24-hour snowfall, it is appropriate that the maximum 24-hour snowfall also be the maximum 2-and 3-day snowfall for the Fermi site. The maximum monthly snowfall is 148.6 cm (58.5 inches) which occurred at Ann Arbor during February 1923 (Reference 2.3-210).

Attachment 9
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-9

NRC RAI 02.03.01-9

Please reevaluate the winter precipitation roof loading in FSAR Subsection 2.3.1.3.4 using the criteria presented in ISG-7, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures" (ADAMS Accession Number ML091490565) or justify an alternative methodology.

*FSAR Subsection 2.3.1.3.4, "Weight of Snow and Ice on Structures," assumes scuppers and drains on the roof of the ESBWR are designed to limit water accumulation to no more than 10.2 cm (4 inches) of water. This assumption conflicts with the ESBWR DCD which assumes water accumulation on the roof could reach 0.61 meters (2.0 feet), which is the height of the parapets, during the extreme winter precipitation event when the roof scuppers and drains are assumed to be clogged (see footnote ** in Table 3G.1-2 of Tier 2 of DCD Revision 6).*

Response

In accordance with the Interim Staff Guidance (ISG) DC/COL-ISG-07 winter precipitation roof loads to be considered in the design of Fermi 3 structures should be based on the weight of the maximum Normal Winter Precipitation (NWP) event plus the weight of the maximum Extreme Winter Precipitation (EWP) event.

Maximum Ground-Level Weight of Normal Winter Precipitation (NWP)

The NWP event in the Fermi 3 region can be described by the highest ground-level weight among the 100-year return period snowpack, historical maximum snowpack, 100-year return period snowfall, or historical maximum snowfall.

100-Year Return Period Snowpack: During the late fall, winter, and early spring the frequency of surface low pressure systems tracking across southeast Michigan is at a maximum. Each surface low pressure system that passes through the region has the potential to produce heavy snowfall at the Fermi site. SEI/ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures," identifies that the Fermi site is located in a ground snow load zone of 24 lb_f/ft^2, based on a 50-year return period (Reference 2.3-218). In order to convert to a 100-year return period snowpack, Table C7-3 of SEI/ASCE 7-05 cites a conversion factor of 1.22 (1/0.82). Using this conversion factor the ground-level weight of the 100-year return period snowpack for the Fermi site becomes 29.3 lb_f/ft^2 (24 lb_f/ft^2 x 1.22).

Historical Maximum Snowpack Event: Snowpack is defined as the amount of measured snow on the ground reported in inches. The National Weather Service (NWS) measures snowpack on a daily basis at first-order and most Cooperative Observation Program (COOP) stations, reporting it as snow depth. Maximum snow depth measurements were obtained for stations surrounding the Fermi site in order to determine the historical maximum snowpack event. The maximum snowpack recorded is 60.96 cm (24 inches), occurring at the Detroit Metropolitan Airport in January 1999 (Reference 2.3-201). For the Fermi site, using Equation 1 presented in ISG DC/COL-ISG-07, the ground-level weight of the historical maximum snowpack for the Fermi site becomes 21.0 lb_f/ft^2 (0.279 lb_f/ft^2/inch x 24 1.36 inches).

100-year Return Period Snowfall: The 100-year return period snowfall value is intended to provide an estimate of the maximum snowfall event for meteorological observing stations with an insufficient time interval to capture cyclical extremes. 100-year return period snowfall values are extrapolated from a dataset of maximum snowfall events for the time period of the observing station. 100-year return period snowfall amounts for 2-day periods were obtained from NCDC's Snow Climatology web site for first order and COOP stations in the Fermi region. Utilizing values over a 2-day period ensures that snow events that occur for more than a 1-day recording period are captured. The maximum 100-year return period snowfall for the Fermi region is 46.48 cm (18.3 inches) as obtained from the Flint observing station records (Reference 2.3-237). Determining the ground-level weight of the 100-year return period snowfall is not exact, as snow can vary in density with different air temperatures. A more useful method to determine the ground-level weight of snowfall is to calculate the water equivalent of the falling snow. The snow to water equivalent ratio varies anywhere from 0.2 to 0.4 cm (0.07 to 0.15 inches) for 2.54 cm (1 inch) of snow (Reference 2.3-238). Using 0.15 as a conservative snow to water equivalent ratio and the weight of one inch of water, the weight of the 100-year return period snowfall for the Fermi region is given by:

$$18.3 \text{ inches} \times 0.15 \times 5.2\ lb_f/\text{inch}\ ft^2 = 14.3\ lb_f/ft^2$$

Historical Maximum Snowfall Event: In order to determine the historical maximum snowfall event, maximum 24-hour snowfall amounts were obtained for stations surrounding the Fermi site. FSAR Section 2.3.1.2.4 discussed the maximum 24-hour snowfall values in the Fermi region. The highest 24-hour snowfall amounts for the NWS first order and COOP sites around the Fermi site are displayed in FSAR Table 2.3-206. The highest 24-hour snowfall of 63.2 cm (24.5 inches) occurred during April of 1886 and is attributed to the Detroit City Airport in the database. Using 63.2 cm (24.5 inches) as the historical maximum snowfall event, 0.15 as the snow to water equivalent ratio, and the weight of one inch of water, the ground-level weight becomes 19.1 lb_f/ft^2 (24.5 inches x 0.15 x 5.2 lb_f/ft^2).

Based on the discussion above, the 100-year return period snowpack (29.3 lb_f/ft^2) provides the maximum ground-level weight for the NWP event. This estimate is bounded by the ESBWR standard plant site parameter value (50 lb_f/ft^2) as shown in FSAR Table 2.0-201 (see attached markup).

Maximum Ground-Level Weight of the Extreme Winter Precipitation Event (EWP)

As indicated in ISG DC/COL-ISG-07, the EWP event is considered to be the highest ground-level weight resulting from either the extreme frozen winter precipitation event or the extreme liquid winter precipitation event. The extreme frozen winter precipitation event is considered to be the higher ground-level weight between the 100-year return period snowfall event and the historical maximum snowfall event, which for the Fermi region is 19.1 lb_f/ft^2.

The extreme liquid winter precipitation event is defined as the theoretical greatest depth of precipitation during a 48-hour period for a 25.9-square-kilometer (10-square-mile) area during the months having the historically greatest snowpack. Hydrometeorological Report No. 53 (HMR 53) provides a method to determine the 48-hour probable maximum winter precipitation (PMWP) for the Fermi site based on long-term climatological normals. The winter precipitation amounts provided in HMR 53 are liquid equivalent amounts and incorporate all winter precipitation in the 10 square mile area that surrounds the Fermi site

(Reference 2.3-235). Section 5 of HMR 53 recommends interpolation with a smooth depth-duration curve of the 24-hour and 72-hour PMWP amounts through the point of origin (0,0) to estimate the 48-hour PMWP. In the Fermi region, the greatest snowpack historically has occurred between the months of November and April; therefore, these months have been examined to develop the highest 48-hour PMWP. From Figures 24, 34, and 44 in Reference 2.3-235, the 6-, 24-, and 72-hour PMWP are determined to be 27.9, 40.6, and 52.1 cm (11, 16 and 20.5 inches), respectively, occurring in November. Using the method recommended by HMR 53 yields a 48-hour PMWP of 49 cm (19.3 inches) for the Fermi site. The parapets on the roof of the ESBWR are designed to allow water accumulation of no more than 60.96 cm (24 inches) during the extreme winter precipitation event when the roof scuppers and drains are assumed to be clogged. The weight of 60.96 cm (24 inches) of water is calculated to be 124.8 lb_f/ft^2 (24 inches of water x 5.2 $lb_f/inch\ ft^2$).

Therefore, the weight of the 48-hour PMWP (124.8 lb_f/ft^2) is considered a conservative estimate for the EWP event at the Fermi site.

DCD Tier 1, Table 5.1-1 shows the standard plant site parameter for the maximum ground snow load for the EWP event. The maximum ground snow load for the EWP event includes the contribution from the NWP event. The combined ground-level weight from the NWP and EWP event at the Fermi site is 154.1 lbf/ft^2 (124.8 lb_f/ft^2 + 29.3 lb_f/ft^2). This estimate is bounded by the ESBWR standard plant site parameter of 162 lb_f/ft^2 given in DCD Tier 1, Table 5.1-1.

Maximum Roof Load

As described in FSAR Section 2.3.1.2.4, the Fermi region can be characterized as experiencing liquid and frozen precipitation extremes during the late fall, winter, and early spring seasons. A method for determining the maximum roof load from the ground-level weights of the maximum normal and extreme winter precipitation events is described in ISG DC/COL-ISG-07. The maximum roof load for the Fermi site can theoretically occur during one of the following scenarios:

1. Historical maximum snowfall on top of 100-year return period snowpack,
2. 48-hour PMWP on top of 100-year return period ice accretion, or
3. 48-hour PMWP on top of 100-year return period snowpack.

The scenario that results in the maximum roof load is taken as the maximum roof load for Seismic I Structures at the Fermi site.

Historical Maximum Snowfall Event on the 100-Year Return Period Snowpack: FSAR Section 2.3.1.3.4.1 indicates that maximum ground-level weight of the NWP event for the Fermi region is 29.3 lb_f/ft^2, which is the value for the 100-year return period snowpack. The maximum ground-level weight of the extreme frozen winter precipitation event for the Fermi region is 19.1 lb_f/ft^2, resulting from the historical maximum snowfall. In the event that the historical maximum snowfall event occurs while the Fermi site is experiencing a 100-year return period snowpack, the resulting ground-level weight is 48.4 lb_f/ft^2 (19.1 lb_f/ft^2 + 29.3 lb_f/ft^2). SEI/ASCE 7-05 provides a method to convert ground-level weights of snow to roof snow loads by using the following formula for flat roofs:

$$p_f = 0.7 \times C_e \times C_t \times I \times p_g$$

where: p_f = Snow load on flat roofs, in lb_f/ft^2

C_e = Exposure factor for sheltered roofs as listed in Table 7-2 of SEI/ASCE 7-05

C_t = Thermal factor as determined from Table 7-3 of SEI/ASCE 7-05

I = Importance factor as determines from Table 7-4 of SEI/ASCE 7-05

p_g = Ground-level snow load, in lb_f/ft^2

Using an exposure factor (C_e) of 1.1, a thermal factor (C_t) of 1, an importance factor (I) of 1, and a ground-level snow load (p_g) of 48.4 lb_f/ft^2, the roof load (p_f) for the historical maximum snowfall on top of the 100-year return period snowpack is 37.3 lb_f/ft^2.

48-Hour PMWP on the 100-Year Return Period Ice Accretion Event: The propensity of the Fermi site to experience significant ice accretion events presents an additional scenario in which the 48-hour PMWP falls on top of the 100-year return period ice accretion. FSAR Table 2.3-209 provides ice accretion values for the 24 freezing rain events that occurred in the five-counties surrounding the Fermi site during the 1993-2007 period. The ice accretion values were estimated from liquid precipitation amounts obtained from hourly observations at Detroit Metropolitan Airport. To provide a conservative estimate of the ice accretion for each event, all hourly precipitation was considered to fall as freezing rain. A conversion factor (1.09) for the expansion of water to ice as it freezes was applied to the liquid equivalent amounts for each event. The highest ice accumulation displayed in FSAR Table 2.3-209 occurred on March 13, 1997 when a major ice storm struck southeastern Michigan and deposited ice accumulations of 3.8-6.4 cm (1.5-2.5 inches) from Detroit to Ann Arbor and south to the Ohio-Michigan state line. A general search for ice storms in the southeast Michigan and northwestern Ohio region prior to 1993 resulted in an ice storm producing a higher amount. On January 26-27, 1967 a storm produced freezing rain and sleet that lasted nearly 24 hours and produced ice accumulations of up to 7.6 cm (3 inches) across northwestern Ohio and parts of southern Michigan (Reference 2.3-236).

In order to determine the 100-year return period ice accretion for the Fermi site, Gumbel distributions were calculated from the method of moments as described by Wilks (Reference 2.3-234). Using this method, the 100-year return period ice accretion becomes 8.4 cm (3.31 inches). The significant accumulations of ice that have occurred in the Fermi region confirm that 8.4 cm (3.31 inches) represents the 100-year return period ice accretion event. It is reasonable to use the weight of 8.4 cm (3.31 inches) of ice and the 60.96 cm (24 inches) of water to estimate the maximum roof load for the 48-hour PMWP falling on top of the 100-year return period ice accretion event. The weight of 60.96 cm (24 inches) of water is calculated to be 124.8 lb_f/ft^2 (24 inches of water x 5.2 $lb_f/in\ ft^2$). The weight of 8.4 cm (3.31 inches) of ice (equivalent to 7.7 cm [3.04 inches] of water) is calculated to be 15.8 lb_f/ft^2 (3.04 inches of water x 5.2 $lb_f/in\ ft^2$). The summation of these two roof loads yields 140.6 lb_f/ft^2 as the maximum roof load for the 48-hour PMWP on top of the 100-year return period ice accretion event scenario.

48-Hour PMWP on the 100-Year Return Period Snowpack: As previously mentioned, the maximum roof load for 60.96 cm (24 inches) of water resulting from the 48-hour PMWP is 124.8 lb_f/ft^2. The ground-level weight of the 100-year return period snowpack on safety-related structures at the Fermi site is 29.3 lb_f/ft^2. Using equation 7-1 from SEI/ASCE 7-05, the roof load of the 100-year return period snowpack becomes 22.6 lb_f/ft^2 (0.7 x 1.1 x 1 x 1 x 29.3 lb_f/ft^2). SEI/ASCE 7-05 also mentions for rain on snow loads a surcharge of 5 lb_f/ft^2

must be added to account for heavy rain events where rain will flow through the snowpack and then drain away. This is reasonable since thunderstorms are possible at the Fermi site during the wintertime. Therefore, the roof load of the 48-hour PMWP on the 100-year return period snowpack for design purposes at the Fermi site is determined as:

$$124.8 \text{ lb}_f/\text{ft}^2 + 22.6 \text{ lb}_f/\text{ft}^2 + 5 \text{ lb}_f/\text{ft}^2 = 152.4 \text{ lb}_f/\text{ft}^2$$

Based on the discussion above, the roof load scenario of the 48-hour PMWP on the 100-year return period snowpack provides a conservative estimate of the maximum roof load resulting from the normal and extreme winter precipitation events for the safety-related structure roofs at the Fermi site. This estimate is bounded by the ESBWR site design parameters shown in Table 3G.1-2 of the ESBWR DCD. From this table, the maximum roof load resulting from the normal and extreme winter precipitation event determined as:

$$38.5 \text{ lb}_f/\text{ft}^2 + 125 \text{ lb}_f/\text{ft}^2 = 163.5 \text{ lb}_f/\text{ft}^2$$

Proposed COLA Revision

FSAR Section 2.3.1.3.4 has been revised to incorporate the response to this RAI and FSAR Table 2.0-201, Sheet 4 of 28 has also been revised to reflect ESBWR DCD, Revision 6, Table 2.0-1, specifically "Precipitation (for Roof Design)," as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 13 page(s))

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

Maximum Ground Snow Load for Normal Winter Precipitation Event

Subject (16)	DCD Site Parameter Value(1)(16)	Fermi 3 Site Characteristic	Evaluation
Precipitation (for Roof Design) (continued)			
Maximum Roof Load (5)	2873 Pa (60 lbf/ft^2) [2394; 50]	2638 Pa (55.1 lbf/ft^2) [1403; 29.3]	The Fermi 3 site characteristic value for maximum roof load is based on site characteristic values for both 100-yr snow pack and 48-hr PMWP, each of which are less than the corresponding DCD site parameter value (as shown in comparisons below). [the; return period; Ground Snow Load for Normal Winter Precipitation Event] The Fermi 3-specific roof live load from antecedent snow pack represents a 100-year return ground snow load of 1403 Pa (29.3 lb/ft^2). Because precipitation during a PMWP event is liquid at the Fermi 3 site, the total roof loading includes a rain-on-snow surcharge to account for liquid flowing through the 100-yr snow pack on the roof before it accumulates on the roof. Per Section 7.10 of ASCE 7-05, 239 Pa (5 lbf/ft^2) accounts for the rain-on-snow surcharge. Therefore, the total maximum roof load (snow pack plus rain) on a Fermi 3 safety-related building is 2638 Pa (29.3 + 20.8 + 5 = 55.1 lbf/ft^2). The Fermi 3 site characteristic value of 2638 pa (55.1 lbf/ft^2) falls within (is lower than) the DCD site parameter value of 2873 pa (60 lbf/ft^2). [1403; 29.3; 2394; 50]
Maximum Ground Snow Load (5) (100-year recurrence interval): [for Extreme Winter Precipitation Event]	2394 Pa (50 lbf/ft^2) [7757; 162]	1403 Pa (29.3 lbf/ft^2) (100-yr recurrence) [7378; 154.1]	The site characteristic value for maximum ground snow load [for Extreme Winter Precipitation Event] is defined as the weight of the 100-yr return period snow pack (to be used in determining extreme winter precipitation loads for roofs) [combined weight of the 100-year return period snowpack and the 48-hour probable maximum winter precipitation]. The site characteristic value falls within (is lower than) the DCD site parameter value.
Maximum 48-hr Winter Rainfall (5)	91.4 cm (36 in)	49.0 cm (19.3 in) of water (48-hr probable maximum winter precipitation)	The site characteristic value for 48-hr probable maximum winter precipitation is defined as the probable maximum precipitation during the winter months (to be used in conjunction with the 100-year snow pack in determining extreme winter precipitation loads for roofs). The site characteristic value falls within (is lower than) the DCD site parameter value.

Table 2.0-201 Evaluation of Site/Design Parameters and Characteristics (Notes) [EF3 COL 2.0-1-A]

1. The design of the Radwaste Building uses a set of design parameters that are specified in RG 1.143, Table 2, Class RW IIa instead of the corresponding values given in this table for all parameters except as follows: 1) Tornado: wind speeds, radius, pressure drop and rate of pressure drop; 2) Seismology: horizontal and vertical ground spectra: See DCD Figures 2.0-1 and 2.0-2.
2. Probable maximum flood level (PMF), as defined in Table 1.2-6 of Volume III of DCD Reference 2.0-4.
3. Maximum speed selected is based on Attachment I of DCD Reference 2.0-5, which summarizes the NRC Interim Position on RG 1.76. Concrete structures designed to resist Spectrum I missiles of SRP 3.5.1.4, Rev. 2, will also resist missiles postulated in RG 1.76, Revision 1.
4. Based on probable maximum precipitation (PMP) for one hour over 2.6 km^2 (one square mile) with a ratio of 5 minutes to one hour PMP of 0.32 as found in DCD Reference 2.0-3. ~~Roof scuppers and drains are designed independently to limit water accumulation on the roof to no more than 100 mm (4 in) during PMP conditions.~~ See also DCD Table 3G.1-2.
5. ~~Maximum design roof load accommodates snow load and 48 hour probable maximum winter precipitation (PMWP) in DCD References 2.0-2 and 2.0-6. Roof scuppers and drains are designed independently to limit water accumulation on the roof to no more than an average depth of 100 mm (4 in) during PMWP conditions.~~ See also DCD Table 3G.1-2.
6. Zero percent exceedance values are based on conservative estimates of historical high and low values for potential sites. They represent historical limits excluding peaks of less than one hour: which are conservative relative to DCD Reference 2.0-4. One and two percent exceedance values were selected in order to bound the values presented in DCD Reference 2.0-4 and available Early Site Permit applications.
7. At foundation level of Seismic Category I structures. For minimum dynamic bearing capacity site-specific application, use the larger value or a linearly interpolated value of the applicable range of shear wave velocities at the foundation level. The shear wave velocities of soft, medium and hard soils are 300 m/sec (1000 ft/sec), 800 m/sec (2600 ft/sec) and greater than or equal to 1700 m/sec (5600 ft/sec), respectively.
8. This is the equivalent uniform shear wave velocity (V_{eq}) over the entire soil column at seismic strain, which is a lower bound value after taking into account uncertainties. V_{eq} is calculated to achieve the same wave traveling time over the depth equal to the embedment depth plus 2 times the largest foundation plan dimension below the foundation as follows:

$$V_{eq} = \frac{\Sigma d_i}{\Sigma \frac{d_i}{V_i}}$$

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where d_i and V_i are the depth and shear wave velocity, respectively, of the i^{th} layer. The ratio of the largest to the smallest shear wave velocity over the mat foundation width at the foundation level does not exceed 1.7.

9. Safe Shutdown Earthquake (SSE) design ground response spectra of 5% damping, also termed Certified Seismic Design Response Spectra (CSDRS), are defined as free-field outcrop spectra at the foundation level (bottom of the base slab) of the Reactor/Fuel and Control Building structures. For ground surface founded Firewater Service Complex structures, the CSDRS is 1.35 times the values shown in DCD Figures 2.0-1 and 2.0-2.

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See Reference 2.0-9 for the definition of normal winter precipitation and extreme winter precipitation events. The maximum ground snow load for extreme winter precipitation event includes the contribution from the normal winter precipitation event.

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during the 15-year period is 1.6 events per year (24 events/15 years). The high number of freezing precipitation events during the last 15 years provides an assessment of how frequent they are in the Fermi region.

Probable Maximum Annual Duration

In order to determine the duration of each ice event that occurred in the five-county region surrounding the Fermi site, hourly temperature and precipitation data was obtained from Detroit Metropolitan Airport. To provide a conservative estimate of the duration for each event, only hours that reported measurable precipitation were counted. In addition, the precipitation type was ignored such that hours with rain are included. Table 2.3-209 provides the duration of each freezing rain event during the 1993-2007 time period. The ice event with the longest duration occurred from January 30 into the afternoon of February 1, 2002 when 62 consecutive hours of precipitation was reported.

Using the method of moments as suggested by Wilks with the durations of ice events listed in Table 2.3-209, the Gumbel probability distribution estimates a probable maximum annual duration of 72 hours for ice events in the Fermi region (Reference 2.3-234). This provides a conservative estimate of the maximum duration for ice events at Fermi 3.

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~~2.3.1.3.4 Weight of Snow and Ice on Structures~~

~~It is important to determine the potential maximum weight of frozen precipitation on structures at the Fermi site for safety reasons. The following subsections will provide estimates for the weights of the 100-year return period snowpack and the 48-hour probable maximum winter precipitation (PMWP), as well as the 100-year probable maximum ice accretion for the Fermi site. Per guidance by NUREG-0800, winter precipitation loads to be considered in the design of the Fermi 3 reactor should be based on the weight of the 100-year return period snowpack at ground level plus the weight of the 48-hour PMWP. As mentioned previously, the Fermi site is located in a region that experiences frequent occurrences of ice, snow, and rain events on an annual basis. The possibility exists for many types of precipitation to fall on snow or ice accumulations from previous storms. Therefore, the following analysis will provide an estimate of the weight of the 48-hour PMWP in the form of rain in combination with the 100 year probable maximum ice accretion, as well as the 100-year snowpack. This estimate will provide a~~

Insert 2)

2.3.1.3.4 Roof Loads of Winter Precipitation Events on Fermi Structures

It is important to determine the potential maximum weight of frozen and liquid precipitation on structures at the Fermi site for safety reasons. The following subsections provide estimates for the resulting ground-level weights and roof loads from the 100-year return period snowpack, historical maximum snowpack, 100-year return period snowfall, historical maximum snowfall, and 48-hour probable maximum winter precipitation (PMWP) in the Fermi region. In accordance with the Interim Staff Guidance (ISG) DC/COL-ISG-07, "Interim Staff Guidance on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures," winter precipitation roof loads to be considered in the design of Fermi 3 structures should be based on the weight of the maximum Normal Winter Precipitation (NWP) event plus the weight of the maximum Extreme Winter Precipitation (EWP) event. This estimate will provide a conservative and realistic maximum roof load of frozen and liquid precipitation on structures for design purposes at Fermi 3.

2.3.1.3.4.1 Maximum Ground-Level Weight of the Normal Winter Precipitation Event

The NWP event in the Fermi 3 region can be described by the highest ground-level weight among the 100-year return period snowpack, historical maximum snowpack, 100-year return period snowfall, or historical maximum snowfall. The remainder of this subsection provides the basis for each ground-level weight.

<u>100-Year Return Period Snowpack</u>

During the late fall, winter, and early spring the frequency of surface low pressure systems tracking across southeast Michigan is at a maximum. Each surface low pressure system that passes through the region has the potential to produce heavy snowfall at the Fermi site. SEI/ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures," identifies that the Fermi site is located in a ground snow load zone of 24 lb_f/ft^2 based on a 50-year return period (Reference 2.3-218). In order to convert to a 100-year return period snowpack Table C7-3 of SEI/ASCE 7-05 cites a conversion factor of 1.22 (1/0.82). Using this conversion factor the ground-level weight of the 100-year return period snowpack for the Fermi site becomes 29.3 lb_f/ft^2 (24 lb_f/ft^2 x 1.22).

<u>Historical Maximum Snowpack Event</u>

Snowpack is defined as the amount of measured snow on the ground reported in inches. The NWS measures snowpack on a daily basis at first-order and most COOP stations, reporting it as snow depth. Maximum snow depth measurements were obtained for stations surrounding the Fermi site in order to determine the historical maximum snowpack event. The maximum snowpack recorded is 60.96 cm (24 inches), occurring at the Detroit Metropolitan Airport in January 1999 (Reference 2.3-201). For the Fermi site, using Equation 1 presented in ISG DC/COL-ISG-07, the ground-level weight of the historical snowpack for the Fermi site becomes

21.0 lb_f/ft^2 (0.279 lb_f/ft^2/inch x $24^{1.36}$ inches).

100-year Return Period Snowfall

The 100-year return period snowfall value is intended to provide an estimate of the maximum snowfall event for meteorological observing stations with an insufficient time interval to capture cyclical extremes. 100-year return period snowfall values are extrapolated from a dataset of maximum snowfall events for the time period of the observing station. 100-year return period snowfall amounts for 2-day periods were obtained from NCDC's Snow Climatology web site for first order and COOP stations in the Fermi region. Utilizing values over a 2-day period ensures that snow events that occur for more than a 1-day recording period are captured. The maximum 100-year return period snowfall for the Fermi region is 46.48 cm (18.3 inches) as obtained from the Flint observing station records (Reference 2.3-237). Determining the ground-level weight of the 100-year return period snowfall is not exact, as snow can vary in density with different air temperatures. A more useful method to determine the ground-level weight of snowfall is to calculate the water equivalent of the falling snow. The snow to water equivalent ratio varies anywhere from 0.2 to 0.4 cm (0.07 to 0.15 inches) for 2.54 cm (1 inch) of snow (Reference 2.3-238). Using 0.15 as a conservative snow to water equivalent ratio and the weight of one inch of water, the weight of the 100-year return period snowfall for the Fermi region is given by:

$$18.3 \text{ in} \times 0.15 \times 5.2 \text{ lb}_f/\text{in ft}^2 = 14.3 \text{ lb}_f/\text{ft}^2$$

Historical Maximum Snowfall Event

In order to determine the historical maximum snowfall event, maximum 24-hour snowfall amounts were obtained for stations surrounding the Fermi site. Subsection 2.3.1.2.4 discussed the maximum 24-hour snowfall values in the Fermi region. The highest 24-hour snowfall amounts for the NWS first order and COOP sites around the Fermi site are displayed in Table 2.3-206. The highest 24-hour snowfall of 63.2 cm (24.5 inches) occurred during April of 1886 and is attributed to the Detroit City Airport in the database.. Using 63.2 cm (24.5 inches) as the historical maximum snowfall event, 0.15 as the snow to water equivalent ratio, and the weight of one inch of water, the ground-level weight becomes 19.1 lb_f/ft^2 (24.5 inches x 0.15 x 5.2 lb_f/ft^2).

Based on the discussion above, the 100-year return period snowpack (29.3 lbf/ft2) , provides the maximum ground-level weight of the NWP event. This estimate is bounded by the ESBWR standard plant site parameter valuse (50 lbf/ft2) as shown in Table 2.0-201.

2.3.1.3.4.2 Maximum Ground-Level Weight of the Extreme Winter Precipitation Event

As indicated in ISG DC/COL-ISG-07, the EWP event is considered to be the highest ground-level weight resulting from either the extreme frozen winter precipitation event or the extreme liquid winter precipitation event. The extreme frozen winter precipitation event is considered to be the higher ground-level weight between the 100-year return period snowfall event and the historical maximum snowfall event, which for the Fermi region is 19.1 lb_f/ft^2.

The extreme liquid winter precipitation event is defined as the theoretical greatest depth of precipitation during a 48-hour period for a 25.9-square-kilometer (10-square-mile) area during the months having the historically greatest snowpack. Hydrometeorological Report No. 53 (HMR 53) provides a method to determine the 48-hour PMWP for the Fermi site based on long-term climatological normals. The winter precipitation amounts provided in HMR 53 are liquid equivalent amounts and incorporate all winter precipitation in the 10 mi^2 area that surrounds the Fermi site (Reference 2.3-235). Section 5 of HMR 53 recommends interpolation with a smooth depth-duration curve of the 24-hour and 72-hour PMWP amounts through the point of origin (0,0) to estimate the 48-hour PMWP. In the Fermi region, the greatest snowpack historically has occurred between the months of November through April; therefore, these months have been examined to develop the highest 48-hour PMWP. From Figures 24, 34, and 44 in Reference 2.3-235, the 6-, 24-, and 72-hour PMWP are determined to be 27.9, 40.6, and 52.1 cm (11, 16 and 20.5 inches), respectively, occurring in November. Using the method recommended by HMR 53 yields a 48-hour PMWP of 49 cm (19.3 inches) for the Fermi site. The parapets on the roof of the ESBWR are designed to allow water accumulation of no more than 60.96 cm (24 inches) during the extreme winter precipitation event when the roof scuppers and drains are assumed to be clogged. The weight of 60.96 cm (24 inches) of water is calculated to be 124.8 lb_f/ft^2 (24 inches of water x 5.2 $lb_f/in\ ft^2$).

Therefore, the weight of the 48-hour PMWP (124.8 lbf/ft2) is considered a conservative estimate for the EWP event at the Fermi site.

Table 2.0-201 shows the standard plant site parameter for the maximum ground snow load for the EWP event. The maximum ground snow load for the EWP event includes the contribution from the NWP event. The combined ground-level weight from the NWP and EWP event at the Fermi site is 154.1 lb_f/ft^2 (124.8 lbf/ft2 + 29.3 lbf/ft2). This estimate is bounded by the ESBWR standard plant site parameters of 162 lb_f/ft^2 give in Table 2.0-201.

2.3.1.3.4.3 Maximum Roof Load

As described in Subsection 2.3.1.2.4, the Fermi region can be characterized as experiencing liquid and frozen precipitation extremes during the late fall, winter, and early spring seasons. A method for determining the maximum roof load from the ground-level weights of the maximum normal and extreme winter precipitation events is described in ISG DC/COL-ISG-07. The maximum roof load for the Fermi site can theoretically occur during one of the following scenarios: historical maximum snowfall on top of 100-year return period snowpack, 48-hour PMWP on top of 100-year return period ice accretion, or 48-hour PMWP on top of 100-year return period snowpack. The scenario that results in the maximum roof load can be considered a conservative estimate of the maximum roof load for Seismic I Structures at the Fermi site.

Historical Maximum Snowfall Event on the 100-Year Return Period Snowpack

Subsection 2.3.1.3.4.1 indicates that maximum ground-level weight of the NWP event for the Fermi region is 29.3 lb_f/ft^2, which is the value for the 100-year return period snowpack. The maximum ground-level weight of the extreme frozen winter precipitation event for the Fermi region is 19.1 lb_f/ft^2, resulting from the historical maximum snowfall. In the event that the historical maximum snowfall event occurs while the Fermi site is experiencing a 100-year return period snowpack, the resulting ground-level weight is 48.4 lb_f/ft^2 (19.1 lb_f/ft^2 + 29.3 lb_f/ft^2). SEI/ASCE 7-05 provides a method to convert ground-level weights of snow to roof snow loads by using the following formula for flat roofs:

$$p_f = 0.7 \times C_e \times C_t \times I \times p_g$$

where:

p_f = Snow load on flat roofs, in lb_f/ft^2
C_e = Exposure factor for sheltered roofs as listed in Table 7-2 of SEI/ASCE 7-05
C_t = Thermal factor as determined from Table 7-3 of SEI/ASCE 7-05
I = Importance factor as determines from Table 7-4 of SEI/ASCE 7-05
p_g = Ground-level snow load, in lb_f/ft^2

Using an exposure factor (C_e) of 1.1, a thermal factor (C_t) of 1, an importance factor (I) of 1, and a ground-level snow load (p_g) of 48.4 lb_f/ft^2, the roof load (p_f) for the historical maximum snowfall on top of the 100-year return period snowpack becomes 37.3 lb_f/ft^2.

48-Hour PMWP on the 100-Year Return Period Ice Accretion Event

The propensity of the Fermi site to experience significant ice accretion events presents an additional scenario in which the 48-hour PMWP falls on top of the 100-year return period ice accretion. Table 2.3-209 provides ice accretion values for the 24 freezing rain events that occurred in the five-counties surrounding the Fermi site during the 1993-2007 period. The ice accretion values were estimated from liquid precipitation amounts obtained from hourly observations at Detroit Metropolitan Airport. To provide a conservative estimate of the ice accretion for each event, all hourly precipitation was considered to fall as freezing rain. A conversion factor (1.09) for the expansion of water to ice as it freezes was applied to the liquid equivalent amounts for each event. The highest ice accumulation displayed in Table 2.3-209 occurred on March 13, 1997 when a major ice storm struck southeastern Michigan and deposited ice accumulations of 3.8-6.4 cm (1.5-2.5 inches) from Detroit to Ann Arbor and south to the Ohio-Michigan state line. A general search for ice storms in the southeast Michigan and northwestern Ohio region prior to 1993 resulted in an ice storm producing a higher amount. On January 26-27, 1967 a storm produced freezing rain and sleet that lasted nearly 24 hours and produced ice accumulations of up to 7.6 cm (3 inches) across northwestern Ohio and parts of southern Michigan (Reference 2.3-236).

In order to determine the 100-year return period ice accretion for the Fermi site, Gumbel distributions were calculated from the method of moments as described by Wilks (Reference

2.3-234). Using this method, the 100-year return period ice accretion becomes 8.4 cm (3.31 inches). The significant accumulations of ice that have occurred in the Fermi region confirm that 8.4 cm (3.31 inches) represents the 100-year return period ice accretion event.

It is reasonable to use the weight of 8.4 cm (3.31 inches) of ice and the 60.96 cm (24 inches) of water to estimate the maximum roof load for the 48-hour PMWP falling on top of the 100-year return period ice accretion event. The weight of 60.96 cm (24 inches) of water is calculated to be 124.8 lb_f/ft^2 (24 inches of water x 5.2 $lb_f/in\ ft^2$). The weight of 8.4 cm (3.31 inches) of ice (equivalent to 7.7 cm [3.04 inches of water]) is calculated to be 15.8 lb_f/ft^2 (3.04 inches of water x 5.2 $lb_f/in\ ft^2$). The summation of these two roof loads yields 140.6 lb_f/ft^2 as the maximum roof load for the 48-hour PMWP on the 100-year return period ice accretion event scenario.

<u>48-Hour PMWP on the 100-Year Return Period Snowpack</u>

As previously mentioned, the maximum roof load for 60.96 cm (24 inches) of water resulting from the 48-hour PMWP is 124.8 lb_f/ft^2. The ground-level weight of the 100-year return period snowpack on safety-related structures at the Fermi site is 29.3 lb_f/ft^2. Using equation 7-1 from SEI/ASCE 7-05, the roof load of the 100-year return period snowpack becomes 22.6 lb_f/ft^2 (0.7 x 1.1 x 1 x 1 x 29.3 lb_f/ft^2). SEI/ASCE 7-05 also mentions for rain on snow loads a surcharge of 5 lb_f/ft^2 must be added to account for heavy rain events where rain will flow through the snowpack and then drain away. This is reasonable since thunderstorms are possible at the Fermi site during the wintertime. Therefore, the roof load of the 48-hour PMWP on the 100-year return period snowpack for design purposes at the Fermi site is determined as:

$$124.8\ lb_f/ft^2 + 22.6\ lb_f/ft^2 + 5\ lb_f/ft^2 = 152.4\ lb_f/ft^2$$

Based upon the discussions above, the roof load scenario of the 48-hour PMWP on the 100-year return period snowpack provides a conservative estimate of the maximum roof load resulting from the normal and extreme winter precipitation events for the roofs of safety-related structures at the Fermi site. This estimate is bounded by the ESBWR site design parameters shown in Table 3G.1-2 of the ESBWR DCD that provides the maximum roof load resulting from the normal and extreme winter precipitation event determinded as:

38.5 lbf/ft2 + 125 lbf/ft2 = 163.5 lbf/ft2 conservative and realistic probable maximum weight of snow and ice on structures for design purposes at Fermi 3.

2.3.1.3.4.1 Rain on Ice Load

48-Hour Probable Maximum Winter Precipitation

Hydrometeorological Report No. 53 (HMR-53) provides a method to determine the 48-hour PMWP for the Fermi site based on long-term climatological normals. The winter precipitation amounts provided in HMR-53 are liquid-equivalent amounts and incorporate all winter precipitation in the 10 mi^2 area that surrounds the Fermi site (Reference 2.3-235). Section 5 of HMR-53 recommends interpolation with a smooth depth duration curve of the 24-hour and 72-hour PMWP amounts through the point of origin (0,0) to estimate the 48-hour PMWP. In the Fermi region, ice events historically have occurred between the months of November through April; therefore, these months have been examined to develop the highest 48-hour PMWP. From Figures 24, 34, and 44 in Reference 2.3-235, the 6-, 24-, and 72-hour PMWP are determined to be 27.9, 40.6, and 52.1 cm (11, 16 and 20.5 inches), respectively, occurring in November. Using the method recommended by HMR-53 yields a 48-hour PMWP of 49 cm (19.3 inches) for the Fermi site. Detroit Edison has decided to build an Economic Simplified Boiling Water Reactor (ESBWR) for Fermi 3. Scuppers and drains on the roof of the ESBWR are designed to limit water accumulation to no more than 10.2 cm (4 inches) of water.

Rain on Ice

Table 2.3-209 provides ice accretion values for the 24 ice events that occurred in the five counties surrounding the Fermi site during the period 1993-2007. The ice accretion values were estimated from liquid precipitation amounts obtained from hourly observations at Detroit Metropolitan Airport. To provide a conservative estimate of the ice accretion for each event, all hourly precipitation was considered to fall as freezing rain. A conversion factor (0.09) for the expansion of water to ice when it freezes was applied to the liquid equivalent amounts for each event. The highest ice accumulation displayed in Table 2.3-209 occurred during March 13, 1997 when a major ice storm struck southeastern Michigan and deposited ice accumulations of 3.8-6.4 cm (1.5-2.5 inches) from Detroit to Ann Arbor and south to the Ohio-Michigan state line. A general search for ice storms in the southeast Michigan and

~~northwestern Ohio region prior to 1993 resulted in an ice storm producing a higher amount. During January 26-27, 1967 a storm produced freezing rain and sleet that lasted nearly 24 hours and ice accumulations of up to 7.6 cm (3 inches) across northwestern Ohio and parts of southern Michigan (Reference 2.3-236).~~

~~In order to determine the 100-year return period probable maximum ice accretion for the Fermi site, Gumbel distributions were calculated from the method of moments as described by Wilks (Reference 2.3-234). Using this method, the 100-year recurrence return period probable maximum ice accretion becomes 8.4 cm (3.31 inches). The significant accumulations of ice that have occurred in the Fermi region confirm that 8.4 cm (3.31 inches) represents the 100-year probable maximum ice accretion. Therefore, it is reasonable to use the weight of 8.4 cm (3.31 inches) of ice and the 10.2 cm (4 inches) of water to estimate the weight of rain and ice on the roof of the ESBWR.~~

~~The weight of 10.2 cm (4 inches) of water is calculated to be 20.8 lb_f/ft^2 (4 inches of water X 5.2 $lb_f/in\ ft^2$). The weight of 8.4 cm (3.31 inches) of ice (equivalent to 7.7 cm [3.04 inches of water]) is calculated to be 15.8 lb_f/ft^2 (3.04 inches of water X 5.2 $lb_f/in\ ft^2$). The summation of these two weights yields 36.6 lb_f/ft^2 as the probable maximum weight of rain on ice for the roof of the ESBWR.~~

~~2.3.1.3.4.2 **Rain on Snow Load**~~

~~100 Year Return Period Snowpack~~

~~During the late fall, winter, and early spring the storm track increases the frequency of storms across southeast Michigan. Each storm that passes through the region has the potential to produce heavy snowfall at the Fermi site. The SEI/ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures," identifies that the Fermi site is located in a snow load zone of 24 lb_f/ft^2 based on a 50-year recurrence (Reference 2.3-218). In order to convert to a 100-year recurrence Table C7-3 of SEI/ASCE 7-05 cites a conversion factor of 1.22 (1/0.82). Using this conversion factor the 100-year recurrence snowpack for the Fermi site becomes 29.3 lb_f/ft^2 (24 lb_f/ft^2 x 1.22).~~

~~In order to verify the SEI/ASCE 7-05 100-year recurrence snowpack value, maximum snowfall amounts were obtained for stations surrounding Fermi 3. Subsection 2.3.1.2.4 discussed the maximum 24-hour snowfall values in the Fermi region. The highest 24-hour~~

snowfall amounts for the NWS first-order and COOP sites around the Fermi site are displayed in Table 2.3-206. The highest 24-hour snowfall of 62.2 cm (24.5 inches) occurred during April of 1886 at Detroit City Airport. The highest 2- and 3-day snowfall occurred at the Flint recording station where 57.7 cm (22.7 inches) was reported during a 48 hour period (Reference 2.3-237).

Snowpack is defined as the amount of measured snow on the ground reported in inches. The NWS measures snowpack on a daily basis at first-order and most COOP stations, reporting it as snow depth. Determining the weight of the snowpack is not exact, as snow can vary in density with different air temperatures. A more useful method to determine the weight of snowpack is to calculate the water equivalent of the falling snow. The snow to water equivalent ratio varies anywhere from 0.2 to 0.4 cm (0.07 to 0.15 inches) for 2.54 cm (1 inch) of snow (Reference 2.3-238). Using this ratio the weights of the 24-hour snowfall maximum in the Fermi region is given by:

$$24.5 \text{ inches} \times (0.07 + 0.15)/2 \times 5.2 \ lb_f/in\ ft^2 = 14.0 \ lb_f/ft^2$$

This value is much lower than the 100-year snowpack for the Fermi site indicated by SEI/ASCE 7-05. Therefore, a conservative estimate is to consider 29.3 lb_f/ft^2 to be the 100-year maximum snowpack value for structures at Fermi 3.

Rain on Snow

As mentioned in Subsection 2.3.1.3.4.1, the maximum load of water on the roof of the ESBWR is 20.8 lb_f/ft^2. The weight of the 100-year snowpack on safety-related structures at the Fermi site is 29.3 lb_f/ft^2. A conservative approach would be to consider the weight of the snowpack on the ground as equivalent to that on the roof of the ESBWR. Section C7.10 of the SEI/ASCE 7-05 also mentions for rain on snow loads a surcharge of 5 lb_f/ft^2 must be added to account for heavy rain events where rain will flow through the snowpack and then drain away. This is reasonable since thunderstorms are possible at the Fermi site during the wintertime. Therefore, the maximum total load of the rain load on the 100-year snowpack for design purposes at the Fermi site is determined as:

$$29.3 \ lb_f/ft^2 + 20.8 \ lb_f/ft^2 + 5 \ lb_f/ft^2 = 55.1 \ lb_f/ft^2$$

~~The weight of the rain on snow scenario, therefore, provides a more conservative estimate of the maximum loads of snow and ice on the roofs of safety-related structures at the Fermi site. However, this estimate is bounded by the ESBWR standard plant site parameters cited in the ESBWR DCD that provides the maximum roof load as 60 lb_f/ft^2.~~

2.3.1.3.5 Design Basis Ambient Temperature and Humidity Statistics

The design of structures at power generating facilities, such as the plant heat sink and plant heating, ventilation, and air conditioning systems, is based upon long-term climatological data such as that produced in the 2005 ASHRAE Handbook (Reference 2.3-239). ASHRAE for design purposes provides 2.0 percent and 1.0 percent maximum ambient threshold values (annual exceedance probabilities) for the dry-bulb (DB) temperature and the mean coincident wet-bulb (MCWB) temperature, as well as the non-coincident wet-bulb (WB) temperatures. The 99.0 percent and 99.6 percent annual exceedance probabilities are also provided for minimum ambient thresholds. Detroit Metropolitan Airport is the closest location to the Fermi site for which the 2005 ASHRAE provides design values. Based upon a 30-year period of record from 1972 through 2001, Table 2.3-210 shows that the maximum 2.0 percent annual DB cooling exceedance temperature is 29.3°C (84.7°F) with a corresponding MCWB of 21.6°C (70.8°F). The maximum 1.0 percent annual DB cooling exceedance temperature is 30.7°C (87.3°F) with a corresponding MCWB of 22.3°C (72.2°F).The maximum 2.0 percent and 1.0 percent annual WB cooling exceedance temperatures are 22.8°C (73.1°F) and 23.8°C (74.8°F), respectively. The minimum 99.0 percent and 99.6 percent annual DB heating exceedance temperatures are -14.8°C (5.3°F) and -17.7°C (0.2°F), respectively.

<u>0 percent Exceedance Values</u>

0 percent exceedance values represent the maximum or minimum value that is observed over a long period of time, usually 30-years or greater. In order to determine the 0 percent exceedance values for the Fermi site, hourly dry-bulb and wet-bulb temperatures were obtained from the Detroit Metropolitan Airport for the period 1961-2007 (47 years) (Reference 2.3-227, Reference 2.3-229). Table 2.3-210 displays the 0 percent exceedance values of maximum dry-bulb, coincident wet-bulb, and non-coincident wet-bulb, as well as the minimum dry-bulb.

Attachment 10
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-10

NRC RAI 02.03.01-10

Revise FSAR Table 2.0-201 (Sheet 6 of 28) to identify the Fermi 3 maximum and minimum 0 percent exceedance ambient design temperature site characteristic values as the more extreme of either the historic recorded values or the 100-year return values.

10 CFR 52.79(a)(1)(iii) states, in part, that the COL FSAR shall include the meteorological characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and time in which the historical data have been accumulated. In order to be compliant with 10 CFR 52.79(a)(1)(iii), the ambient design temperature site characteristics should be based on the more extreme or either historic or 100-year return period values. Temperatures based on a 100-year return period are considered to provide sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated as required by regulation.

The 0 percent exceedance ambient design temperature Fermi 3 site characteristic values presented in Table 2.0-201 (Sheet 6 of 28) are based on historic extreme values. Please justify why these site characteristic values are not based on the more extreme of either the historic or 100-year return values. Note that FSAR Subsection 2.3.1.3.5 already states that the more extreme 100-year temperature values are considered representative of the Fermi site for design purposes.

Response

The 0 percent exceedance ambient design temperatures for Fermi 3 are based on the highest of either the historic extreme values or the 100-year return period values. The discussion below supports that the 0 percent exceedance design temperatures for Fermi 3 are represented by the 100-year return period minimum dry bulb (DB) temperatures and 100-year return period maximum wet bulb (WB) temperature (non-coincident).

Historic Extreme Values

Historic extreme values represent the maximum or minimum value that is observed over a long period of time, usually 30-years or greater. Extreme maximum and minimum dry bulb (DB) temperatures for meteorological stations in the region surrounding the Fermi site are discussed in FSAR Section 2.3.1.2.2 and summarized in FSAR Table 2.3-206.

The highest DB temperature of 42.2°C (108°F) occurred at the Adrian 2 NNE Cooperative Observation Program (COOP) weather station in July 1934 (Reference 2.3-210). The lowest DB temperature recorded was -32.2°C (-26°F) in January 1892, also occurring at Adrian 2 NNE. In comparison, Detroit Metropolitan maximum and minimum DB temperatures over a 48-year period (1959-2006) are 40°C (104°F) and -29.4°C (-21.0°F), respectively, occurring during June 1988 and January 1984, respectively (Reference 2.3-201). Temperature data from Detroit Metropolitan Airport is considered more representative for the Fermi site due to its proximity. The Adrian 2 NNE COOP weather station is located further inland and historically experiences temperatures that may not be representative of maximum temperature extremes experienced at the Fermi site, which is along the shoreline of Lake Erie.

In order to determine the historic extreme wet-bulb temperature (non-coincident) and the mean coincident wet bulb temperature (MCWB) associated with the maximum DB temperature, hourly data was obtained from the Detroit Metropolitan Airport for the 47-year period (1961-2007) (Reference 2.3-227, Reference 2.3-228, & Reference 2.3-229). The Detroit Metropolitan Airport is the closest station that measures hourly dry-bulb temperature, dewpoint temperature, and station pressure, all of which are necessary to calculate wet-bulb temperatures. The extreme maximum wet-bulb temperature (non-coincident) calculated from the Detroit Metropolitan Airport data is 29.4°C (85.0°F). The MCWB temperature observed with the historic maximum DB temperature observed at the Detroit Metropolitan Airport is 24.8°C (76.6°F).

100-year Return Period Values

Dry-bulb and wet-bulb temperatures based on 100-year return period values provide sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. FSAR Section 2.3.1.3.5 discusses the 100-year return period values representative for the Fermi site.

The 100-year return period MCWB temperature associated with the 100-year return period maximum DB temperature cannot be determined using the Gumbel distribution. ASHRAE's Weather Data Viewer Version 4.0 (WDVIEW 4.0) provides a method to estimate the 100-year return period MCWB temperature by linear extrapolation of historical observations of maximum DB and MCWB using the data from the Detroit Metropolitan Airport for the period 1982-2006 (25 years) (Reference 2.3-2XX, see markup). A linear trend through the six highest DB temperatures in the joint frequency matrix extrapolates out to a DB temperature of 40.1°C (104.1°F) and a projected 100-year return period MCWB temperature of 23.3°C (73.9°F).

<u>Proposed COLA Revision</u>

FSAR Sections 2.3.1.3.5 and FSAR Tables 2.0-201 (Sheet 6 of 28) and 2.3-210 will be revised as shown in the proposed markup.

Markup of Detroit Edison COLA

(following 8 page(s))

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

Subject [16]	DCD Site Parameter Value[1][16]	Fermi 3 Site Characteristic	Evaluation
Ambient Design Temperature (continued)			
1% Annual Exceedance Values (continued)			
Maximum	27.8°C (82°F) wet bulb (non-coincident)	23.8°C (74.8°F) wet-bulb (non-coincident)	The Fermi 3 site characteristic value for the maximum wet bulb temperature (non-coincident) for 0.4% annual exceedance. This value is defined as the ambient wet-bulb temperature that will be exceeded 1% of the time annually. This value is 23.8°C (74.8°F) wet bulb (non-coincident) and falls within (is less than) the DCD site parameter value for 1% Annual exceedance.
Minimum	-23.3°C (-10°F)	-14.8°C (5.3°F) (1% Annual exceedance value)	The Fermi 3 site characteristic value is the site characteristic value for the minimum dry bulb temperature for 1% annual exceedance. This value is defined as the ambient dry-bulb temperature below which dry-bulb temperatures will fall 1% of the time annually. This value falls within (is less than) the DCD site parameter value for 1% Annual exceedance.
0% Exceedance Values			
Maximum	47.2°C (117°F) dry bulb 26.7°C (80°F) wet bulb (mean coincident)	~~40.0~~ 40.1°C (~~104.0~~ 104.1°F) dry-bulb with ~~24.8~~ 23.3°C (~~76.6~~ 73.9°F) wet bulb coincident (0% exceedance values)	The Fermi 3 site characteristic values ~~are~~ for the 0% maximum dry bulb and wet bulb, coincident temperatures are the 100-year return period values ~~for 0% annual exceedance~~. These values are ~~40.0~~ 40.1°C (~~104.0~~ 104.1°F) dry-bulb with ~~24.8~~ 23.3°C (~~76.6~~ 73.9°F) wet bulb coincident fall within (are less than) the DCD site parameter values for 0% exceedance.
	31.1°C (88°F) wet bulb (non-coincident)	~~29.4~~ 30.0°C (~~85~~ 86.0°F) wet-bulb (non-coincident) (0% exceedance value)	The Fermi 3 site characteristic value ~~is~~ for the 0% maximum wet bulb temperature (non-coincident) is the 100-year return period value ~~for 0% annual exceedance~~. This value is ~~29.4~~ 30.0°C (~~85~~ 86.0°F) wet-bulb (non-coincident) and falls within (is less than) the DCD site parameter value for 0% exceedance.
Minimum	-40°C (-40°F)	~~-29.4~~ -34.9°C (~~-21~~ -30.8°F)	The Fermi 3 site characteristic value for minimum temperature is ~~defined as~~ the 100-year return period value ~~ambient dry bulb temperature for which a 0% annual probability of a lower dry bulb temperature exists.~~ This value is ~~-29.4~~ -34.9°C (~~-21~~ -30.8°F) and falls within (is higher than) the DCD site parameter value for 0% exceedance.

The weight of the rain on snow scenario, therefore, provides a more conservative estimate of the maximum loads of snow and ice on the roofs of safety-related structures at the Fermi site. However, this estimate is bounded by the ESBWR standard plant site parameters cited in the ESBWR DCD that provides the maximum roof load as 60 lb_f/ft^2.

2.3.1.3.5 Design Basis Ambient Temperature and Humidity Statistics

The design of structures at power generating facilities, such as the plant heat sink and plant heating, ventilation, and air conditioning systems, is based upon long-term climatological data such as that produced in the 2005 ASHRAE Handbook (Reference 2.3-239). ASHRAE for design purposes provides 2.0 percent and 1.0 percent maximum ambient threshold values (annual exceedance probabilities) for the dry-bulb (DB) temperature and the mean coincident wet-bulb (MCWB) temperature, as well as the non-coincident wet-bulb (WB) temperatures. The 99.0 percent and 99.6 percent annual exceedance probabilities are also provided for minimum ambient thresholds. Detroit Metropolitan Airport is the closest location to the Fermi site for which the 2005 ASHRAE provides design values. Based upon a 30-year period of record from 1972 through 2001, Table 2.3-210 shows that the maximum 2.0 percent annual DB cooling exceedance temperature is 29.3°C (84.7°F) with a corresponding MCWB of 21.6°C (70.8°F). The maximum 1.0 percent annual DB cooling exceedance temperature is 30.7°C (87.3°F) with a corresponding MCWB of 22.3°C (72.2°F).The maximum 2.0 percent and 1.0 percent annual WB cooling exceedance temperatures are 22.8°C (73.1°F) and 23.8°C (74.8°F), respectively. The minimum 99.0 percent and 99.6 percent annual DB heating exceedance temperatures are -14.8°C (5.3°F) and -17.7°C (0.2°F), respectively.

Add Insert "1" Here

~~0 percent Exceedance Values~~

~~0 percent exceedance values represent the maximum or minimum value that is observed over a long period of time, usually 30 years or greater. In order to determine the 0 percent exceedance values for the Fermi site, hourly dry-bulb and wet-bulb temperatures were obtained from the Detroit Metropolitan Airport for the period 1961-2007 (47 years) (Reference 2.3-227, Reference 2.3-229). Table 2.3-210 displays the 0 percent exceedance values of maximum dry-bulb, coincident wet-bulb, and non-coincident wet-bulb, as well as the minimum dry-bulb.~~

Insert 1)

<u>Historic Extreme Values</u>

Historic extreme values represent the maximum or minimum value that is observed over a long period of time, usually 30-years or greater. Extreme maximum and minimum DB temperatures for meteorological stations in the region surrounding the Fermi site were discussed in Subsection 2.3.1.2.2 and summarized in Table 2.3-206. The highest DB temperature of 42.2°C (108°F) occurred at the Adrian 2 NNE COOP weather station on July of 1934 (Reference 2.3-210). The lowest DB temperature recorded was -32.2°C (-26°F) during January of 1892, also occurring at Adrian 2 NNE. In comparison, Detroit Metropolitan maximum and minimum DB temperatures over a 48-year period are 40°C (104°F) and -29.4°C (-21.0°F), respectively, occurring during June 1988 and January 1984, respectively (Reference 2.3-201). For the Fermi site temperature data from Detroit Metropolitan Airport is considered more representative due to its proximity. The Adrian 2 NNE COOP weather station is located further inland and historically experiences temperatures that may not be representative of maximum temperature extremes experienced at the Fermi site, which is along the shoreline of Lake Erie.

In order to determine the historic extreme wet-bulb temperature (non-coincident) and the MCWB associated with the maximum DB temperature, hourly data was obtained from the Detroit Metropolitan Airport for the period 1961-2007 (47 years) (Reference 2.3-227, Reference 2.3-228, Reference 2.3-229). The Detroit Metropolitan Airport is the closest station that measures hourly dry-bulb temperature, dewpoint temperature, and station pressure necessary to calculate wet-bulb temperatures. The extreme maximum value of wet-bulb temperature (non-coincident) estimated from the data from Detroit Metropolitan Airport is 29.4°C (85.0°F). The MCWB temperature observed with the historic maximum DB temperature observed at the Detroit Metropolitan Airport is 76.6°F.

Return Period

100-year ~~Temperature~~ Values

return period hourly return period

Values of 100-year maximum and minimum DB and 100-year maximum WB (non-coincident) are estimated from data obtained from Detroit Metropolitan Airport during a 47-year period (1961-2007) (Reference 2.3-227, Reference 2.3-228, Reference 2.3-229, Reference 2.3-240). As mentioned in Subsection 2.3.1.2.2, long-term temperatures for stations across the Fermi site are influenced by latitude and proximity to Lake Erie. Detroit Metropolitan Airport is located approximately 27.4 km (17 mi) north-northwest of the Fermi site and is considered to have similar temperature extremes. Maximum and minimum DB and WB values were determined for each year of the 47-year period. Using the method of moments as suggested by Wilks with the annual minimum DB values, the Gumbel distribution estimates the 100-year minimum DB to be -34.9°C (-30.8°F) (Reference 2.3-234). Using this same method the 100-year maximum DB temperature is calculated to be 40.1°C (104.1°F), while the 100-year maximum WB (non-coincident) temperature is estimated to be 30°C (86.0°F). ~~These values are displayed in Table 2.3-210. Since the 100-year return period maximum DB temperature value is extrapolated from a probability distribution, the MCWB temperature is not available for this return interval.~~

return period

return period

return period

Add Insert "2" Here

~~Extreme maximum and minimum DB temperatures for meteorological stations in the region surrounding the Fermi site were discussed in Subsection 2.3.1.2.2 and summarized in Table 2.3-206. The highest DB temperature of 42.2°C (108°F) occurred at the Adrian 2 NNE COOP weather station on July of 1934 (Reference 2.3-210). The lowest DB temperature recorded was -32.2°C (-26°F) during January of 1892, also occurring at Adrian 2 NNE. In comparison, Detroit Metropolitan maximum and minimum DB temperatures over the 48 year period are 40°C (104°F) and -29.4°C (-21.0°F), respectively, occurring during June 1988 and January 1984, respectively (Reference 2.3-201). Therefore, the 100 year maximum and minimum DB temperature and 100 year maximum WB temperature (non-coincident) displayed in Table 2.3-210 are considered representative of the Fermi site for design purposes. In addition, the Fermi 3 specific design basis ambient temperature and humidity values are bounded by the values in DCD Table 2.0-1.~~

Insert 2)

The 100-year return period MCWB temperature associated with the 100-year return period maximum DB temperature cannot be determined using the Gumbel distribution. ASHRAE's Weather Data Viewer Version 4.0 provides a method to estimate the 100-year return period MCWB temperature by linear extrapolation of historical observations of maximum DB and MCWB temperatures from Detroit Metropolitan Airport during the period 1982-2006 (Reference 2.3-2XX). A linear trend through the six highest DB temperatures in the joint frequency matrix extrapolated out to a DB temperature of 40.1°C (104.1°F) projects a 100-year return period MCWB temperature of 23.3°C (73.9°F).

<u>0 percent Exceedance Values</u>

The 0 percent Exceedance Values representing the ambient design temperature site characteristics should be based on the more extreme of either historic or 100-year return period values. Therefore, the 100-year return period DB temperature is considered the 0 percent exceedance value for maximum DB temperature. The 100-year return period minimum DB temperatures and 100-year return period maximum WB temperature (non-coincident) are considered the 0 percent exceedance values for the Fermi site. Table 2.3-210 displays the 0 percent exceedance values that are considered representative of the Fermi site for design purposes. In addition, the Fermi 3 specific design ambient temperature and humidity values are bounded by the values in DCD Table 2.0-1.

2.3-255 Huff, F.A., et al, "Effects of Cooling Tower Effluents on Atmospheric Conditions in Northeastern Illinois, a Preliminary Report," Illinois Water Survey, 1971.

2.3-256 Kramer, M.L., D.E. Seymour, M.E. Smith, R.W. Reeves, and T.T. Frankenberg, "Snowfall Observations from Natural Draft Cooling Tower Plumes," Science, pp. 1239-1241, 1976.

2.3-257 Broehl, K.J., "Field Investigations of Environmental Effects of Cooling Towers for Large Steam Electric Plants," Portland General Electric Company, 1968.

2.3-258 Zeller, R.W., et al, "Report on Trip to Seven Thermal Power Plants," Pollution Control Council, Pacific Northwestern Area, 1971.

2.3-259 Kramer, M.L., M.E. Smith, M.J. Butler, D.E. Seymour, T.T. Frankenberg, "Cooling Towers and the Environment," Journal of the Air Pollution Control Association, Vol. 26, No. 6, June 1976.

2.3-260 Hosler, C.L., "Wet Cooling Tower Plume Behavior," Pennsylvania State University, University Park, Pennsylvania, 1971.

2.3-261 Tate, A., "Effects of a Natural Draft Cooling Tower on the Environment," Emory University, Atlanta, Georgia, May 1972.

2.3-262 Detroit Edison, "Fermi 2 Updated Final Safety Analysis Report", Section 2.3.3, Revision 14, November 2006

Add Insert "3" Here

Insert 3)

2.3-2XX American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., "Weather Data Viewer," CD-ROM, Version 4.0, 2009.

Table 2.3-210 Ambient Temperature and Humidity Statistics for Detroit Metropolitan Airport [EF3 COL 2.0-7-A]

Minimum Annual Dry-Bulb Heating Exceedance	99.0%	5.3°F
	99.6%	0.2°F
	0.0%	~~-21.1~~ -30.8°F
Maximum Annual Dry-Bulb/Wet-Bulb (Coincident) Cooling Exceedance	2.0%	84.7°F / 70.8°F
	1.0%	87.3°F / 72.2°F
	0.0%	~~10[illegible].0~~ 104.1°F / ~~70.6~~ 73.9°F
Maximum Annual Wet-Bulb (Non-Coincident) Cooling Exceedance	2.0%	73.1°F
	1.0%	74.8°F
	0.0%	~~85.0~~ 86.0°F
~~Probable 100-year Exceedance~~	~~Maximum Dry-Bulb~~	~~104.1°F~~
	~~Minimum Dry-Bulb~~	~~-30.8°F~~
	~~Maximum Wet-Bulb~~	~~86.0°F~~

Notes:
Data for the 2% and 1% maximum and minimum annual dry-bulb and wet-bulb temperatures are taken from the 2005 ASHRAE handbook.

~~0% exceedance values and probable maximum 100-year exceedance values were obtained from meteorological data collected at Detroit Metropolitan Airport (1961-2007).~~

Source: Reference 2.3-201, Reference 2.3-227, Reference 2.3-228, Reference 2.3-234, Reference 2.3-239

Attachment 11
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-11

NRC RAI 02.03.01-11

Clarify FSAR Subsection 2.3.1.3.7.1, "Background Air Quality," regarding jurisdiction for air quality control management.

The FSAR states that Monroe County is a member of the Air Quality Control Region (AQCR) that included the counties of the Detroit metropolitan area. However, per 40 CFR 81.43, Monroe County is in Metropolitan Toledo Interstate Air Quality Control Region (AQCR) 124 and the nonattainment status for PM2.5 and ozone is reported as a part of the Detroit-Ann Arbor Designated Area as in 40 CFR 81.243

Response

Monroe County's Air Quality Control Region (AQCR) and its PM2.5 and ozone nonattainment designation area are two different geographical groupings. As stated in 40 CFR 81.43, Monroe County is a member of the Metropolitan Interstate Toledo AQCR. However, as provided for in 40 CFR 81.323, Monroe County is considered part of the Detroit-Ann Arbor area as it pertains to attainment status designations for PM2.5 and ozone.

Proposed COLA Revision

FSAR Section 2.3.1.3.7.1 will be updated to clarify the AQCR jurisdiction of Monroe County as shown as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 2 page(s))

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

2.3.1.3.6 Ultimate Heat Sink

The Ultimate Heat Sink (UHS) for the Fermi 3 ESBWR does not require an external source of safety-related cooling water. The UHS function is provided by safety systems integral and interior to the reactor plant. These systems have no cooling towers, basins, or cooling water intake/discharge structures external to the reactor plant. The Fermi 3 ambient temperature values for the reactor building that were provided in Subsection 2.3.1.3.5 are bounded by the maximum and minimum dry-bulb temperature, as well as the maximum wet-bulb temperatures that are cited in DCD Table 2.0-1. A detailed description of the location and operation of the UHS is provided in Subsection 9.2.5.

2.3.1.3.7 Regional Air Quality

2.3.1.3.7.1 Background Air Quality

Add Insert "1" Here

The Fermi site is located in the northeastern tip of Monroe County and along the western shoreline of Lake Erie. Air quality at the Fermi site is heavily influenced by the Detroit and Toledo Metropolitan areas and surrounding emission sources. The MDEQ evaluates the air quality in the Detroit Metropolitan area with a network of monitors mostly located in Wayne County, north of the Fermi site. The MDEQ routinely monitors the U.S. Environmental Protection Agency (EPA) criteria pollutants of NO2, SO2, CO, PM2.5, PM10, and Ozone. ~~Monroe County is a member of the Air Quality Control Region (AQCR) that includes the counties of the Detroit metropolitan area that are ruled as a non-attainment area for the EPA's annualPM2.5 and 8-hour ozone standard (Reference 2.3-241).~~ The EPA as of March 12, 2008 strengthened the definition of ozone non-attainment areas as those that record a 3-year average of the fourth-highest daily maximum 8-hour average ozone concentration of 0.075 parts per million (ppm) or higher (Reference 2.3-242). For PM2.5 the EPA considers areas in violation of the standard when the 3-year average of the weighted annual mean PM2.5 concentration is equal to or exceeds 15 mg/m3.

Maximum concentrations for the annual average of PM2.5 and 8-hour ozone pollutants were obtained from monitors in Monroe and Wayne County. The highest annual PM2.5 concentration reported between 1999 and 2006 is 20.1 mg/m3, occurring at the Dearborn monitor located west of downtown Detroit (Reference 2.3-243). During the same five-year period, the highest 8-hour ozone concentration recorded was 104 ppb

Insert 1:

While Monroe County is a member of the Metropolitan Interstate Toledo Air Quality Control Region (AQCR), it is also included in the Detroit-Ann Arbor air quality designation area. The Detroit-Ann Arbor air quality designation area is currently classified as a $PM_{2.5}$ non-attainment area for violations of the 1997 annual standard and the 2006 24-hour standard (Reference 2.3-241). The county is also currently classified as a maintenance area for the 8-hour ozone standard after being reclassified to attainment on June 29, 2009 by the EPA (Reference 2.3-241). Monroe County is in attainment for all other criteria pollutants (Reference 2.3-241).

Attachment 12
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-12

NRC RAI 02.03.01-12

In Subsection 2.3.1.3.7.1, "Background Air Quality," the FSAR states that only annual-average PM2.5 concentrations exceeded the ambient air quality standards. However, 24-hour average PM2.5 concentrations at monitoring stations around the Fermi site frequently exceeded the respective 35 µg/m3 standard as well. Consider including this fact in the FSAR. Also note that the units for PM2.5 used in this FSAR subsection should be µg/m3 instead of mg/m3.

Response

The U.S. Environmental Protection Agency (EPA) officially designated the Detroit-Ann Arbor area, including Monroe County, as a nonattainment area for the 2006 PM2.5 24-hour standard in the Federal Register on November 13, 2009. At the time of the preparation of the FSAR in February 2008, Monroe County had not been designated as a nonattainment area for the PM2.5 24-hour standard of 35 $\mu g/m^3$ established in 2006, a reduction from the previous standard of 65 $\mu g/m^3$ established in 1997

Proposed COLA Revision

FSAR Section 2.3.1.3.7.1 will be updated to include the latest PM2.5 nonattainment area designations for Monroe County and nearby monitor concentrations for 24-hour PM2.5 and the units associated with the PM2.5 standard will be corrected as shown in the proposed markup.

Markup of Detroit Edison COLA

(following 3 page(s))

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

2.3.1.3.6 Ultimate Heat Sink

The Ultimate Heat Sink (UHS) for the Fermi 3 ESBWR does not require an external source of safety-related cooling water. The UHS function is provided by safety systems integral and interior to the reactor plant. These systems have no cooling towers, basins, or cooling water intake/discharge structures external to the reactor plant. The Fermi 3 ambient temperature values for the reactor building that were provided in Subsection 2.3.1.3.5 are bounded by the maximum and minimum dry-bulb temperature, as well as the maximum wet-bulb temperatures that are cited in DCD Table 2.0-1. A detailed description of the location and operation of the UHS is provided in Subsection 9.2.5.

2.3.1.3.7 Regional Air Quality

2.3.1.3.7.1 Background Air Quality

The Fermi site is located in the northeastern tip of Monroe County and along the western shoreline of Lake Erie. Air quality at the Fermi site is heavily influenced by the Detroit and Toledo Metropolitan areas and surrounding emission sources. The MDEQ evaluates the air quality in the Detroit Metropolitan area with a network of monitors mostly located in Wayne County, north of the Fermi site. The MDEQ routinely monitors the U.S. Environmental Protection Agency (EPA) criteria pollutants of NO2, SO2, CO, PM2.5, PM10, and Ozone. [Add Insert "1" Here] ~~Monroe County is a member of the Air Quality Control Region (AQCR) that includes the counties of the Detroit metropolitan area that are ruled as a non-attainment area for the EPA's annualPM2.5 and 8-hour ozone standard (Reference 2.3-241).~~ The EPA as of March 12, 2008 strengthened the definition of ozone non-attainment areas as those that record a 3-year average of the fourth-highest daily maximum 8-hour average ozone concentration of 0.075 parts per million (ppm) or higher (Reference 2.3-242). For PM2.5 the EPA considers areas in violation of the [annual] standard when the 3-year average of the weighted annual mean PM2.5 concentration is equal to or exceeds 15 [$\mu g/m^3$] ~~mg/m3~~. ← [Add Insert "2" Here]

Maximum concentrations for the annual average of PM2.5 and 8-hour ozone pollutants were obtained from monitors in Monroe and Wayne County. The highest annual PM2.5 concentration reported between 1999 and 2006 is 20.1 [$\mu g/m^3$] ~~mg/m3~~, occurring at the Dearborn monitor located west of downtown Detroit [Add Insert "3" Here] (Reference 2.3-243). ~~During the same five-year period~~ [Between 2003 and 2007], the highest 8-hour ozone concentration recorded was 104 ppb

Insert 1:

While Monroe County is a member of the Metropolitan Interstate Toledo Air Quality Control Region (AQCR), it is also included in the Detroit-Ann Arbor air quality designation area. The Detroit-Ann Arbor air quality designation area is currently classified as a $PM_{2.5}$ non-attainment area for violations of the 1997 annual standard and the 2006 24-hour standard (Reference 2.3-241). The county is also currently classified as a maintenance area for the 8-hour ozone standard after being reclassified to attainment on June 29, 2009 by the EPA (Reference 2.3-241). Monroe County is in attainment for all other criteria pollutants (Reference 2.3-241).

Insert 2:

and in violation of the 2006 24-hour standard when the 3-year average of the 98th percentile of the 24-hour concentration is equal to or exceeds 35 μg/m3

Insert 3:

and the highest 24-hour $PM_{2.5}$ concentration over this same period is 58 μg/m3 (98th percentile) occurring at the Allen Park monitor located southwest of downtown Detroit in Wayne County

2.3-235 National Oceanic and Atmospheric Administration (NOAA), "Seasonal Variation of 10-Square-Mi Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Hydrometeorological Report No. 53, Washington D.C., April 1980.

2.3-236 Environmental Science Services Administration, "Storm Data and Unusual Weather Phenomena during January 1967," Volume 9, No. 1, United States Department of Commerce Environmental Data Service, February 1967

2.3-237 National Climatic Data Center Storm Data, "Michigan and Ohio, Record 1-Day, 2-Day and 3-Day Snowfall," 2007, http://www.ncdc.noaa.gov/ussc, accessed 3 April 2008.

2.3-238 Huschke, R.E., "Glossary of Meteorology," Revision American Meteorological Society, Boston, Massachusetts, p. 518, 1959.

2.3-239 ASHRAE Handbook, "2005 American Society Heating, Refrigerating, and Air-Conditioning Engineers, Inc," 2005.

2.3-240 American Society of Civil Engineers, "Evapotranspiration and Irrigation Water Requirements," ASCE Manuals and Reports on Engineering Practice No. 70, pp. 176-177, 1990.

4 January 2010

2.3-241 U.S. Environmental Protection Agency, "US EPA Green Book," (2008), http://www.epa.gov/air/oaqps/greenbk/, accessed ~~3 April 2008~~.

2.3-242 U.S. Environmental Protection Agency, "National Ambient Air Quality Standards," (28 March 2008), http://www.epa.gov/air/criteria.html, accessed 1 April 2008.

2.3-243 Michigan Department of Environmental Quality, "Michigan's 2006 Annual Air Quality Report," (November 2007), http://michigan.gov/documents/deq/deq-aqd-air-reports-06AQReport_216544_7.pdf, accessed 3 April 2008.

2.3-244 Michigan Department of Environmental Quality, "Highest 8-hr Ozone Values for 2003-2007," (2008), http://www.deq.state.mi.us/documents/deq-aqd-mm-ozone-8hrhighestprevious.pdf, accessed 3 April 2008.

Attachment 13
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-13

NRC RAI 02.03.01-13

Revise the FSAR to discuss the impact on plant design and operation due to the Fermi site being located in a PM2.5 and ozone nonattainment area.

Section C.I.2.3.1.2 of RG 1.206 and Section III.3.e of SRP 2.3.2 state that the regional air quality conditions that should be considered in the evaluation of the design and operation of the facility should be identified. FSAR Subsection 2.3.1.3.7.1 states that Monroe County is a member of an Air Quality Control Region (AQCR) that has been classified as in nonattainment for PM2.5 and ozone National Ambient Air Quality Standards (NAAQS). Because the NAAQS have been promulgated to protect both public health and public welfare, exceedances of NAAQS in a region imply that public health and public welfare in that region may be adversely impacted and therefore plant design and operation could be affected.

Response

As published in the Federal Register on June 29, 2009, the Michigan Department of Environmental Quality's (MDEQ) petition to redesignate Monroe County as an attainment area for the 8-hour ozone standard was accepted by the U.S. Environmental Protection Agency (EPA). As a result, Monroe County is now considered a maintenance area for the 8-hour ozone standard and therefore Monroe County's only currently designated nonattainment is for PM2.5 (in violation of both the 1997 annual standard and the 2006 24-hour standard)..

As discussed in FSAR Section 2.3.1.3.7.2, the operation of a new nuclear unit requires few, infrequently operated sources of criteria emissions (including nonattainment pollutants and their precursors – NOx, SO2, VOC, and PM2.5). Sources of air emissions during operation of Fermi 3 are fixed combustion sources including two standby diesel generators (SDG), two ancillary diesel generators (ADG), two diesel driven fire pumps, and an auxiliary boiler, as well as non-combustion sources including the natural draft cooling tower (NDCT) and two multi-cell mechanical draft cooling towers (MDCT). The protection of air quality during operation is programmatically ensured through the implementation of the required MDEQ pre-construction Permit-to-Install (PTI) air permitting program. Additionally, the determination of applicability of 40 CFR Part 51, Subpart W for federal actions located in nonattainment/maintenance areas also ensures that the necessary review of the potential impact of air emissions from the operation of the Fermi 3 facility.

Rule 201 of the Michigan Administrative Rules for Air Pollution Control (hereafter referred to as the Michigan Rules) requires a facility to obtain a PTI before installing or constructing equipment that emits air contaminants. A PTI is a state license to construct a source of air contaminant emissions and is applicable in both attainment and nonattainment areas. According to MDEQ's "PTI – Determining Applicability Guidebook" (http://www.deq.state.mi.us/documents/deq-ess-caap-pti-determiningapplicabilitygdbk.pdf), as long as the facility complies with the conditions of the PTI, public health and the environment are protected. Each piece of equipment proposed to support the operation of Fermi 3 will be authorized by the MDEQ in a PTI and compliance with the PTI will ensure protection of public health and the environment. Additionally, as stated in FSAR Section 2.3.1.3.7.2, the combustion sources mentioned above will be designed for efficiency and operated with good combustion practices on a limited basis throughout the year (often only for testing). These operational practices will be described in the PTI issued by the MDEQ.

An additional measure of protection of public health and welfare via air quality is found in 40 CFR 51, Subpart W, "Determining Conformity of General Federal Actions to State or Federal Implementation Plans" which requires that a federal action undergo a general conformity determination for nonattainment or maintenance areas where the emissions of the criteria pollutant or its precursors would equal or exceed emission thresholds set forth in the regulation. Specifically, 40 CFR 51 Subpart W requires that a federal action, such as NRC's approval of the operation of Fermi 3, must conform to (i.e., not impede) Michigan's plans for improving or maintaining the air quality in nonattainment or maintenance areas, respectively. A project can be assumed to conform to a state's air quality improvement plans if emissions are demonstrated to be below the applicability thresholds set forth in 40 CFR 51 Subpart W. Estimated emissions during the operation of the facility are not expected to exceed the conformity applicability thresholds provided in 40 CFR 51 Subpart W. This indicates that the project conforms to (i.e., does not impede) Michigan's plans for improving the air quality in Monroe County and bringing the area back into attainment with the NAAQS; ultimately improving public health and welfare.

As currently designed, the operation of Fermi 3 will not have a negative impact on the current air quality nor impede the state's plans for attaining the NAAQS in the future in Monroe County. Therefore, operation of Fermi 3 will not subsequently adversely impact public health and welfare via air quality.

Proposed COLA Revision

FSAR Section 2.3.1.3.7.1 will be updated to include the latest nonattainment area designations for Monroe County including both $PM_{2.5}$ and ozone as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 4 page(s))

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

2.3.1.3.6 Ultimate Heat Sink

The Ultimate Heat Sink (UHS) for the Fermi 3 ESBWR does not require an external source of safety-related cooling water. The UHS function is provided by safety systems integral and interior to the reactor plant. These systems have no cooling towers, basins, or cooling water intake/discharge structures external to the reactor plant. The Fermi 3 ambient temperature values for the reactor building that were provided in Subsection 2.3.1.3.5 are bounded by the maximum and minimum dry-bulb temperature, as well as the maximum wet-bulb temperatures that are cited in DCD Table 2.0-1. A detailed description of the location and operation of the UHS is provided in Subsection 9.2.5.

2.3.1.3.7 Regional Air Quality

2.3.1.3.7.1 Background Air Quality

The Fermi site is located in the northeastern tip of Monroe County and along the western shoreline of Lake Erie. Air quality at the Fermi site is heavily influenced by the Detroit and Toledo Metropolitan areas and surrounding emission sources. The MDEQ evaluates the air quality in the Detroit Metropolitan area with a network of monitors mostly located in Wayne County, north of the Fermi site. The MDEQ routinely monitors the U.S. Environmental Protection Agency (EPA) criteria pollutants of NO2, SO2, CO, PM2.5, PM10, and Ozone. [Add Insert "1" Here] ~~Monroe County is a member of the Air Quality Control Region (AQCR) that includes the counties of the Detroit metropolitan area that are ruled as a non-attainment area for the EPA's annualPM2.5 and 8-hour ozone standard (Reference 2.3-241).~~ The EPA as of March 12, 2008 strengthened the definition of ozone non-attainment areas as those that record a 3-year average of the fourth-highest daily maximum 8-hour average ozone concentration of 0.075 parts per million (ppm) or higher (Reference 2.3-242). For PM2.5 the EPA considers areas in violation of the [annual] standard when the 3-year average of the weighted annual mean PM2.5 concentration is equal to or exceeds 15 [μg/m³] ~~mg/m3~~. [Add Insert "2" Here]

Maximum concentrations for the annual average of PM2.5 and 8-hour ozone pollutants were obtained from monitors in Monroe and Wayne County. The highest annual PM2.5 concentration reported between 1999 and 2006 is 20.1 [μg/m³] ~~mg/m3~~, occurring at the Dearborn monitor located west of downtown Detroit [Add Insert "3" Here] (Reference 2.3-243). ~~During the same five-year period~~ [Between 2003 and 2007], the highest 8-hour ozone concentration recorded was 104 ppb

Insert 1:

While Monroe County is a member of the Metropolitan Interstate Toledo Air Quality Control Region (AQCR), it is also included in the Detroit-Ann Arbor air quality designation area. The Detroit-Ann Arbor air quality designation area is currently classified as a $PM_{2.5}$ non-attainment area for violations of the 1997 annual standard and the 2006 24-hour standard (Reference 2.3-241). The county is also currently classified as a maintenance area for the 8-hour ozone standard after being reclassified to attainment on June 29, 2009 by the EPA (Reference 2.3-241). Monroe County is in attainment for all other criteria pollutants (Reference 2.3-241).

Insert 2:

and in violation of the 2006 24-hour standard when the 3-year average of the 98^{th} percentile of the 24-hour concentration is equal to or exceeds 35 μg/m3

Insert 3:

and the highest 24-hour $PM_{2.5}$ concentration over this same period is 58 μg/m3 (98^{th} percentile) occurring at the Allen Park monitor located southwest of downtown Detroit in Wayne County

(0.104 ppm), measured at the East Seven Mile monitor located in northeastern Wayne County (Reference 2.3-244). The next closest non-attainment area for a EPA criteria pollutant is Lorain County, Ohio which is part of the Cleveland Metropolitan air shed (also non-attainment for ozone and PM2.5), located approximately 96.6 km (60 mi) east-southeast of the Fermi site (Reference 2.3-241). There are no Class I Areas that are located within 300 km (186.5 mi) of the Fermi site (Reference 2.3-245). Given the minor nature of air emissions associated with operations of Fermi 3 (discussed below), this distance is sufficiently far as to not warrant a concern.

two

pumps

2.3.1.3.7.2 Projected Air Quality

two ancillary diesel generators,

towers

Air emissions of criteria pollutants will be minor given the nature of a nuclear facility and its lack of significant gaseous exhausts of effluents to the air. Sources of air emissions for Fermi 3 include two standby diesel generator~~s,~~ an auxiliary boiler, and ~~a~~ diesel fire ~~pump~~, as well as a natural draft cooling tower (NDCT) and two multi-cell mechanical draft cooling ~~tower~~ (MDCT). The combustion sources mentioned above will be designed for efficiency and operated with good combustion practices on a limited basis throughout the year (often only for testing). Given their small magnitude of size and infrequent operation, these emissions will not only have little effect on the nearby ozone and PM2.5 non-attainment areas, but will have minimal impact on the local and regional air quality as well. The air emissions from the listed equipment are regulated by the MDEQ.

Construction of Fermi 3 will lead to an increase of vehicular traffic surrounding the Fermi site prior to operations. Furthermore, increased traffic and construction activities will lead to further release of particulates prior to operation of Fermi 3. However, any increase in particulate emissions from vehicles is expected to be minor and remain local to the Fermi site.

The Fermi 3 cooling towers will not be a source of the typical combustion-related criteria pollutants or other toxic emissions. They will, however, emit small amounts of particulate matter as drift. The towers will be equipped with drift eliminators designed to limit drift to 0.001 percent or less of total water flow. Additionally, the primary normal power heat sink (NPHS) for Fermi 3 is a NDCT. The height of the tower will allow for good dispersion of the drift and not allow localized concentrations of

2.3-235 National Oceanic and Atmospheric Administration (NOAA), "Seasonal Variation of 10-Square-Mi Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Hydrometeorological Report No. 53, Washington D.C., April 1980.

2.3-236 Environmental Science Services Administration, "Storm Data and Unusual Weather Phenomena during January 1967," Volume 9, No. 1, United States Department of Commerce Environmental Data Service, February 1967

2.3-237 National Climatic Data Center Storm Data, "Michigan and Ohio, Record 1-Day, 2-Day and 3-Day Snowfall," 2007, http://www.ncdc.noaa.gov/ussc, accessed 3 April 2008.

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2.3-240 American Society of Civil Engineers, "Evapotranspiration and Irrigation Water Requirements," ASCE Manuals and Reports on Engineering Practice No. 70, pp. 176-177, 1990.

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2.3-242 U.S. Environmental Protection Agency, "National Ambient Air Quality Standards," (28 March 2008), http://www.epa.gov/air/criteria.html, accessed 1 April 2008.

2.3-243 Michigan Department of Environmental Quality, "Michigan's 2006 Annual Air Quality Report," (November 2007), http://michigan.gov/documents/deq/deq-aqd-air-reports-06AQ Report_216544_7.pdf, accessed 3 April 2008.

2.3-244 Michigan Department of Environmental Quality, "Highest 8-hr Ozone Values for 2003-2007," (2008), http://www.deq.state.mi.us/documents/deq-aqd-mm-ozone-8 hrhighestprevious.pdf, accessed 3 April 2008.

Attachment 14
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4120)

RAI Question No. 02.03.01-14

NRC RAI 02.03.01-14

Please revise the FSAR to evaluate the trends in severe weather phenomena and extremes in the proposed site vicinity and discuss whether such trends may be indicative of climate change.

SRP 2.3.1 states that the applicability of the data on severe weather phenomena that is used to represent site conditions during the expected period of reactor operation should be substantiated. SPR 2.3.1 further states that current literature on possible changes in the weather in the site region should also be reviewed to be confident that the methods used to predict weather extremes are reasonable.

Response

Natural climate variation is cyclical phenomenon that deviates on both a time and spatial scale. Prediction of these events over any length of time on a global scale is often speculative at best. The uncertainty is especially compounded when referring to specific areas or locations.

A large resource of historical climatic data allows for the evaluation of climate conditions and thus climate changes over the expected life span of Fermi 3. Long-term historical temperature, precipitation and storm data including both normal and extreme conditions that may affect plant operation and design are readily available for the region.

The National Climatic Data Center (NCDC) publishes "Climatography of the United States, No. 85". The publication summarizes 344 climate divisions in the lower 48 contiguous states. Trends of temperature as well as precipitation and their appropriate standard deviations have been collected over five 30-year periods and the 70-year period between 1931-2000 for each climate division in a state. Climate divisions, which typically follow county lines, are designed to represent regions within a state that have similar climates. The Fermi 3 facility is located within the Michigan-10 Climate Division.

In general the temperature data in "Climatography of the United States, No. 85" shows little in the way of change or variability over the 70-year period, with both the beginning period of 1931-1960 and the latest time period of 1971-2000 showing an average annual temperature of 9.0°C (48.3°F). Precipitation on the other hand, did show some increase during the 70-year period, especially when compared with the latest 30-year interval. The average precipitation increased from 30.72 inches per year for the 1931-1960 time period to 32.86 inches per year over the 1971-2000 time period.

Temperature and precipitation data for Detroit Metropolitan Airport is available in 20-year increments prior to 2000 and individually for the years 2000 – 2009 through the Detroit Office of the National Weather Service (NWS). Climatological data for Detroit starting in 1920 was examined. A comparison of 1980-2000 Detroit temperature data with 1971-2000 "Climatography of the United States, No. 85" data shows a warm bias of 0.1C° (1.3F°) for the Detroit area. Much of the temperature bias between Detroit and the rest of its climatic region can likely be attributed to an urban heat island effect inside the Detroit Metropolitan area. The precipitation data for the same 1980-2000 period for Detroit is also slightly higher when compared to 1971-2000 "Climatography of the United States, No. 85" data.

The statistics found on the Detroit National Weather Service website for the Detroit Metropolitan Airport were not indicative of any type of trend in the annual average temperature between the 1920-1940 period and the 1980-2000 period. Average annual temperatures did, however show an increase of slightly less than 0.5C° (1F°) for the 2000-2009 period when compared with the 1980-2000 period for the Detroit Metropolitan Airport. Precipitation however, much like with the "Climatography of the United States, No. 85" data, did show an increase when comparing the 1920-1940 period with the 1980-2000 period: the average annual precipitation increased from an average of 30.4 inches to 33.9 inches, respectively. The upward trend in average annual precipitation continues in the 2000-2009 period, which has averaged 34.1 inches of precipitation per year.

Besides the use of average statistics, extreme temperatures as well as extreme precipitation events will also show trends when it comes to climate change. FSAR Table 2.3-206 shows individual station records and dates for several First Order NWS stations as well as Cooperative Observation Program (COOP) stations in the Fermi 3 region. Detroit, Ann Arbor and Adrian have data sets that go back over 100 years, while the data sets for Windsor, Monroe, Toledo and Flint all go back more than 50 years. The dates for extreme maximum and minimum temperatures do not show any discernable trend, if in fact; most of the extreme high and low temperatures occurred more than 30 years ago. Like the temperatures, many of the extreme precipitation events including maximum 24-hour and monthly precipitation, minimum monthly precipitation, as well as maximum 24-hour and monthly snowfall totals also occurred more than 30 years ago, therefore not indicating any type of extreme precipitation trend.

Another possible indication of climate change would be statistics for the number of severe weather events occurring in a particular region. FSAR Section 2.3.1.3.1 contains subsections for thunderstorms, tornadoes, high winds and hail that present statistical trends for these severe weather phenomena. These subsections come to the general conclusion that no discernable trends are seen in the severe weather events that can't be primarily explained by a simple increase in communication techniques in the more recent years.

An evaluation of historical data identified no discernable trends in extreme temperatures, precipitation or severe weather. Since no discernable trends in extreme weather data representing site conditions were identified, the data presented here and in other FSAR Sections appropriately characterizes the climate of the region. As such, the derivation of the probable maximum events covering the period of operation of the proposed new unit and beyond are considered to be substantiated and to remain bounded by the design values as this type of return period goes beyond the design life of the proposed new unit.

As shown in FSAR Table 2.0-201, the Fermi site specific meteorological parameters are within the associated parameters specified in the ESBWR DCD, Rev. 6.

Proposed COLA Revision

FSAR Section 2.3.1.3 will be revised to add a subsection containing a discussion of potential changes in the climate as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 7 page(s))

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

2.3 Meteorology and Air Quality

2.3.1.3.8

This section describes the general climate of the Fermi site and the surrounding regional meteorological and air quality conditions. This section also documents the range of meteorological conditions that would likely exist during the construction and operation of Fermi 3. Data presented includes a climatological summary of normal and extreme values of several meteorological parameters recorded by National Weather Service (NWS) meteorological instruments located in Detroit (Detroit Metropolitan Airport) and Flint, Michigan, Toledo, Ohio and the Fermi onsite meteorological station. Supplemental meteorological data from four NWS Cooperative Observation Program (COOP) stations with data sets dating back 30 years or more were also added to the analysis of the region surrounding the Fermi site. Air quality data obtained from the Michigan Department of Environmental Quality (MDEQ) monitors was also used to discuss the regional air quality surrounding Fermi 3. The regional climate and air quality conditions that surround the Fermi site are described in Subsection 2.3.1 and Subsection ~~2.3.1.3.7~~ 3, respectively. Details regarding severe weather conditions that are observed in the Fermi region are provided in Subsection 2.3.1.3.1, while the description of the local meteorology and topographic description for the Fermi site is located in Subsection 2.3.2 and Subsection 2.3.2.2, respectively. Subsection 2.3.3 provides a description of the Fermi onsite meteorological monitoring program that collected the meteorological data used to describe the onsite meteorological conditions. Short- and long-term diffusion estimates of radiation, as they relate to dose concentrations to the public and surrounding area are presented in Subsection 2.3.4 and Subsection 2.3.5.

EF3 COL 2.0-7-A

2.3.1 General Regional Climate

The following climatology for Fermi 3 uses data from the NWS first-order stations at Detroit Metropolitan Airport, Toledo, and Flint, as well as four NWS COOP stations located within 80.5 km (50 mi) of the Fermi site. The above stations have long return periods of meteorological parameters that provide the regional climatology representative of the Fermi region. The meteorological data obtained for this climatology were collected and processed by the National Oceanic and Atmospheric Administration's

Add Insert "1" Here

2.3.1.3.7

~~2.3.1.3.6~~ Ultimate Heat Sink

The Ultimate Heat Sink (UHS) for the Fermi 3 ESBWR does not require an external source of safety-related cooling water. The UHS function is provided by safety systems integral and interior to the reactor plant. These systems have no cooling towers, basins, or cooling water intake/discharge structures external to the reactor plant. The Fermi 3 ambient temperature values for the reactor building that were provided in Subsection 2.3.1.3.5 are bounded by the maximum and minimum dry-bulb temperature, as well as the maximum wet-bulb temperatures that are cited in DCD Table 2.0-1. A detailed description of the location and operation of the UHS is provided in Subsection 9.2.5.

2.3.1.3.8

~~2.3.1.3.7~~ Regional Air Quality

2.3.1.3.8.1

~~2.3.1.3.7.1~~ Background Air Quality

The Fermi site is located in the northeastern tip of Monroe County and along the western shoreline of Lake Erie. Air quality at the Fermi site is heavily influenced by the Detroit and Toledo Metropolitan areas and surrounding emission sources. The MDEQ evaluates the air quality in the Detroit Metropolitan area with a network of monitors mostly located in Wayne County, north of the Fermi site. The MDEQ routinely monitors the U.S. Environmental Protection Agency (EPA) criteria pollutants of NO2, SO2, CO, PM2.5, PM10, and Ozone. Monroe County is a member of the Air Quality Control Region (AQCR) that includes the counties of the Detroit metropolitan area that are ruled as a non-attainment area for the EPA's annualPM2.5 and 8-hour ozone standard (Reference 2.3-241). The EPA as of March 12, 2008 strengthened the definition of ozone non-attainment areas as those that record a 3-year average of the fourth-highest daily maximum 8-hour average ozone concentration of 0.075 parts per million (ppm) or higher (Reference 2.3-242). For PM2.5 the EPA considers areas in violation of the standard when the 3-year average of the weighted annual mean PM2.5 concentration is equal to or exceeds 15 mg/m3.

Maximum concentrations for the annual average of PM2.5 and 8-hour ozone pollutants were obtained from monitors in Monroe and Wayne County. The highest annual PM2.5 concentration reported between 1999 and 2006 is 20.1 mg/m3, occurring at the Dearborn monitor located west of downtown Detroit (Reference 2.3-243). During the same five-year period, the highest 8-hour ozone concentration recorded was 104 ppb

Insert 1:

2.3.1.3.6 **Potential Changes in Climate**

Natural climate variation is cyclical phenomenon that deviates on both a time and spatial scale. Prediction of these events over any length of time on a global scale is often speculative at best. The uncertainty is especially compounded when referring to specific areas or locations.

A large resource of historical climatic data allows for the evaluation of climate conditions and thus climate changes over the expected life span of Fermi 3. Long-term historical temperature, precipitation and storm data including both normal and extreme conditions that may affect plant operation and design are readily available for the region.

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(0.104 ppm), measured at the East Seven Mile monitor located in northeastern Wayne County (Reference 2.3-244). The next closest non-attainment area for a EPA criteria pollutant is Lorain County, Ohio which is part of the Cleveland Metropolitan air shed (also non-attainment for ozone and PM2.5), located approximately 96.6 km (60 mi) east-southeast of the Fermi site (Reference 2.3-241). There are no Class I Areas that are located within 300 km (186.5 mi) of the Fermi site (Reference 2.3-245). Given the minor nature of air emissions associated with operations of Fermi 3 (discussed below), this distance is sufficiently far as to not warrant a concern.

2.3.1.3.8.2

~~2.3.1.3.7.2~~ Projected Air Quality

Air emissions of criteria pollutants will be minor given the nature of a nuclear facility and its lack of significant gaseous exhausts of effluents to the air. Sources of air emissions for Fermi 3 include two standby diesel generators, an auxiliary boiler, and a diesel fire pump, as well as a natural draft cooling tower (NDCT) and two multi-cell mechanical draft cooling tower (MDCT). The combustion sources mentioned above will be designed for efficiency and operated with good combustion practices on a limited basis throughout the year (often only for testing). Given their small magnitude of size and infrequent operation, these emissions will not only have little effect on the nearby ozone and PM2.5 non-attainment areas, but will have minimal impact on the local and regional air quality as well. The air emissions from the listed equipment are regulated by the MDEQ.

Construction of Fermi 3 will lead to an increase of vehicular traffic surrounding the Fermi site prior to operations. Furthermore, increased traffic and construction activities will lead to further release of particulates prior to operation of Fermi 3. However, any increase in particulate emissions from vehicles is expected to be minor and remain local to the Fermi site.

The Fermi 3 cooling towers will not be a source of the typical combustion-related criteria pollutants or other toxic emissions. They will, however, emit small amounts of particulate matter as drift. The towers will be equipped with drift eliminators designed to limit drift to 0.001 percent or less of total water flow. Additionally, the primary normal power heat sink (NPHS) for Fermi 3 is a NDCT. The height of the tower will allow for good dispersion of the drift and not allow localized concentrations of particulate matter to be realized. The minor nature of the effects of the new cooling towers on visibility and air quality, including potential for increases in ambient temperature and moisture, icing, fogging, and salt deposition, are discussed in further detail in Subsection 2.3.2.2.

2.3.1.3.8.3

~~2.3.1.3.7.3~~ Air Stagnation

The main components of air stagnation are light winds and weak vertical mixing. Light winds can also be associated with weak or poor horizontal mixing of the atmosphere which has the general effect of leading to restrictive horizontal and vertical dispersion and thus air stagnation (Reference 2.3-246). Along with wind speed, wind direction plays a key roll in horizontal mixing as winds with non-persistent directions can also lead to poor dispersion, especially under light wind speeds when the air may re-circulate. Finally, temperature inversions are also associated with little to no vertical mixing of the atmosphere and, therefore, air stagnation. Analyses of inversions are discussed in Subsection 2.3.2.1.8 while the persistence of wind speeds and directions are covered in Subsection 2.3.2.1.6.

Air stagnation episodes typically occur when high pressure systems (anti-cyclones) have a strong influence on the regional weather for four days or more. These systems often lead to generally light winds and little vertical mixing due to a general sinking of the air in their vicinity. The region surrounding the Fermi site can expect approximately 10 days per year of air stagnation, or two episodes per year (Reference 2.3-246). The mean duration of each air stagnation episode typically is three to four days.

Air stagnation conditions primarily occur during the second half of the summer and early fall seasons that runs from July through September. This is a result of the migration of the storm track to areas well north of the Fermi site, which creates weaker pressure and temperature gradients, and therefore weaker wind circulations during this period. Wang & Angell confirm that air stagnation episodes in the region surrounding the Fermi site begin to occur in June and July (Reference 2.3-246). The number of air stagnation episodes reaches a maximum during August before decreasing in magnitude during September and October. During the fall season the storm track moves south and positions itself over southeastern Michigan and increases the

Table 2.3-206 Climatological Extremes for National Weather Service First-Order and Cooperative Observation Stations Surrounding the Fermi Site

[EF3 COL 2.0-7-A]

Parameter	Monroe	Detroit [1]	Windsor, ON	Ann Arbor (Univ. of Michigan)	Toledo, OH	Adrian [2] NNE	Flint
Maximum Temperature	106 (A) (1934) (1988)	105 (B) (1934)	104 (D) (1988)	105 (A) (1934)	~~105~~ 104 (E) (1995)	108 (A) (1934) (1936)	101 (G) (1995)
Minimum Temperature	-21 (A) (1918)	-24 (B) (1872)	-20 (D) (1994)	-23 (A) (1885)	-20 (F) (1984)	-26 (A) (1892)	-25 (G) (1976)
Max 24-hr Precipitation (inches)[2]	4.22 (A) (1931)	4.78 (C) (1947)	3.72 (D) (2000)	4.54 (A) (1998)	~~5.98~~ 4.39 (E) (1969)	4.74 (A) (1981)	6.04 (G) (1950)
Max Monthly Precipitation (inches)	9.03 (A) (2007)	8.76 (B) (2004)	N/A --	10.78 (A) (2002)	9.19 (F) (2006)	~~10.26~~ 11.17 (A) (1943)	11.04 (G) (1975)
Max 24-hr Snowfall (inches)	20.0 (A) (1974)	24.5 (B) (1886)	14.5 (D) (1965)	20.0 (A) (1894)	~~19.0~~ 13.9 (E) (1974)	15.0 (A) (2000)	19.8 (G) (1967)
Max Monthly Snowfall (inches)	29.0 (A) (1978)	38.4 (B) (2008)	N/A --	58.5 (A) (1923)	30.8 (F) (1978)	34.5 (A) (1978)	35.3 (G) (2000)

1. Extreme values for Detroit were observed in the vicinity of the meteorological stations at Detroit City Airport and Willow Run Airport.
2. The highest reported 24-hour precipitation amount for COOP stations was reported at Grosse Pointe Farms in July 1976 with a value of 5.13 inches.(H)

Source A: Reference 2.3-210
Source B: Reference 2.3-211
Source C: Reference 2.3-212
Source D: Reference 2.3-205
Source E: Reference 2.3-203
Source F: Reference 2.3-213
Source G: Reference 2.3-202
Source H: Reference 2.3-214

Parameter	Monroe	Detroit [1]	Windsor, ON	Ann Arbor (Univ. of Michigan)	Toledo, OH	Adrian [2] NNE	Flint
Min Monthly Precipitation (inches)	0.03 (A) (1987)	0.13 (B) (2005)	–	0.00 (A) (1894)	0.27 (F) (2005)	0.00 (A) (2004)	0.07 (G) (1945)

Attachment 15
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4122)

RAI Question No. 02.03.02-1

NRC RAI 02.03.02-1

Please review and explain the ratios between 10-m and 60-m onsite wind speeds.

Staff experience indicates 60-m wind speeds are typically 1.2-1.6 times the magnitude of the 10-m wind speed during the day and twice or higher the magnitude at night. The Fermi wind roses appear to show approximately a factor of 2 difference for all hours combined, whereas the staff would expect more like a factor of 1.5-1.7. Please elaborate on the reason for differences of ratios between 10-m and 60-m wind

Response

Southeastern Michigan is in a location where the Polar Jet Stream Front (Polar Jet) is typically located over or near the region during the fall through spring periods. Even during the summertime a weakened version of the Polar Jet frequently moves over the area. The importance of the Polar Jet location lies in the vertical shear profile it creates. A vertical shear results in wind speeds that increase in speed at a more rapid pace in relation to elevation than would be expected in the absence the presence of the Polar Jet. The Polar Jet typically moves across southeastern Michigan in a general west to east direction. This phenomenon leads to potentially higher 60 meter wind speeds, and thus higher speed ratios between the 10 meter and 10 meter levels, especially in high wind situations associated with west or southwest winds.

Analysis of annual wind speed ratios between the 10 meter and 60 meter levels for the 2001-2007 period were conducted for onshore winds (i.e. winds clockwise from 50 to 190 degrees) and for offshore winds (i.e. winds clockwise from 191 to 49 degrees). The results concluded that the average wind speed ratio between 10 meter and 60 meter level for onshore winds was 1.71, while the average wind speed ratio between 10 meter and 60 meter level for offshore winds was 2.40. The lower wind speed ration between 10 meter and 60 meter level for onshore winds is a direct result of localized solar heating of the lower elevations of the onshore air mass during the height of afternoon sun resulting in greater vertical mixing and thus producing a lower speed ratio between 10 meter and 60 meter levels.

Another potential cause of the higher wind speed ratios between the 10 meter and 60 meter levels could be the tree growth to the northwest, west and southwest of the meteorological tower. Given the relative heights of the trees, the trees can potentially reduce the wind speed sensed at the 10 meter level and not at the 60 meter level resulting in a higher ratio of the two wind speeds. The wind speed ratio between the 10 meter and 60 meter levels was also analyzed on a monthly basis for all wind directions. This study indicated that wind speed ratios are highest during the late spring, summer and early fall seasons. The increase in the wind speed ratio between 10 meter and 60 meter levels correlates well with the outgrowth of leaves on the deciduous trees to the northwest, west and southwest of meteorological tower. These analyses show that the trees appear to have an affect on wind speeds at the 10 meter level. The response to RAI-02.03.03-1 in Attachment 21 discusses the impacts of the apparent increasing frequency of low wind speed observations due to the flow blockage potentially resulting from the trees to the west of the Fermi meteorological tower.

Proposed COLA Revision

None

Attachment 16
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4122)

RAI Question No. 02.03.02-2

NRC RAI 02.03.02-2

Did the contents of FSAR Figure 2.3-204 change from a precipitation rose in Revision 0 to a wind rose in Revision 1?

Response

During the insertion of the text "[EF3 COL 2.0-8-A]" as part of Revision 1 to FSAR Figure 2.3-204, the precipitation rose graphic for Figure 2.3-204 was replaced, in error, with the wrong graphic, a wind rose.

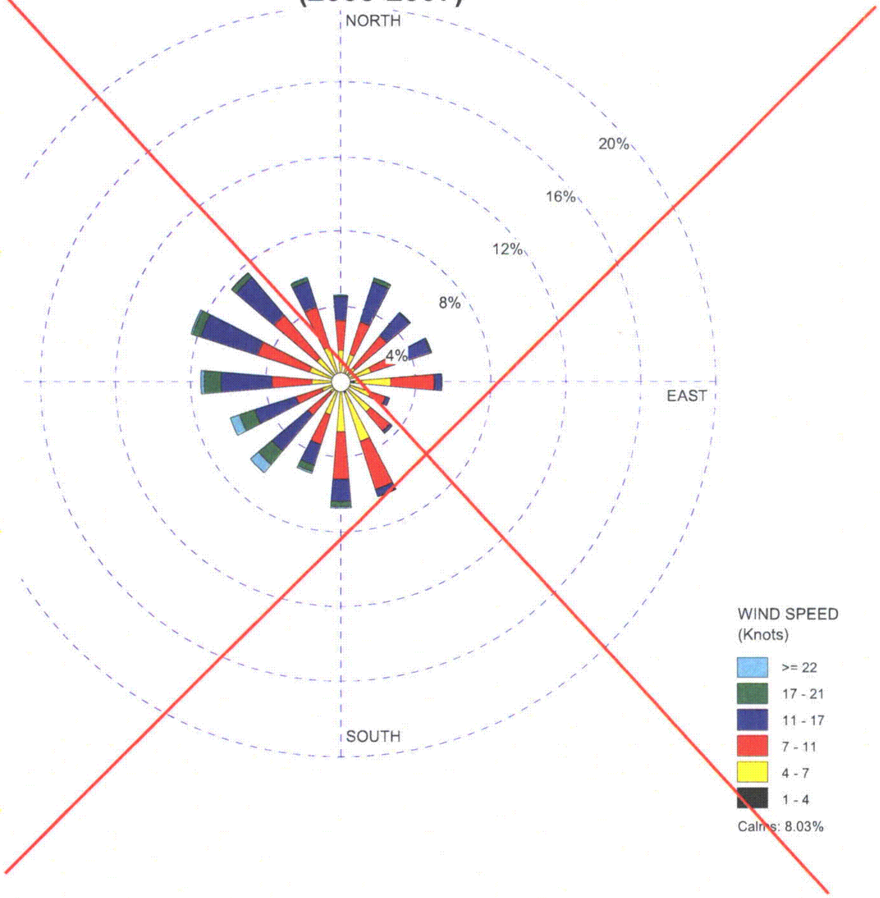
Proposed COLA Revision

The precipitation rose from FSAR, Revision 0 will be properly used for FSAR Figure 2.3-204 as shown in the proposed markup.

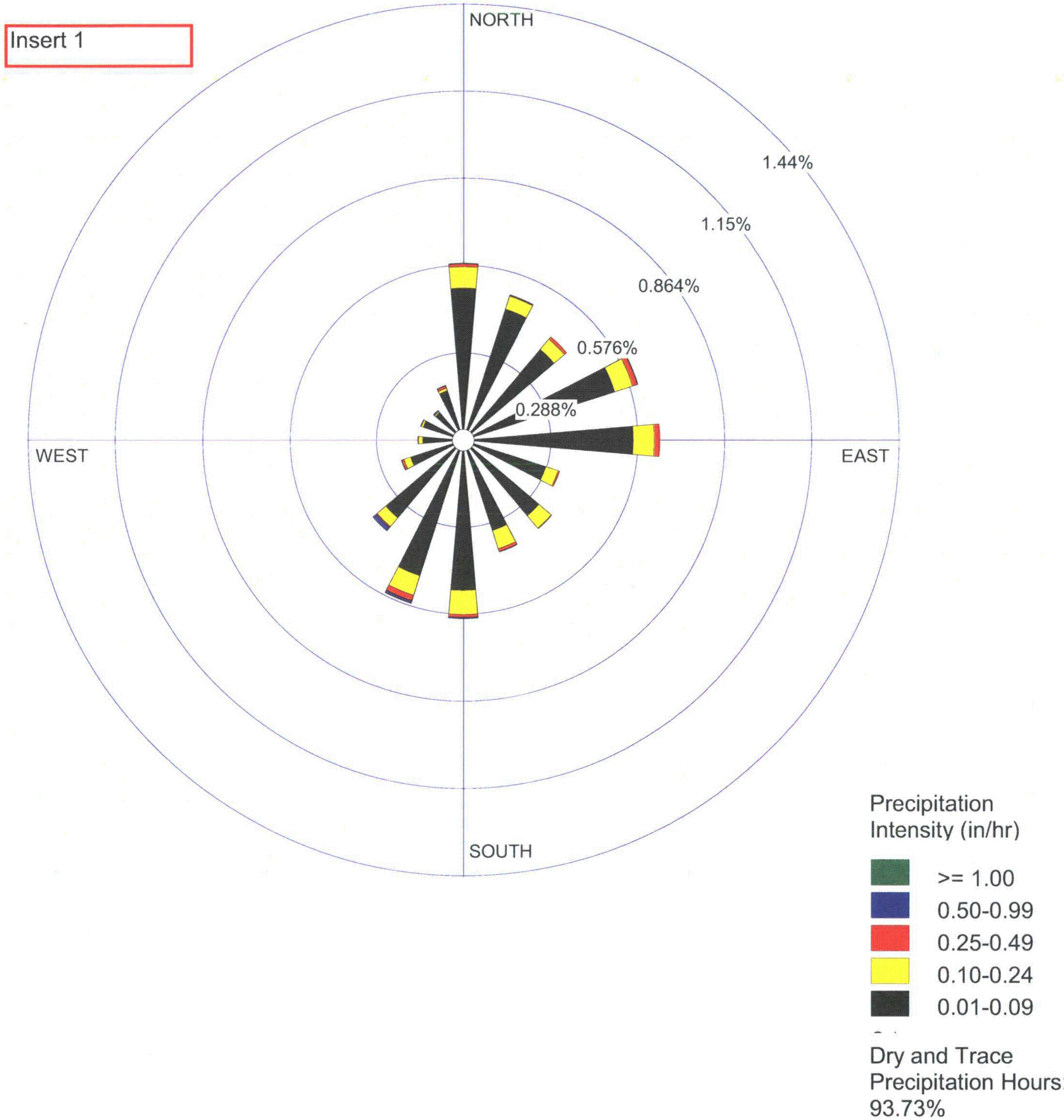
Markup of Detroit Edison COLA
(following 2 page(s))

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

Figure 2.3-204 Detroit Metropolitan Airport Annual Precipitation Rose (2003-2007) [EF3 COL 2.0-8-A]



Source: Reference 2.3-229, Reference 2.3-247


Insert 1
NORTH
WEST
EAST
SOUTH
1.44%
1.15%
0.864%
0.576%
0.288%
Precipitation Intensity (in/hr)
>= 1.00
0.50-0.99
0.25-0.49
0.10-0.24
0.01-0.09
Dry and Trace Precipitation Hours: 93.73%

Attachment 17
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4122)

RAI Question No. 02.03.02-3

NRC RAI 02.03.02-3

Please describe the methodology used to generate the Detroit Metropolitan Airport wind and precipitation roses presented in FSAR Figures 2.3-204 through 2.3-229.

The FSAR presents monthly and annual precipitation and wind roses for the Detroit Metropolitan Airport for the period 2003-2007. Wind directions in the Integrated Surface Hourly Data (ISHD) that were used to develop these figures are reported in the nearest 10 degrees. However, the precipitation and wind roses plotted from these data bin the wind directions into sixteen 22.5° sectors, which means the data are typically more concentrated in the four cardinal directions (N, E, S, and W). Please indicate in the FSAR if a randomization scheme was applied to the ISHD raw data to generate the Detroit Metropolitan Airport wind roses.

Response

FSAR Section 2.3.2.1.3 and 2.3.2.1.5 discuss the precipitation and wind roses for Detroit Metropolitan Airport during the period 2003-2007. Hourly raw wind direction and raw wind speed data obtained in Integrated Surface Hourly Data (ISHD) format, where the wind direction from the raw data is reported to the nearest 10 degrees. In order to prevent a directional bias for the four cardinal wind directions (N, E, S, and W), a randomization of the wind direction is necessary. The hourly wind direction and wind speed data was input into PCRAMMET (EPA-454/B-96-001, 1996) which converts all wind directions to flow vectors within the range of 0 to 360 degrees. PCRAMMET then randomizes these flow vectors by adding a random integer number of azimuth degrees between -4 and 5 degrees. The resulting flow vectors have an equal probability of occurring anywhere between the 10 degree range, thus incorporating the natural fluctuation of wind direction. The PCRAMMET randomized wind directions were then used to generate the wind and precipitation roses for Detroit Metropolitan Airport presented in FSAR Figures 2.3-204 through 2.3-229.

Proposed COLA Revision

FSAR Section 2.3.2.1.3 and 2.3.2.1.5 will be revised to clarify the methodology used to generate the Detroit Metropolitan Airport wind and precipitation roses as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 4 page(s))

The following markup represents how Detroit Edison intends to reflect this RAI response in the next submittal of the Fermi 3 COLA 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 equal to or greater than the 100-year recurrence interval values in Table 2.3-214.

for Detroit Metropolitan Airport

Precipitation Wind Roses

Add Insert "1" Here

Monthly and annual precipitation roses were created to correlate hourly precipitation with wind direction for the Fermi region during the 2003-2007 timeframe and are presented in Figure 2.3-204 through Figure 2.3-216. As shown in Figure 2.3-204, annually the majority of hourly precipitation events, regardless of intensity, occur when winds are from the east and east-northeast with secondary maximum occurring equally from the north and south directions. As can be seen in both Table 2.3-213 and Figure 2.3-204, a significant amount of the hourly precipitation events were less than 0.25 cm (0.10 inches). In addition, it appears from the annual precipitation rose that winds from the southwest and south-southwest yield the highest percentage of hourly rainfall events with intensities greater than 1.27 cm (0.50 inches).

Snowfall

Mean annual snowfall, as well as 24-hour snowfall and maximum monthly values were discussed in Subsection 2.3.1.2.4. Table 2.3-205 and Table 2.3-206 present climatological normal and extreme values of snowfall, respectively, for the first-order and COOP stations in the region of the Fermi site. As indicated in these tables, annual amounts of snow vary greatly amongst the stations, and the region is characterized by heavy snow events. The highest 24-hour snowfall is 62.2 cm (24.5 inches) at the Detroit City Airport located north-northeast of the Fermi site, occurring during April 1886 (Reference 2.3-211). The highest 2- and 3-day and maximum monthly snowfall is 56.6 and 148.6 cm (22.3 and 58.5 inches), respectively, which occurred at Flint and Ann Arbor, respectively (Reference 2.3-210, Reference 2.3-237).

2.3.2.1.4 **Fog and Smog**

Fog

Fog is reported at NWS first-order stations when the horizontal visibility is less than or equal to 9.7 km (6 mi) and the difference between the temperature and dew-point is 5°F or less. Detroit Metropolitan Airport is the nearest NWS station that routinely observes visibility and fog. Detroit Metropolitan Airport is located 27.4 km (17 mi) north-northwest of the Fermi site and has a similar elevation and relative proximity to Lake Erie.

Insert 1)

A randomization scheme using EPA's computer program PCRAMMET was applied to the hourly wind direction data used to create the precipitation roses to eliminate the typical concentration toward the four cardinal directions (i.e., N, E, S, and W).

Wind Roses-Detroit Metropolitan Airport

Figure 2.3-217 through Figure 2.3-229 contain the 10-m annual and monthly wind roses presenting the distribution of wind speed at 22.5 degree intervals for Detroit Metropolitan Airport during the 5-year period of 2003-2007 (Reference 2.3-229). ← Add Insert "2" Here

The annual wind rose plot in Figure 2.3-217 shows that winds at Detroit Metropolitan Airport predominantly blow from southwesterly directions. According to the annual 2006 LCD, the prevailing wind direction for Detroit Metropolitan Airport is from 240 degrees (west-southwesterly) (Reference 2.3-201). Monthly wind roses for Detroit Metropolitan Airport are presented in Figure 2.3-218 to Figure 2.3-229. The transition is apparent from dominant northwesterly and northerly winds during the spring months to southwesterly wind directions during the summer through fall months as the Bermuda High develops over the southeast United States and the storm track shifts north of the Fermi region. During May through September, the number of calm hours increase and the wind directions often become light and variable as the synoptic scale pressure gradient weakens, corresponding with the months having the highest number of air stagnation episodes (Reference 2.3-246). Detroit Metropolitan Airport considers calm hours as those with wind speeds less than three knots. As the storm track begins to move south and closer to southeastern Michigan during late the fall and winter, northwesterly and westerly wind directions become more frequent.

Wind Roses-Fermi 10-m Level

Annual and monthly wind roses for the 10-m level at the Fermi site are depicted in Figure 2.3-230 through Figure 2.3-242. These figures show wind speeds and directions at 22.5 degree intervals by direction at the Fermi site for the 2003 through 2007 time period.

Figure 2.3-230 indicates that annually winds are southwesterly most often, occurring approximately 10 percent of the time. Winds with a northwesterly component are the second most common direction for the 10-m level at the Fermi site. Apparent is the increase of easterly and southeasterly winds annually at the Fermi site when compared to Detroit Metropolitan Airport at the same level. During the late spring, summer, and early fall, onshore lake breezes occur frequently at the Fermi site. The breezes form as air temperatures over land heat up faster than the air above the waters of Lake Erie. By afternoon a sharp temperature

Insert 2)

A randomization scheme using EPA's computer program PCRAMMET was applied to the hourly wind direction data used to create the wind roses to eliminate the typical concentration toward the four cardinal directions (i.e., N, E, S, and W).

Attachment 18
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4122)

RAI Question No. 02.03.02-4

NRC RAI 02.03.02-4

Please provide more inform in FSAR Subsection 2.3.2.2.1 regarding inputs to the SACTI cooling tower model analysis.

a. *Update the FSAR to describe and justify how atmospheric stability was provided as input to the SACTI cooling tower model analysis.*

   Subsection 5.3.3.1 "Heat Dissipation to the Atmosphere" of the Fermi 3 COLA Environmental Report states meteorological data elements from onsite and Detroit Metro Airport were combined into the appropriate CD-144 format for input into the SACTI cooling tower model. Neither the FSAR nor ER mentions how the stability classes are calculated; i.e., using the onsite delta-T data or the cloud/wind data at Detroit Airport. The cloud/wind data methodology at Detroit Metro Airport is expected to generate more frequent neutral conditions and less frequent unstable and stable conditions as compared to the onsite delta-T data. Consequently, behaviors of cooling tower plumes would be expected to be somewhat different between the two data sets because of the difference in stability class distributions. Please specify whether the stability classes are from the onsite delta-T data or cloud/wind data at Detroit Airport. For the former, specify how the onsite delta-T data were converted into cloud/wind data in the CD-144 format. For the latter, please compare the SACTI results using the different stability calculation schemes.

b. *Update the FSAR to justify the use of a surface roughness of 100 cm as input to the SACTI cooling tower model analysis.*

   Subsection 5.3.3.1 "Heat Dissipation to the Atmosphere" of the Fermi 3 COLA Environmental Report states a surface roughness of 100 cm was selected based on the general obstruction profile typical of industrial facilities. The U.S. EPA Guidance on Air Quality Models (Appendix W to 40 CFR Part 51) suggests that urban versus rural input to dispersion modeling depends on the general land use within a 3-km radius from the source. If industrial, commercial, or compact residential land use types account for 50% or more, the area is assigned as urban. If not, the area is assigned as rural. The nearby area around the Fermi site is an industrial complex but the farther area is agricultural land or water bodies. The area of interest is somewhere between urban and rural. Please justify using a surface roughness of 100 cm, including discussing the difference in results between assuming an urban environment versus a rural environment.

c. *Justify the use of mean monthly mixing heights as inputs to the SACTI cooling tower model analysis.*

   FSAR Subsection 2.3.2.2.1 states mean monthly morning and afternoon mixing height data were input to the SACTI model, even though daily morning and afternoon mixing height data are available. Please justify using mean monthly morning and afternoon mixing height data instead of daily mixing data, including discussing the difference in results between the two methods.

Response

a. *Update the FSAR to describe and justify how atmospheric stability was provided as input to the SACTI cooling tower model analysis.*

The SACTI cooling tower modeling analysis presented in the FSAR Sections 2.3.2.2.1 and 2.3.2.2.2 was performed using a CD-144 formatted meteorological data set comprised of both onsite data and data recorded at the Detroit Metropolitan Airport. As discussed in FSAR Section 2.3.2.2.1, the five-year hourly data set was made up of wind direction, wind speed, dew-point temperature, and dry-bulb temperature measurements from the existing on-site meteorological tower at 10- and 60-meter heights and atmospheric pressure, ceiling height, and cloud cover from the Detroit Metropolitan Airport.

The preprocessor code of SACTI is capable of handling three meteorological formats: CD-144, TDF-14, and NRC. CD-144 and TDF-14 formats are produced by the National Climatic Data Center (NCDC) and contain basically the same meteorological variables. According to the SACTI user's manual (EPRI CS-3403-CCM, 1984), the NRC format is that which is "recommended by the NRC," but no format example or references to any formatting guides such as Reg Guide 1.23 are provided in the manual to clarify the exact format expected by SACTI. For this reason, for the remainder of this response, when the term "NRC" appears in quotes, it represents the title of a data format allowable in SACTI and not the official meteorological format published by the NRC in Appendix A of Reg Guide 1.23.

When CD-144 format is selected as the meteorological input to SACTI, as was done in the FSAR analysis, stability class is based on measured wind speed (onsite), ceiling height (airport), cloud cover (airport), solar elevation angle (based on Fermi latitude/longitude), and time of day. When the "NRC" format is selected as the meteorological input to SACTI, the temperature lapse rate, computed from the upper and lower dry-bulb temperature sensors, is used to derive stability.

The "NRC" data format was not selected for input of the meteorological data in the SACTI model for the following reasons:

1. The FORTRAN code of the SACTI model is no longer maintained giving rise to a data mismatch between current NRC-requested onsite meteorological data format and that expected by the SACTI code when selecting "NRC" as the meteorological data format type. While the NRC meteorological data format presented in Appendix A of Reg Guide 1.23 may have once matched the meteorological data format expected by the SACTI code (upon selection of the format type as "NRC" in the model), that is no longer the case. For example, the meteorological data file input to the SACTI model expects the dew-point temperature to be written not into the "moisture" column, but rather into the "other" data column as presented in Appendix A of Reg Guide 1.23. In order for SACTI to accept the meteorological data in "NRC" format, the dew-point temperature must be moved from its current position in the Reg Guide 1.23 format as "moisture" over to the "other" data column.

2. The SACTI model is not extremely robust when it comes to execution of its code. After making the above change in dew-point variable location, the SACTI model processes the meteorological data without error, but then terminates prematurely during the plume execution code. The SACTI model, being programmed without forethought to user-friendly error messages, does not give the user any indication why or where it terminated. It is possible that somewhere in the 5 years of hourly data, when a combination of meteorological variables is encountered that doesn't fit one of the preprogrammed plume categories, the code terminates, but again no information is provided upon termination. Only two of the five years of onsite data (2005-2006) in "NRC" format execute successfully in the model compared with all five years of known and well documented CD-144 formatted data executing fully.

Regardless, transposing dew-point to the SACTI-expected column rather than the Reg Guide 1.23 - Appendix A location for dew-point and executing two years of meteorological data in the "NRC" format, a sensitivity analysis was performed against the five years of CD-144 formatted data (results of which are presented in the FSAR). That analysis indicated no significant changes in model-predicted results between the two data sets. Parameters such as maximum annual and seasonal plume length and average hours per year of shadowing showed a decrease in impacts when using the "NRC"-formatted meteorological data compared to the results presented in the FSAR. A more critical parameter such as maximum annual and seasonal salt deposition showed no change between the two data sets. The "NRC" formatted meteorological data set did produce a slight increase in maximum annual water deposition as compared to the results presented in the FSAR. However, both impacts continue to be extremely low resulting in no measurable change to the additional precipitation analysis when converting the model-predicted results of kilogram per square kilometer per month into millimeters per month.

The use of the CD-144 formatted meteorological data set and its subsequent results presented in the FSAR remains a representative and valid analysis of the potential impacts of the proposed new Fermi 3 natural draft cooling tower (NDCT).

It may also be of interest to note that one of the reasons that large differences in model-predicted impacts were not seen between the two data set formats, stability is computed differently for each data format, is that, according the SACTI user's manual, stability class has been relegated to the status of a secondary parameter for choosing plume categories. Further, the user's manual presents a fogging and icing study where the ambient stability did not affect the model predictions significantly and was actually neglected for the study.

b. *Update the FSAR to justify the use of a surface roughness of 100 cm as input to the SACTI cooling tower model analysis.*

SACTI showed no sensitivity in the selection of surface roughness height between 10 and 100 cm for a NDCT analysis. The 100 cm surface roughness value used in the analysis is simply representative of the Fermi facility proper due to its large obstructions to wind flow such as the existing Fermi 2 NDCTs and existing and proposed reactor and turbine buildings.

As for the selection of rural versus urban landuse type, the model only requests such explicit input in the selection of the mixing height interpolation scheme. Prior to the recent update in air dispersion modeling theory with the release of models such as AERMOD (EPA "AERMOD Implementation Guide", 2009) which no longer use rural and urban distinctions), it was generally acceptable to classify an area as rural or urban based on the Auer landuse method (Auer 1978) of circumscribing an area within a 3 kilometer radius around the proposed source location. Using the Auer landuse method, it was determined that more that 50 percent of the land within 3 kilometers of the NDCT is classified as rural. As such, the rural selection in the mixing height interpolation scheme was used in the modeling.

Auer, August H. Jr., "Correlation of Land Use and Cover with Meteorological Anomalies," Journal of Applied Meteorology, pp. 636-643, 1978.

c. *Justify the use of mean monthly mixing heights as inputs to the SACTI cooling tower model analysis.*

The SACTI model is endorsed by the NRC in NUREG-1555, Section 5.3.3.1, as an acceptable model for the evaluation of cooling tower impacts. The SACTI user's manual indicates that average mixing heights such as seasonal or annual may be used as an alternative to the National Weather Service (NWS) bi-daily measurements and gives no further indication of model's lacking performance in doing so. The manual goes on to provide such average mixing height data along with other monthly average variables such as Clearness Indices and Solar Insolation values for use in the SACTI model.

Monthly average mixing height data was chosen to simplify the analyses since twice-daily mixing height data received from the National Climatic Data Center (NCDC) which undoubtedly contains missing height values periodically throughout the dataset. Averaging the mixing height values on a monthly basis avoided data filling/substitution while maintaining a reasonable breakdown of the variations in mixing heights experienced in the region throughout the year. The averaging of monthly mixing heights also provided the model with higher mixing height values versus certain instances of lower twice-daily mixing height values which showed that approximately 30 percent of the twice-daily mixing height values were below the SACTI-calculated average plume height. Dispersion theory suggests that in those instances, the cooling tower plume would be emitted above the mixing height into the isothermal and more laminar layer of the atmosphere, theoretically reducing the chance of plume touchdown and thus impacts.

Finally, analyses performed by SACTI are accumulated over seasonal, annual, or other cumulative meteorological data period time frames. That is, results are not presented on an hourly output basis. Results are rolled up to averages or totals over larger time frames than the average monthly mixing height data used as input to the model suggesting that the monthly resolution of a parameter such as mixing height is adequate for use in the modeling analyses.

Regardless, a mixing height sensitivity analysis was performed using twice-daily mixing heights versus the monthly average mixing heights used in the modeling presented in the FSAR. That analysis indicated no significant changes in model-predicted results between the two data sets. Parameters such as maximum annual and seasonal plume length, as expected, showed a decrease when using twice-daily mixing height values compared to the results presented in the FSAR. Other parameters such as plume shadowing and the more critical maximum annual and seasonal salt deposition showed no change between the two data sets. The twice-daily mixing height data did produce a slight increase in maximum annual water deposition as compared to the results presented in the FSAR. However, both impacts continue to be extremely low resulting in no measurable change to the additional precipitation analysis when converting the model-predicted results of kilogram per square kilometer per month into millimeters per month.

Given the discussion above, the monthly average mixing height meteorological data set and its subsequent results presented in the FSAR remains a representative and valid analysis of the potential impacts of the proposed Fermi 3 NDCT.

Proposed COLA Revision

FSAR Section 2.3.2.2.1 will be revised to provide a discussion of the use of the CD-144 data format with the SACTI model and the model's calculation of stability class when using this data format as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 2 page(s))

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

of the effects of the cooling tower plumes on the local meteorology is provided in the following sub-section.

compiled into the CD-144 format

2.3.2.2.1 Cooling Tower Plumes

Cooling systems depend on evaporation of water to dissipate heat created from the energy production process. In this cooling process the cooling towers often create visible plumes that can produce effects on the local environment. The visible plumes can produce shadows on surfaces such as trees, vegetation and nearby buildings. Cooling tower plumes can also create or enhance ground level fogging or icing, as well as increase salt deposition. An assessment of cooling tower plumes emitted during the operation of a new power production facility at the Fermi site on the local environment and atmosphere was performed. The investigation was performed using the Electric Power Research Institute's Seasonal/Annual Cooling Tower Impact Prediction Code (SACTI), a model endorsed by Section 5.3.3.1 of NUREG-1555 (Reference 2.3-254). The model used meteorological data from the Fermi onsite tower for the available five-year period of 2003 through 2007. The onsite data contains wind direction, wind speed, dew-point temperature, and dry-bulb temperature measurements at 10- and 60-m heights. Since the meteorological tower does not record atmospheric pressure, ~~station pressure~~ data commensurate with the onsite data~~,~~ was taken from Detroit Metropolitan Airport. Using the dry-bulb and dew-point temperature from the Fermi site, as well as the station pressure from Detroit Metropolitan Airport, the required wet-bulb temperature and relative humidity values were calculated (Reference 2.3-240). Mean monthly mixing height values calculated in Subsection 2.3.2.1.7 were also used as inputs for the SACTI cooling tower model analysis.

ceiling height, or cloud cover,

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To assess the potential plume impacts, the NDCT was evaluated for Fermi 3. The cooling tower was modeled as if the power generation process was producing the maximum heat load. Tower-specific data used in the SACTI cooling tower model analysis, such as projected cooling tower dimensions, top exit diameter, and total heat rejection rates, are provided in Table 2.3-285. Since the auxiliary Heat Sink (AHS) will use the two multi-cell MDCTs to dissipate heat from the Plant Service Water System mainly during plant shutdown/cool down, the operation of the two multi-cell MDCTs is expected to be minimal. For this reason, the environmental impact associated with the operation of the two multi-cell MDCTs is bounded by the impacts associated with the NDCT. The

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When CD-144 format is used as the meteorological input to SACTI, the model determines stability class based on measured wind speed, ceiling height, cloud cover, solar elevation angle, and time of day.

Attachment 19
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4122)

RAI Question No. 02.03.02-5

NRC RAI 02.03.02-5

Please update FSAR Subsection 2.3.2.2.2 to provide estimates of the likelihood of drizzle icing effects from the NDCT.

FSAR Section 2.3.2.2.2 addresses icing as a result of fogging from the NDCT plume, but icing resulting from drizzle produced by the NDCT plume is not presented.

Response

FSAR Section 2.3.2.2.2 discusses the enhancement of precipitation events (drizzle and light snow) from the operation of the natural draft cooling tower (NDCT). The references cited in FSAR Section 2.3.2.2.2 indicate that, while drizzle and light snow have been observed downwind of natural draft cooling towers, it is rare and localized. It is appropriate to conclude that the occurrence of freezing drizzle associated with operation of the NDCT occurs less frequently as the surface temperatures have to be at or below freezing for freezing drizzle to occur.

The SACTI model (EPRI CS-3404-CCM, 1984) does not estimate freezing precipitation events, but does predict water deposition which can be compared with historical amounts from natural precipitation events. As presented in FSAR Section 2.3.2.2.2, the water deposition rate from the operation of the NDCT predicted by the SACTI model is less than 0.0001 percent of the mean monthly rainfall of the driest month. This would then result in an even smaller percent contribution when considering freezing conditions and associated precipitation events.

Proposed COLA Revision

The discussion of the potential for icing from drizzle produced by the NDCT in FSAR Section 2.3.2.2.2 will revised as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 4 page(s))

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

also have an effect of lowering the wind speed downwind of the wind direction to a distance of five times the width of the top of the tower. As was mentioned previously in Subsection 2.3.2.2, turbulent wind flow from the cooling towers is expected to affect the onsite meteorological tower. Therefore, the meteorological tower would require relocation in accordance with Regulatory Guide 1.23.

Temperature

The plume that is released from the cooling towers is typically warmer than the ambient air and is mostly dissipated into the atmosphere above the tower height. However, some of the heat is transported downward to the ground downwind of the wind direction. Air temperature at the surface, thereby, is expected to be only slightly warmer within a few hundred feet of the tower. Large plumes may also block the heat from the sun and have the effect of cooling the ambient air at the surface during the day and warming it at night. Once again the effect of the plume on the surface ambient temperature is minimal and cannot be measured beyond a few hundred feet from the tower or plume.

Atmospheric Water Vapor

The vapor plumes increase the absolute and relative humidity values immediately above cooling towers, as indicated by the high frequency of visible plume occurrence. At the surface the absolute humidity only increases slightly as some of the moisture from the plume is transported downward downwind from the cooling tower. During colder temperatures the increase of relative humidity near the cooling tower may be greater due to the relatively lower moisture-bearing capacities of cold air. Overall, the ground level humidity increases from the operation of cooling towers is expected to be very small.

Precipitation

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As presented by Huff, drizzle and light snow have been observed within a few hundred feet downwind of cooling towers (Reference 2.3-255). The occurrence of such precipitation events is rare and much localized. Huff compared the fluxes of water vapor from NDCT and MDCT cooling towers to those natural water vapor fluxes ingested into cloud bases of showers and thunderstorms. His results indicate that some enhancement of small rain showers might be expected, as tower fluxes are within an order of magnitude of the shower fluxes. Thunderstorms, with their much

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From this it can be concluded that the occurrence of freezing drizzle associated with operation of the NDCT would be an even rarer event as the surface temperatures would have to be at or below freezing.

greater flux values, should not be significantly affected, except that the cooling tower plume may act as a triggering mechanism. In addition, discharge of cooling tower moisture has been shown to augment natural precipitation as much as 1.0 cm (0.4 inches) annually for a 2,200-MWe station (Reference 2.3-255). The maximum SACTI model predicted water deposition rate for the Fermi 3 NDCT is approximately 0.00001 mm per month. By comparison, this precipitation rate is less than 0.0001 percent of the mean monthly rainfall of the driest month at Detroit Metropolitan Airport (Reference 2.3-201). Thus, impacts due to water deposition (additional precipitation) are expected to be small at the Fermi site.

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Light snowfall has also been observed at distances downwind from cooling towers. However, induced snowfall events have resulted only in light, fluffy snow accumulations of less than 2.5 cm (1 inch) (Reference 2.3-256). Most induced snowfall observed preceded or occurred during natural snowfall events, occurring when temperatures were very cold and diffusion conditions at plume height were relatively stable. While the Fermi site experiences these conditions, literature indicates that snow amounts are light (less than 2.5 cm [1 inch]) and would be only a small fraction of the typical snowfall the area receives. Therefore, the operation of a NDCT or MDCT cooling tower is not expected to increase average snowfall at the Fermi site.

Fogging and Icing

Ground level fogging and icing occurs when the visible plume from a cooling tower reaches the ground. Studies conducted by Broehl, Zeller, Kramer and Hosler indicated that icing and fogging from a NDCT does not present a significant problem (Reference 2.3-257 through Reference 2.3-260). Zeller in a two year study observed one occurrence where the plume from a NDCT reached the ground.

The SACTI cooling tower model was run to assess the potential for fogging and icing for Fermi 3 as a result of operation of a NDCT. The model assumed that the occurrence of fogging from the NDCT is unlikely and thus does not predict estimates of fogging for the NDCT (Reference 2.3-254). Based upon the above SACTI model predictions, ground level fogging or icing at the Fermi site from operation of the NDCT is not expected to be significant.

MDCT cooling towers emit plumes at a lower level and have a tendency to reach the ground more frequently. Icing may be possible from the

Insert 2:

Further, when considering freezing conditions and associated precipitation events, potential drizzle ice accumulation from operation of the NDCT is immeasurable as evidenced by taking the maximum 0.0001 percent fraction of the highest monthly average precipitation value (of any month having recorded an icing event) of 3.05 inches (April) which results in 0.000003 hundredths of an inch accumulation assuming it is cold enough to result in freezing drizzle conditions (Reference 2.3-201).

Attachment 20
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4122)

RAI Question No. 02.03.02-6

NRC RAI 02.03.02-6

Please revise FSAR Section 2.3.2.2 to address the effects of the natural draft cooling tower moisture and salt deposition on electrical transmission lines and electrical equipment (including transformers and switchyard).

Response

Using the inputs provided in FSAR Table 2.3-285, the SACTI model (EPRI CS-3404-CCM, 1984) predicted average annual and seasonal monthly salt deposition rates for the natural draft cooling tower (NCDT). Due to the high initial plume of the NDCT, no salt is predicted to be deposited within 4,100 meters (13,451 ft) of the NDCT. Given this large distance, no salt deposition is predicted at the existing Fermi 2 switchyard, the planned location of the Fermi 3 switchyard, or the Fermi 3 main transformer area which are all within 4,100 meters of the NDCT.

The maximum SACTI-predicted annual salt deposition rate is 0.01 kilogram per square kilometer per month and occurs between 4,200 and 9,400 meters (13,779 and 30,840 ft) east-northeast of the NDCT. The maximum seasonal impact occurs during the winter with 0.02 kilogram per square kilometer per month predicted to occur between 4,400 and 9,400 meters (14,436 and 30,840 ft) east-northeast of the NDCT. The only other electrical equipment associated with the operation of Fermi 3 existing beyond 4,100 meters are the transmission lines that run offsite and traverse the surrounding area. The Transformers Committee of the IEEE Power Engineering Society sponsored an "IEEE Guide for Application of Power Apparatus Bushings" (Ref 2.3-2XX, see markup) which provides ranges of salt deposition density levels for various types of contaminated environments ranging from light contamination environments to extra heavy contamination environments. The maximum impact values given above are well below the lowest bound equivalent salt deposit density level associated with even the lightest contaminated environments which is given in the reference as 300 kg/km2 (0.03 mg/cm2). This indicates that the operation of the NDCT for Fermi 3 will not produce a contaminated environment on power apparatus bushings which are incorporated as part of transformers, power circuit breakers, and isolated-phases bus. The cumulative salt deposition buildup should not cause a contaminated environment given that 1) the maximum monthly deposition rate is orders of magnitude below the light contamination level and 2) natural precipitation would wash off and reduce salt deposition long before significant buildup could occur.

The impact of operation of the NDCT upon atmospheric water vapor (humidity), precipitation, and dew formation are discussed in detail in FSAR Section 2.3.2.2.2. As discussed in that subsection, the NDCT is not expected to significantly alter the natural occurrences of these meteorological phenomena. The electrical equipment mentioned above are designed to operate during naturally occurring events such as precipitation and fog and since the NDCT will not significantly alter the natural occurrences of these meteorological phenomena in the existing environment, the operation of the NDCT is not expected to adversely impact the electrical transmission lines and other electrical equipment (including transformers and switchyards).

Proposed COLA Revision

FSAR Section 2.3.2.2.1 will be updated to include the impacts of the NDCT upon electrical transmission lines and other electrical equipment (including transformers and switchyards) as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 4 page(s))

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

Estimated Plume Lengths

remainder of this section will provide the potential plume impacts that result from the operation of the NDCT.

Table 2.3-286 displays the average plume lengths by season and direction during NDCT operation. Average plume lengths are longest for the NDCT during winter when average monthly temperatures are coldest (Reference 2.3-201). Table 2.3-287 presents annual plume length frequency for the NDCT. Previously it was stated that the NDCT will be positioned approximately 414 m (1359 ft) southwest from the meteorological tower. It can be reasonably stated that winds that blow from the southwest and south-southwest will allow a plume to travel towards the onsite meteorological tower. Using this method the tables indicate that plumes from the NDCT traveling in the northeast and north-northeast directions reached the onsite meteorological tower 7.66 percent and 7.76 percent, respectively, of the time annually. This evaluation does not account for the height of the plume as it travels from the cooling towers and is likely an overestimate of the number of times a plume reaches the meteorological tower on an annual basis. In addition, plumes from the NDCT are emitted at a height of 182.9 m (600 ft) and after additional plume rise will have negligible effects on the meteorological tower.

Add Insert "1" Here

2.3.2.2.2 Cooling Tower Plume Effects on Ground Level Meteorological Variables

As was discussed previously, the plume effects on the onsite meteorological tower are considered negligible. However, cooling tower plumes will influence some of the ground level meteorological variables very near the base of the cooling tower. This section investigates these influences and their impact at the Fermi site.

Wind

There are two effects of the NDCT on the local wind field. During the operation of the cooling tower air is drawn in at the base of the tower. The air is then heated by evaporation as it passes over the heated water located on the fill, collects moisture, and naturally rises. As the air rises it begins to cool and eventually saturates, forming a plume that exits at the top of the cooling tower. This process is continuous and causes the local wind field to converge toward the base of the cooling towers. The effect of airflow toward the cooling tower is localized and will likely remain within the Fermi property boundary. Hyperbolic shaped cooling towers

Insert 1:

Estimated Salt Deposition Impacts
Using the inputs provided in FSAR Table 2.3-285, the SACTI model predicted average annual and seasonal monthly salt deposition rates for the Natural Draft Cooling Tower (NCDT). Due to the high initial plume of the NDCT, no salt is predicted to be deposited within 4100 meters (13,451 ft) of the NDCT. Given this large distance, no salt deposition is predicted at the existing Fermi 2 switchyard, the planned location of the new Fermi 3 switchyard, or the planned Fermi 3 main transformer area as these areas lie within 4100 meters of the NDCT.

The maximum SACTI-predicted annual salt deposition rate is 0.01 $kg/km^2/mo$ and occurs between 4200 and 9400 meters (13,779 and 30,840 ft) east-northeast of the NDCT. The maximum seasonal impact occurs during the winter with 0.02 $kg/km^2/mo$ predicted to occur between 4400 and 9400 meters (14,436 and 30,840 ft) east-northeast of the NDCT. The only other electrical equipment associated with the operation of Fermi 3 existing beyond 4100 meters are the transmission lines that run offsite and traverse the surrounding area. The Transformers Committee of the IEEE Power Engineering Society sponsored an "IEEE Guide for Application of Power Apparatus Bushings" which provides ranges of salt deposition density levels for various types of contaminated environments ranging from light contamination environments to extra heavy contamination environments. The maximum predicted impact values given above are well below the lowest bound equivalent salt deposit density level associated with even the lightest contaminated environments which is given in the reference as 300 kg/km^2 (0.03 mg/cm^2) (Reference 2.3-2XX). This indicates that the operation of the NDCT for Fermi 3 will not produce a contaminated environment on power apparatus bushings which are incorporated as part of transformers, power circuit breakers, and isolated-phases bus. It is also reasonable to assume that cumulative salt deposition buildup would not cause a contaminated environment as the maximum monthly deposition rates are orders of magnitude below the light contamination level and natural precipitation events would wash off and reduce salt deposition long before any significant buildup could occur.

Estimated Water Vapor Impacts
The operation of the NDCT's impacts upon atmospheric water vapor (humidity), precipitation, and dew formation are discussed in detail in FSAR Subsection 2.3.2.2.2. As discussed in that subsection, the NDCT is not expected to significantly alter the natural occurrences of these meteorological phenomena. The electrical equipment mentioned above are designed to operate during naturally occurring events such as precipitation and fog and since the NDCT will not significantly alter the natural occurrences of these meteorological phenomena in the existing environment, the operation of the NDCT is not expected to adversely impact the electrical transmission lines and other electrical equipment (including transformers and switchyards).

2.3-255 Huff, F.A., et al, "Effects of Cooling Tower Effluents on Atmospheric Conditions in Northeastern Illinois, a Preliminary Report," Illinois Water Survey, 1971.

2.3-256 Kramer, M.L., D.E. Seymour, M.E. Smith, R.W. Reeves, and T.T. Frankenberg, "Snowfall Observations from Natural Draft Cooling Tower Plumes," Science, pp. 1239-1241, 1976.

2.3-257 Broehl, K.J., "Field Investigations of Environmental Effects of Cooling Towers for Large Steam Electric Plants," Portland General Electric Company, 1968.

2.3-258 Zeller, R.W., et al, "Report on Trip to Seven Thermal Power Plants," Pollution Control Council, Pacific Northwestern Area, 1971.

2.3-259 Kramer, M.L., M.E. Smith, M.J. Butler, D.E. Seymour, T.T. Frankenberg, "Cooling Towers and the Environment," Journal of the Air Pollution Control Association, Vol. 26, No. 6, June 1976.

2.3-260 Hosler, C.L., "Wet Cooling Tower Plume Behavior," Pennsylvania State University, University Park, Pennsylvania, 1971.

2.3-261 Tate, A., "Effects of a Natural Draft Cooling Tower on the Environment," Emory University, Atlanta, Georgia, May 1972.

2.3-262 Detroit Edison, "Fermi 2 Updated Final Safety Analysis Report", Section 2.3.3, Revision 14, November 2006

Add Insert "2" Here

Insert 2:

2.3-2XX Institute of Electrical and Electronics Engineers, "Guide for Application of Power Apparatus Bushings", IEEE Std. C57.19.100-1995(R2003).

Attachment 21
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4123)

RAI Question No. 02.03.03-1

NRC RAI 02.03.03-1

Regulatory Guide 1.23 states that the meteorological wind sensors on the tower should be located over level, open terrain at a distance of at least 10 times the height of any nearby obstruction, if the height of the obstruction exceeds one-half the height of the wind measurement. Visual inspection during the February 2-6, 2009 Fermi 3 environmental site audit indicated that the distance from the tower to the nearest obstruction (i.e., the wooded area located west of the tower) is less than 10 obstruction heights.

a. *What is the current average height of these trees and what is their closest distance to the tower?*

b. *The applicant stated during the audit that this was a self-identified issue entered into the Fermi 2 corrective action system in 2004 and was resolved as having no impact on the monitoring program based on a comparison with historic data collected during the past 30 years. Please describe the evaluation that closed out this issue.*

Response

a. *What is the current average height of these trees and what is their closest distance to the tower?*

A current survey of the 60-meter meteorological tower area, provided as Figure 1 in Enclosure 1, shows the current separation between the wind instruments and the obstructions, in this case trees, is less than ten times the obstruction height recommended in Reg Guide 1.23 as annotated in FSAR Table 1.9-202 (sheet 3).

b. *The applicant stated during the audit that this was a self-identified issue entered into the Fermi 2 corrective action system in 2004 and was resolved as having no impact on the monitoring program based on a comparison with historic data collected during the past 30 years. Please describe the evaluation that closed out this issue.*

In 2004, Fermi 2 identified that obstructions, in this case tree(s), were present at a distance of less than ten times the height of the tree(s) against the recommendations of Reg Guide 1.23. As part of this evaluation, a survey of the 60-meter meteorological tower area was performed. The survey, provided as Figure 2 in Enclosure 1, confirmed that the separation between the wind instruments and the obstructions (in this case the trees) was less than ten times the obstruction height recommended in Reg Guide 1.23.

Using the wind roses and stability class information for the time period from June 1, 1974 through May 31, 1975 in the Fermi 2 UFSAR, provided as Figure 12 in Enclosure 1, Detroit Edison evaluated the impact of the trees, by comparing the 10-meter and 60-meter wind roses from the 1974/1975 time frame with 10-meter and 60-meter annual wind roses from 1985, 1994, 2003, 2004 and 2005, provided as Figures 3 through 11 in Enclosure 1 and concluded that there was no significant difference in wind direction and speed patterns between the time periods analyzed. Thus, the trees to the west and southwest of the meteorological tower had not altered the wind flow patterns measured at the 60-meter meteorological tower prior to 2004.

Detroit Edison is reviewing the feedback from the NRC Staff conducting the review of the response to related Environmental Report RAI AQ 6.4-1 received via email dated January 26, 2010, but was unable to address this feedback in time for the submission of this response.

Proposed COLA Revision

FSAR Section 2.3.3.1.1 is being revised to provide a discussion the trees to the west of the Fermi meteorological tower and an insert statement to FSAR Table 1.9-202 (Sheet 3 of 24) pointing to FSAR Subsection 2.3.3.1.1 for the justification for the exception of the obstruction distance guidance as required by Reg Guide 1.23 as shown in the proposed markup.

NRC3-10-003
RAI 02.03.04-4

Enclosure 1

Figure 1, Meteorological Tower Area – 2010
Figure 2, Meteorological Tower Area - 2004
Figure 3, JFD 10 Meter Wind Rose Data for 2005
Figure 4, JFD 10 Meter Wind Rose Data for 2004
Figure 5, Fermi 2 JFD 60 Meter Wind Rose Data for 2004
Figure 6, Fermi 2 JFD 10 Meter Wind Rose Data for 2003
Figure 7, Fermi 2 JFD 60 Meter Wind Rose Data for 2003
Figure 8, Fermi 2 JFD 10 Meter Wind Rose Data for 1994
Figure 9, Fermi 2 JFD 60 Meter Wind Rose Data for 1994
Figure 10, Fermi 2 JFD 10 Meter Wind Rose for 1985
Figure 11, Fermi 2 JFD 60 Meter Wind Rose Data for 1985
Figure 12, Fermi 2 UFSAR Figure 2.3-19
(following 12 page(s))

Attachment 21 to
NRC3-10-0003
Page 5

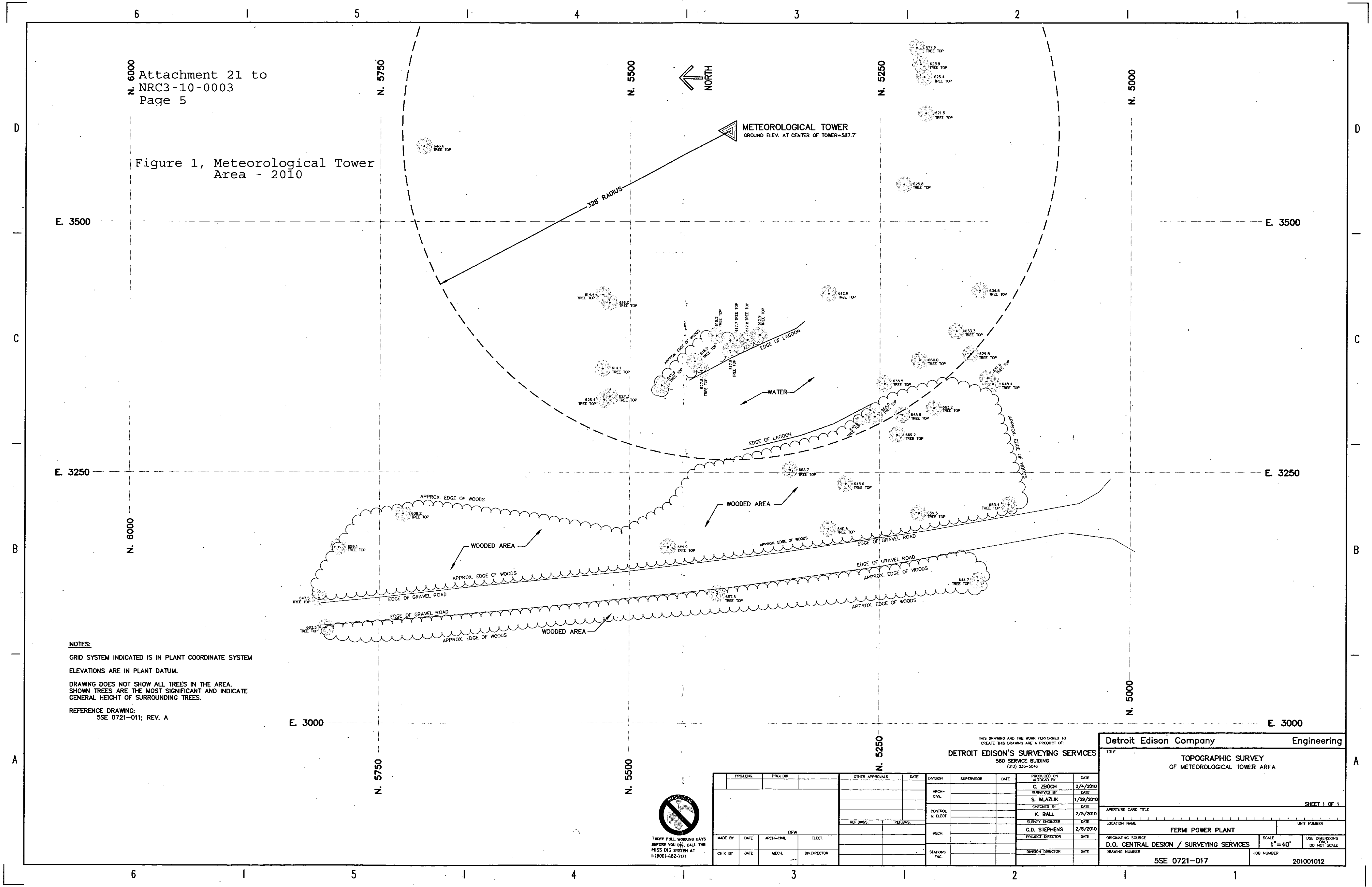

Figure 1, Meteorological Tower
Area - 2010

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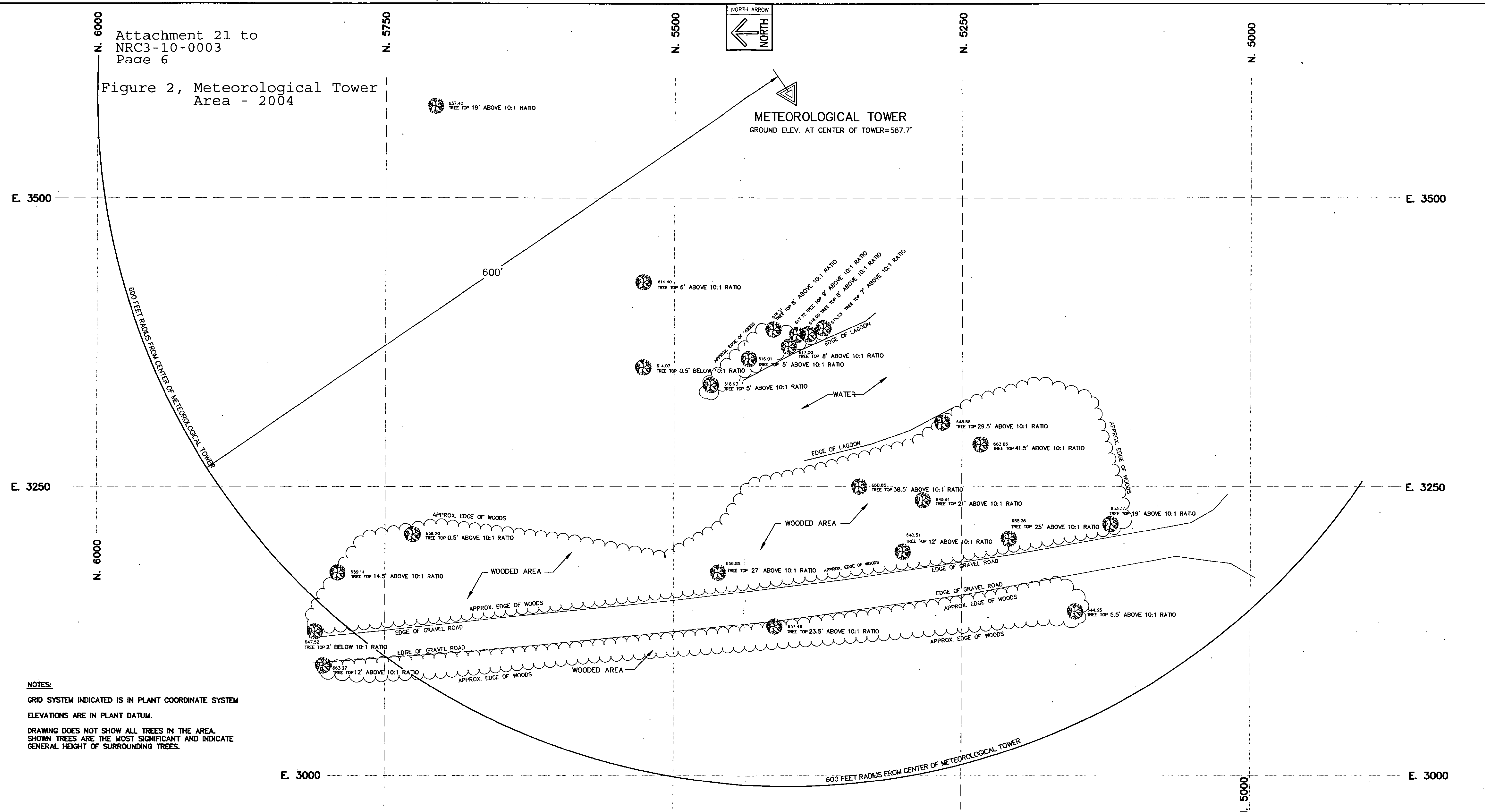
Figure 2, Meteorological Tower Area - 2004



NOTES:

GRID SYSTEM INDICATED IS IN PLANT COORDINATE SYSTEM

ELEVATIONS ARE IN PLANT DATUM.

DRAWING DOES NOT SHOW ALL TREES IN THE AREA. SHOWN TREES ARE THE MOST SIGNIFICANT AND INDICATE GENERAL HEIGHT OF SURROUNDING TREES.

A — DRAWING NO. CHANGED FROM 5MS 0721-11 TO 5SE 0721-11 — OFW

PRODUCED ON AUTOCAD BY: WLAZLIK, 8-2-04
SURVEYED BY: KLEBBA, 7-28-04

Detroit Edison Company — Engineering

TITLE: TOPO OF METEOROLOGICAL TOWER AREA 600 FEET RADIUS

LOCATION NAME: ENRICO FERMI PP

ORIGINATING SOURCE: SYSTEM PROJECTS & ENGINEERING

SCALE: 1"=40'

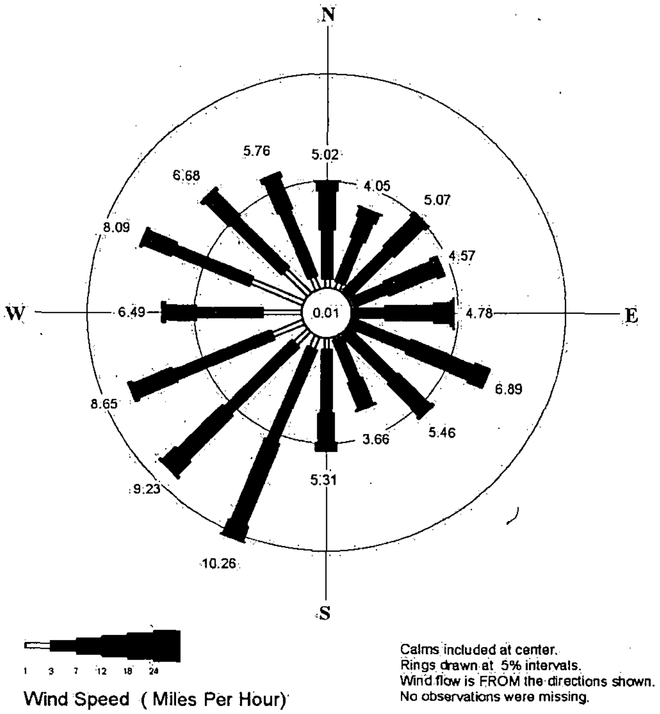
USE DIMENSIONS ONLY DO NOT SCALE

DRAWING NUMBER: 5SE 0721-11

JOB NUMBER: 200407143

Figure 3, JFD 10 Meter Wind Rose Data for 2005

Fermi 2
Joint Frequency Distribution
10 Meter Wind Rose Data for 2005



PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
N	0.42	2.32	1.84	0.40	0.05	0.00
NNE	0.34	2.21	1.03	0.45	0.02	0.00
NE	0.09	2.81	1.93	0.24	0.00	0.00
ENE	0.11	1.69	2.43	0.33	0.00	0.00
E	0.06	1.52	2.28	0.79	0.13	0.01
ESE	0.09	2.89	3.18	0.73	0.00	0.00
SE	0.09	3.12	2.13	0.11	0.00	0.00
SSE	0.11	2.13	1.35	0.07	0.00	0.00

TOTAL OBS = 8761 MISSING OBS = 0

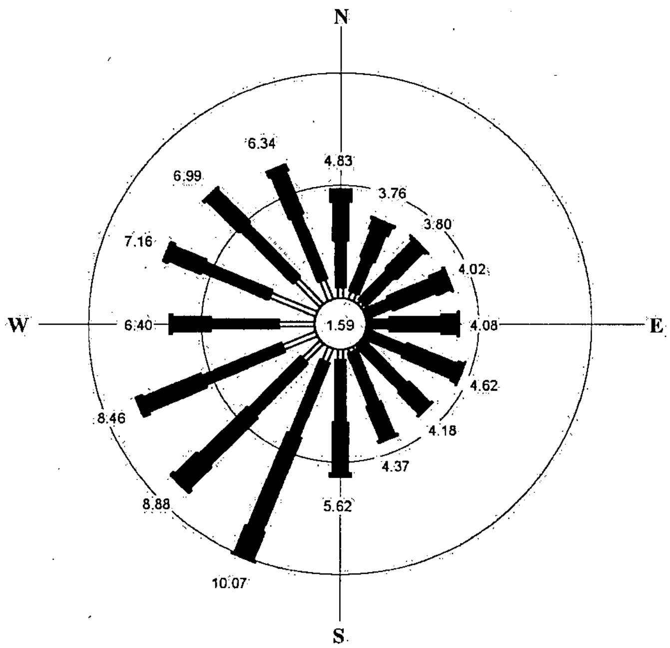
PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

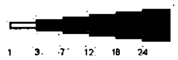
DIR	1	3	7	12	18	24
S	0.54	3.02	1.37	0.38	0.00	0.00
SSW	0.63	4.77	4.11	0.74	0.01	0.00
SW	0.88	4.46	2.93	0.86	0.10	0.00
WSW	1.54	4.98	1.95	0.18	0.00	0.00
W	1.77	3.16	1.44	0.13	0.00	0.00
WNW	2.66	3.90	1.43	0.10	0.00	0.00
NW	1.58	3.38	1.56	0.16	0.00	0.00
NNW	0.63	3.36	1.55	0.23	0.00	0.00

CALM OBS = 1 PERCENT CALM = 0.01

Figure 4, JFD 10 Meter Wind Rose Data for 2004

Fermi 2
Joint Frequency Distribution
10 Meter Wind Rose Data for 2004





Wind Speed (Miles Per Hour)

Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
4.84% of observations were missing..

PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
N	0.46	2.04	1.76	0.57	0.00	0.00
NNE	0.35	1.56	1.30	0.46	0.09	0.00
NE	0.18	1.81	1.67	0.11	0.02	0.00
ENE	0.06	1.14	2.07	0.68	0.07	0.00
E	0.03	0.96	2.31	0.73	0.05	0.00
ESE	0.08	1.82	2.41	0.30	0.01	0.00
SE	0.10	2.70	1.32	0.06	0.00	0.00
SSE	0.18	2.48	1.60	0.10	0.00	0.00

TOTAL OBS = 8785 MISSING OBS = 425

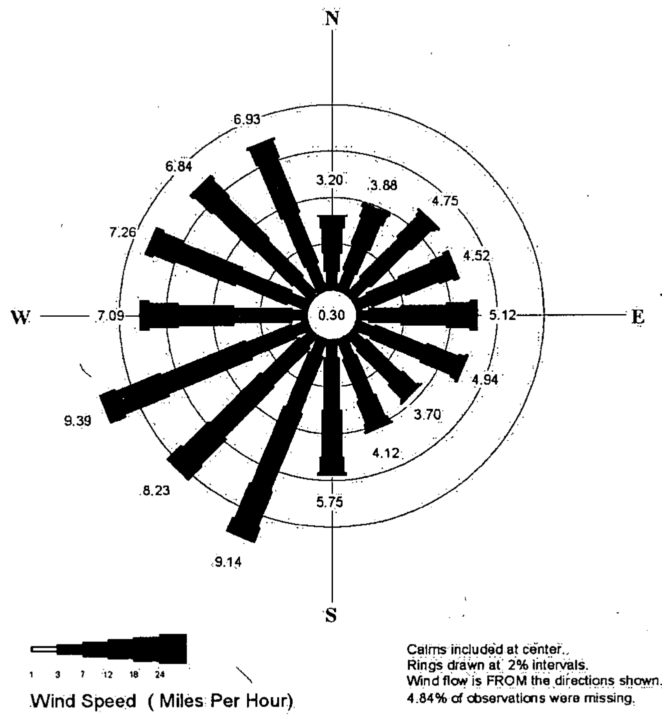
PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
S	0.43	2.75	2.25	0.18	0.00	0.00
SSW	0.65	3.51	4.51	1.39	0.02	0.00
SW	1.12	3.24	3.01	1.34	0.17	0.00
WSW	1.57	3.81	2.77	0.31	0.00	0.00
W	1.55	3.03	1.71	0.11	0.00	0.00
WNW	2.21	3.21	1.53	0.22	0.00	0.00
NW	1.60	3.26	2.06	0.07	0.00	0.00
NNW	0.93	3.05	2.05	0.31	0.00	0.00

CALM OBS = 140 PERCENT CALM = 1.59

Figure 5, Fermi 2 JFD 60 Meter Wind Rose Data for 2004

Fermi 2
Joint Frequency Distribution
60 Meter Wind Rose Data for 2004



PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
N	0.07	0.72	0.80	1.10	0.50	0.01
NNE	0.05	0.88	1.16	1.22	0.46	0.13
NE	0.05	0.89	2.34	1.24	0.19	0.03
ENE	0.07	0.58	1.49	1.54	0.63	0.22
E	0.07	0.41	1.40	1.95	1.00	0.30
ESE	0.03	0.77	2.36	1.45	0.26	0.07
SE	0.06	0.68	2.01	0.83	0.10	0.01
SSE	0.03	0.84	1.89	1.02	0.27	0.06

TOTAL OBS = 8785 MISSING OBS = 425

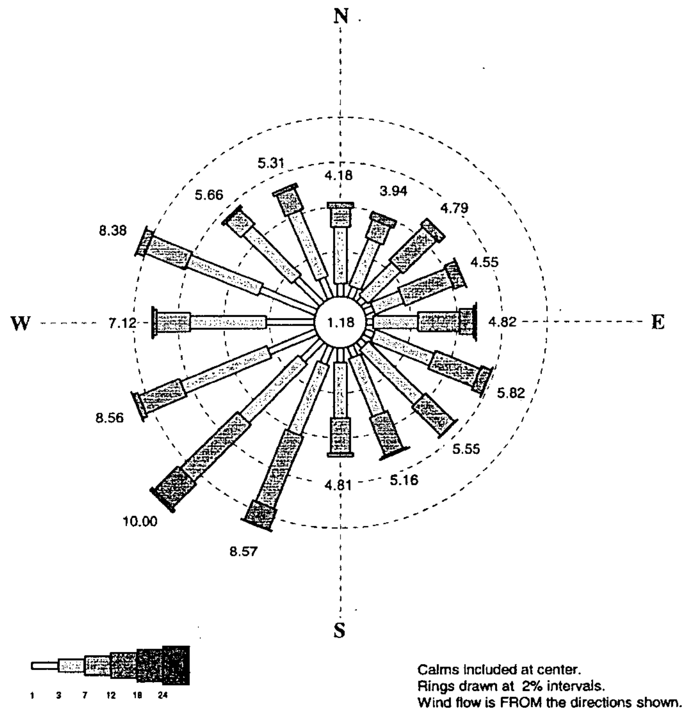
PERCENT OCCURRENCE: Wind Speed (Miles Per Hour).
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
S	0.05	0.69	2.23	2.03	0.66	0.09
SSW	0.02	0.71	2.57	3.57	1.65	0.61
SW	0.05	0.56	2.25	3.01	1.57	0.80
WSW	0.10	0.60	2.11	3.87	2.04	0.67
W	0.08	0.56	2.50	2.36	1.24	0.35
WNW	0.07	0.82	2.34	2.75	0.96	0.32
NW	0.13	0.89	2.15	2.50	1.00	0.17
NNW	0.06	1.21	2.32	2.53	0.76	0.06

CALM OBS = 26 PERCENT CALM = 0.30

Figure 6, Fermi 2 JFD 10 Meter Wind Rose Data for 2003

Fermi 2
Joint Frequency Distribution
10 Meter Wind Rose Data for 2003



Wind Speed (Miles Per Hour)

Calms included at center.
Rings drawn at 2% intervals.
Wind flow is FROM the directions shown.
1.61% of observations were missing.

PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
N	0.57	2.51	0.84	0.25	0.00	0.00
NNE	0.53	2.24	0.86	0.32	0.00	0.00
NE	0.31	2.04	2.07	0.38	0.00	0.00
ENE	0.42	1.36	2.25	0.51	0.01	0.00
E	0.31	1.96	1.80	0.62	0.11	0.01
ESE	0.43	2.77	2.11	0.48	0.02	0.00
SE	0.33	3.40	1.78	0.03	0.00	0.00
SSE	0.50	2.75	1.80	0.07	0.03	0.00

TOTAL OBS = 8761 MISSING OBS = 141

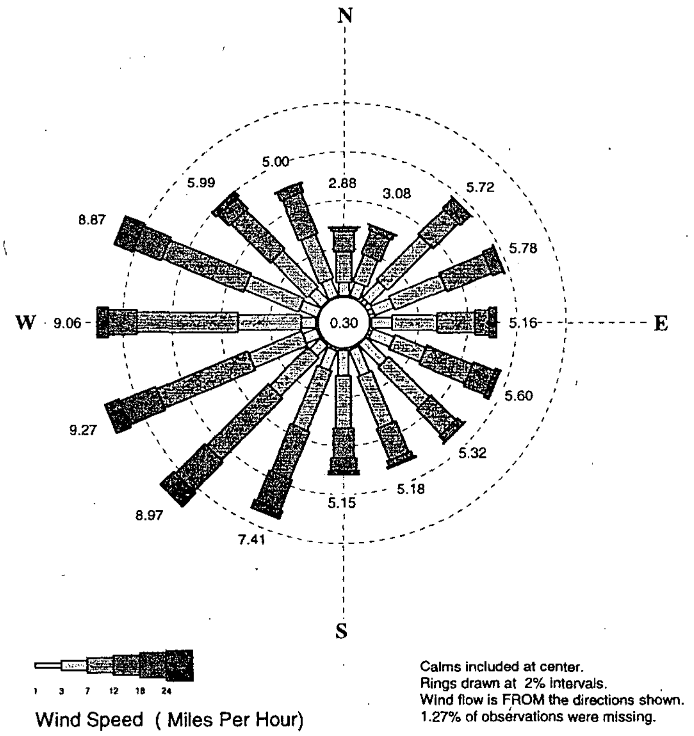
PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
S	0.64	2.44	1.56	0.16	0.00	0.00
SSW	0.83	3.31	3.45	0.94	0.05	0.00
SW	1.21	3.63	3.53	1.48	0.15	0.00
WSW	2.27	4.06	1.96	0.24	0.02	0.00
W	2.15	3.29	1.48	0.16	0.05	0.00
WNW	2.68	3.38	1.92	0.38	0.02	0.00
NW	1.59	3.04	0.92	0.11	0.00	0.00
NNW	0.97	3.16	1.02	0.16	0.00	0.00

CALM OBS = 103 PERCENT CALM = 1.18

Figure 7, Fermi 2 JFD 60 Meter Wind Rose Data for 2003

Fermi 2
Joint Frequency Distribution
60 Meter Wind Rose Data for 2003



Calms included at center.
Rings drawn at 2% intervals.
Wind flow is FROM the directions shown.
1.27% of observations were missing.

PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
N	0.06	0.55	1.24	0.84	0.13	0.06
NNE	0.08	0.59	1.16	1.00	0.21	0.03
NE	0.22	0.92	2.49	1.48	0.59	0.01
ENE	0.22	0.83	2.27	1.96	0.46	0.03
E	0.07	0.82	1.85	1.53	0.58	0.31
ESE	0.14	0.94	1.38	2.01	0.92	0.22
SE	0.03	1.21	2.34	1.40	0.30	0.03
SSE	0.09	1.13	2.26	1.38	0.23	0.09

TOTAL OBS = 8761 MISSING OBS = 111

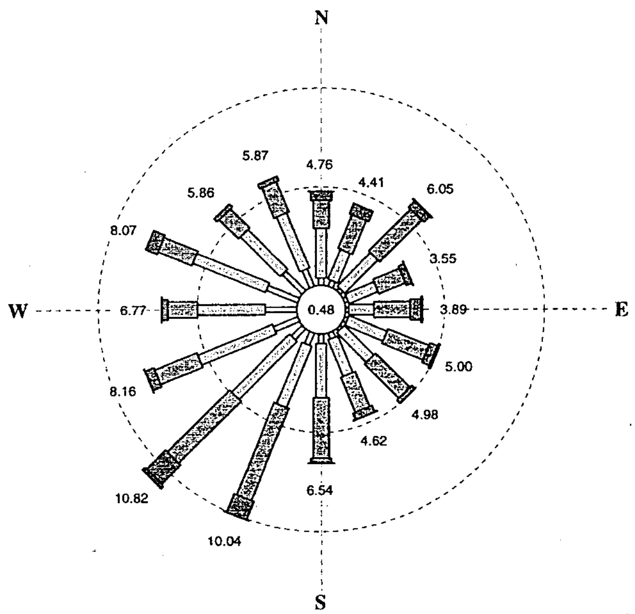
PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

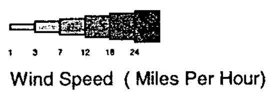
DIR	1	3	7	12	18	24
S	0.07	1.05	2.13	1.21	0.54	0.15
SSW	0.13	0.84	2.63	2.12	1.34	0.35
SW	0.08	0.59	2.25	3.57	1.68	0.80
WSW	0.09	0.58	2.37	4.03	1.55	0.64
W	0.09	0.59	2.63	4.11	1.18	0.47
WNW	0.06	0.76	2.43	3.58	1.21	0.82
NW	0.06	0.70	2.05	2.27	0.65	0.26
NNW	0.08	0.74	1.93	1.84	0.37	0.05

CALM OBS = 26 PERCENT CALM = 0.30

Figure 8, Fermi 2 JFD 10 Meter Wind Rose Data for 1994

Fermi 2
Joint Frequency Distribution
10 Meter Wind Rose Data for 1994





Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
0.14% of observations were missing.

PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
N	0.35	2.56	1.39	0.45	0.01	0.00
NNE	0.32	1.64	1.87	0.57	0.00	0.00
NE	0.18	2.40	3.00	0.41	0.06	0.00
ENE	0.18	1.60	1.44	0.31	0.02	0.00
E	0.16	1.29	1.83	0.54	0.08	0.00
ESE	0.18	2.09	2.23	0.40	0.10	0.00
SE	0.15	2.13	2.45	0.24	0.00	0.00
SSE	0.31	2.00	1.94	0.35	0.02	0.00

TOTAL OBS = 8761 MISSING OBS = 12

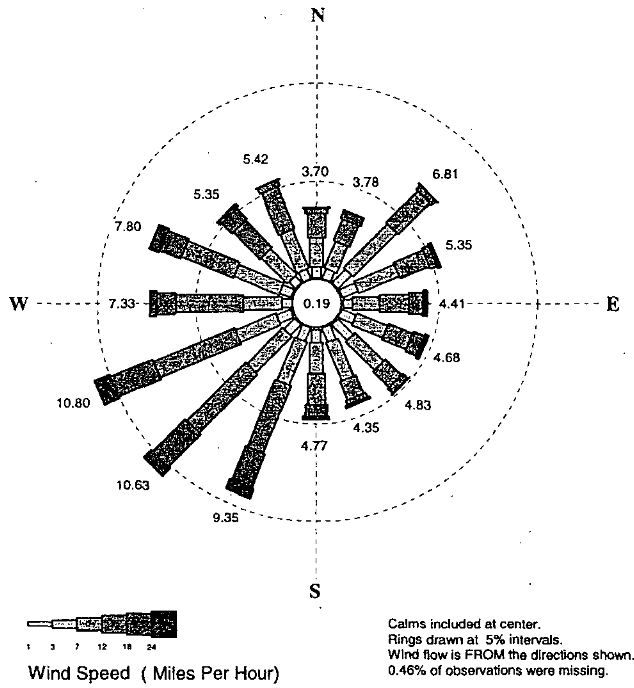
PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
S	0.48	2.74	3.05	0.26	0.01	0.00
SSW	0.65	3.37	5.00	1.00	0.02	0.00
SW	0.76	4.14	4.39	1.35	0.17	0.00
WSW	1.30	4.07	2.28	0.47	0.03	0.00
W	1.58	3.40	1.47	0.31	0.01	0.00
WNW	1.69	3.94	1.83	0.62	0.00	0.00
NW	1.42	2.86	1.37	0.21	0.00	0.00
NNW	0.96	3.02	1.64	0.24	0.00	0.00

CALM OBS = 42 PERCENT CALM = 0.48

Figure 9, Fermi 2 JFD 60 Meter Wind Rose Data for 1994

Fermi 2
Joint Frequency Distribution
60 Meter Wind Rose Data for 1994



Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
0.46% of observations were missing.

PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
N	0.07	0.56	1.51	1.23	0.25	0.08
NNE	0.05	0.56	1.51	1.20	0.47	0.00
NE	0.07	0.98	3.17	2.24	0.31	0.05
ENE	0.09	0.87	2.23	1.62	0.37	0.18
E	0.11	0.47	1.38	1.50	0.72	0.23
ESE	0.06	0.80	1.70	1.32	0.60	0.19
SE	0.09	1.12	2.07	1.14	0.38	0.03
SSE	0.06	0.76	2.11	1.02	0.25	0.15

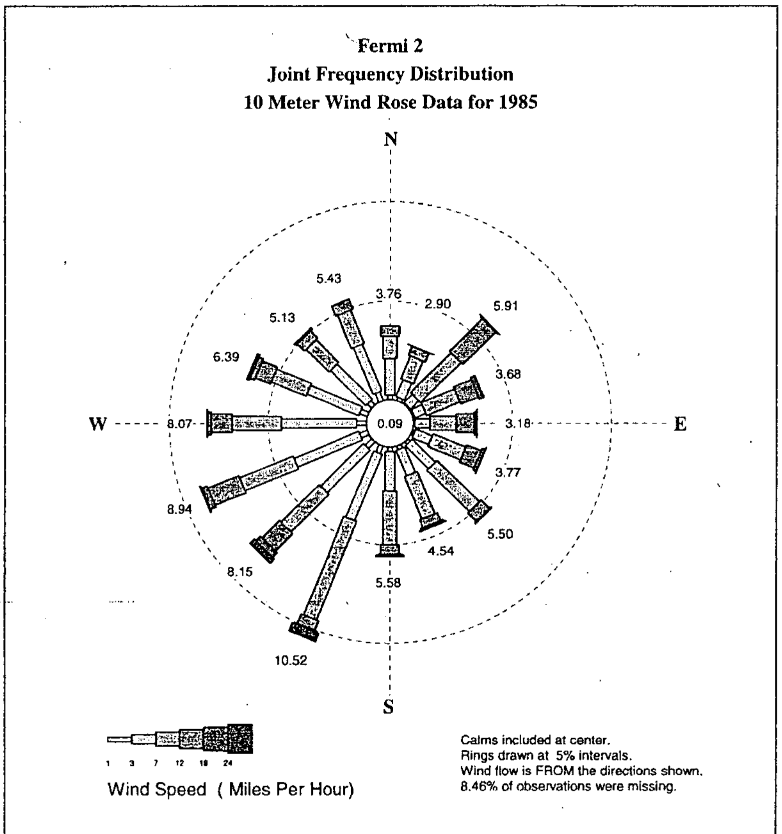
TOTAL OBS = 8761 MISSING OBS = 40

PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
S	0.13	0.66	1.60	1.62	0.58	0.18
SSW	0.03	0.76	2.40	3.73	1.87	0.55
SW	0.08	0.76	2.65	4.25	2.33	0.56
WSW	0.11	0.74	2.29	4.47	2.33	0.84
W	0.01	0.50	2.04	3.46	0.96	0.35
WNW	0.10	0.59	2.53	2.88	1.14	0.55
NW	0.07	0.46	1.89	1.96	0.75	0.22
NNW	0.05	0.55	2.16	2.32	0.31	0.05

CALM OBS = 17 PERCENT CALM = 0.19

Figure 10, Fermi 2 JFD 10 Meter Wind Rose for 1985



PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
N	0.22	1.88	1.13	0.53	0.00	0.00
NNE	0.18	0.92	1.28	0.50	0.00	0.01
NE	0.05	0.59	2.89	2.33	0.05	0.01
ENE	0.09	0.59	1.79	0.96	0.24	0.00
E	0.08	0.75	1.32	0.89	0.13	0.01
ESE	0.13	0.91	1.76	0.79	0.17	0.01
SE	0.17	1.67	3.00	0.60	0.06	0.00
SSE	0.19	1.42	2.35	0.43	0.11	0.03

TOTAL OBS = 8761 MISSING OBS = 741

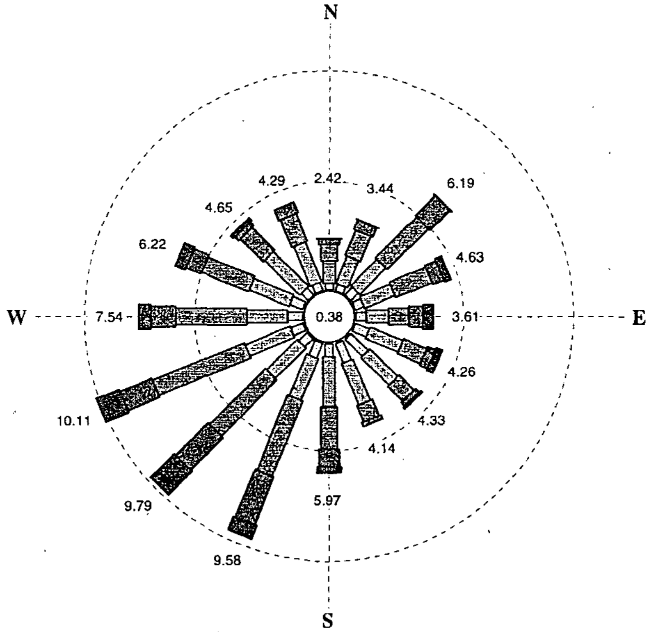
PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

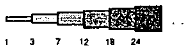
DIR	1	3	7	12	18	24
S	0.22	2.03	2.72	0.47	0.06	0.09
SSW	0.41	3.68	5.40	0.53	0.07	0.45
SW	0.47	3.10	2.73	1.21	0.32	0.32
WSW	0.42	3.57	2.93	1.66	0.31	0.05
W	0.48	3.84	2.49	1.04	0.19	0.03
WNW	0.42	2.86	1.91	0.81	0.25	0.14
NW	0.30	2.55	1.66	0.54	0.09	0.00
NNW	0.49	2.59	1.80	0.55	0.00	0.00

CALM OBS = 8 PERCENT CALM = 0.09

Figure 11, Fermi 2 JFD 60 Meter Wind Rose Data for 1985

Fermi 2
Joint Frequency Distribution
60 Meter Wind Rose Data for 1985





Wind Speed (Miles Per Hour)

Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
8.46% of observations were missing.

PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
N	0.06	0.30	1.02	0.75	0.25	0.05
NNE	0.05	0.32	1.34	1.26	0.47	0.01
NE	0.06	0.49	1.68	2.67	1.26	0.03
ENE	0.08	0.41	1.50	1.80	0.54	0.31
E	0.07	0.47	1.02	0.94	0.65	0.47
ESE	0.08	0.71	1.63	1.13	0.40	0.31
SE	0.10	1.11	1.83	0.96	0.23	0.10
SSE	0.10	0.96	2.08	0.80	0.21	0.00

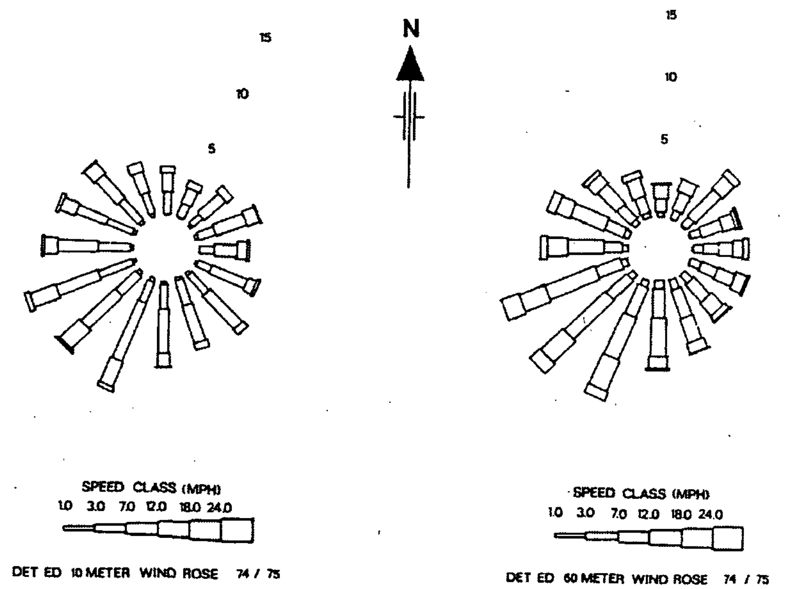
TOTAL OBS = 8761 MISSING OBS = 741

PERCENT OCCURRENCE: Wind Speed (Miles Per Hour)
LOWER BOUND OF CATEGORY

DIR	1	3	7	12	18	24
S	0.08	0.59	2.32	1.92	0.78	0.29
SSW	0.08	0.74	2.09	3.68	2.33	0.66
SW	0.07	0.55	1.96	3.62	2.09	1.51
WSW	0.09	0.58	2.23	4.51	1.56	1.14
W	0.07	0.68	1.88	3.22	1.13	0.56
WNW	0.10	0.62	1.97	2.29	0.73	0.50
NW	0.05	0.43	2.25	1.51	0.24	0.17
NNW	0.07	0.40	1.93	1.36	0.54	0.00

CALM OBS = 33 PERCENT CALM = 0.38

Figure 12, Fermi 2 UFSAR Figure 2.3-19



Fermi 2
UPDATED FINAL SAFETY ANALYSIS REPORT

FIGURE 2.3-19

FERMI SITE WIND ROSE DATA FOR ANNUAL PERIOD 1 JUNE 1974 – 31 MAY 1975

Markup of Detroit Edison COLA
(following 3 page(s))

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

Table 1.9-202 Conformance with Regulatory Guides (Sheet 3 of 24)

[EF3 COL 1.9-3-A]

RG Number	Title	Revision	Date	RG Position	Evaluation
1.22	Periodic Testing of Protection System Actuation Functions	Rev. 0	Feb-72	General	Conforms. Operational program implementation is described in Section 13.4.
1.23	Meteorological Monitoring Programs For Nuclear Power Plants	Rev. 1	Mar-07	General	Exception: The RG in part requires that sensors should be located … at a distance of at least 10 times the height of any nearby obstruction if the height of the obstruction exceeds one-half the height of the wind measurement. This criterion is not met for the existing meteorological tower at Fermi 2 and relocation of the tower would be required for construction. of Fermi 3 (Refer to Subsection 2.3.3.1.1)
1.24	Assumptions Used for Evaluating the Potential Radiological Consequences of a Pressurized Water Reactor Radioactive Gas Storage Tank Failure	Rev. 0	Mar-72	All	Not applicable
1.25	Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors	Rev. 0	Mar-72	General	Not applicable. RG 1.183 is used.
1.26	Quality Group Classifications and Standards or Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants	Rev. 4	Mar-07	All	Exception: The requirements for quality group classifications and standards are defined by the DCD which implements Rev. 3. Refer to DCD Tables 1.9-21, 1.9-21a, 1.9-21b.
		Rev. 3	Feb-76	All	Conforms. Refer to DCD Tables 1.9-21, 1.9-21a, 1.9-21b.

location in reference to structures are in conformance with Regulatory Guide 1.23.

Add Insert "1" Here

The influence of terrain near the base of the tower on temperature measurements is minimal. The tower is situated in a relatively flat area. A small climate controlled instrument shelter is located at the base of the onsite meteorological tower. ~~The tower is situated in an area undisturbed by trees or bushes and is~~ sufficiently close to the shoreline of Lake Erie such that it can measure the dynamic onshore flow conditions that could affect gaseous effluent releases. This effect on the dispersion conditions is representative of the site since the facility itself is located along the western shoreline of Lake Erie.

2.3.3.1.2 Instrumentation and Their Accuracies and Thresholds

Meteorological Sensors

The instrumentation on the meteorological tower consists of the following: wind speed and wind direction sensors at the 10- and 60-m levels, a 10-m air temperature sensor, a 10- to 60-m vertical air temperature difference system (ΔT), and a dewpoint temperature sensor at the 10-m level. In addition, a heated tipping bucket rain gauge monitors precipitation at ground level at the base of the meteorological tower. Table 2.3-288 provides a listing of the meteorological parameters monitored on the Fermi onsite meteorological tower, the sampling height(s), as well as the sensing technique for the primary and secondary systems.

To minimize data loss due to ice storms, external heaters are installed on the primary wind sensors. The heaters are thermostatically controlled and are of the slip-on/slip-off design for easy attachment. The wind sensor specifications are not affected by these heaters. A windscreen is mounted around the precipitation gage to minimize the amount of windblown snow and debris deposited in the gage.

The accuracies and thresholds for the meteorological sensors located on the meteorological tower are presented in Table 2.3-289. The accuracies and thresholds for each sensor are within the limitations specified in Regulatory Guide 1.23.

Data Recording Equipment

After the data are collected by the sensors the output is routed through signal conditioning equipment and then directed to digital data recorders.

Insert 1)

The tower is situated in an area east of a grove of trees that is located less than ten times the obstruction height recommended in Regulatory Guide 1.23. However, based on analysis of historic wind data collected from the meteorological tower it has been determined that the trees do not impact the wind measurements. The tower is located

Attachment 22
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4123)

RAI Question No. 02.03.03-2

NRC RAI 02.03.03-2

Please verify all the instrumentation information provided in FSAR Table 2.3-289, including sensor performance specifications and system accuracies, and update FSAR Table 2.3-289 accordingly. Please also identify any deviations from the guidance provided in Regulatory Guide 1.23.

a. *Based on February 2-6, 2009 Fermi 3 environmental site audit, it appears that the wind speed and wind direction sensor manufacturer is incorrectly stated in FSAR Table 2.3-289 (i.e., Climet instead of Met One/Climatronics).*

b. *FSAR Table 2.3-288 states the dew point monitoring system is a lithium chloride sensor whereas FSAR Table 2.3-289 states the dew point sensor is a EG&G model #110S-M which is a chilled mirror sensor.*

Response

FSAR Table 2.3-289 displays meteorological instruments for the Fermi 2 preoperational meteorological system. FSAR Table 2.3-289 will be revised to include the instruments and sensor performance specifications used for the Fermi 3 preapplication meteorological monitoring program.

Proposed COLA Revision

FSAR Section 2.3.3 and FSAR Table 2.3-289 will be revised to correctly reflect the instrumentation for the Fermi 2 meteorological tower as shown in the proposed markup.

Markup of Detroit Edison COLA

(following 6 page(s))

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

2.3.2.3 Local Meteorological Conditions for Design and Operating Bases

Subsection 2.3.2 provides a discussion of the onsite meteorological conditions in comparison to the regional conditions. The conclusion is that nearby meteorological stations such as Detroit Metropolitan Airport experience climatic conditions that are representative of meteorological conditions at the Fermi site. Wind speed and direction conditions that determine the air dispersion of the region are unique at the Fermi site due to the lake and land breezes that form along the Lake Erie shore. For these reasons the onsite meteorological data would be used for design and operating bases of Fermi 3; however, these data may be supplemented with data from Detroit Metropolitan Airport.

(September 1980)

EF3 COL 2.0-9-A

2.3.3 Meteorological Monitoring

the proposed Revision 1 to

The current Fermi onsite meteorological monitoring program has been in place since it was implemented for Fermi 2 pre-operational meteorological assessment beginning in June 1975. Starting in June 1975, the onsite meteorological monitoring program has met the requirements of Regulatory Guide 1.23 (Reference 2.3-262). Since June 1975, some of the meteorological monitoring program components have been upgraded. This section will describe the current state of the onsite meteorological measurement program. The Fermi 2 meteorological monitoring program provides the basis for the Fermi 3 meteorological preapplication monitoring, site preparation and construction monitoring, preoperational monitoring, and operational monitoring. In addition, data from the onsite meteorological tower is used as the sole input for models that describe the atmospheric transport and diffusion characteristics of the site, as provided for in Regulatory Guides 1.111 and 1.21. A description of the model used to analyze the atmospheric transport and diffusion conditions of the site is described in Subsection 5.3.3 of the Environmental Report.

2.3.3.1 Onsite Meteorological Measurement Program

The purpose of this section is to identify that the onsite meteorological measurements program and other data-collection programs used by Fermi 3 are adequate to: (1) describe local and regional atmospheric transport and diffusion characteristics within 50 mi (80 km) of the plant, (2) ensure environmental protection, and (3) provide an adequate location in reference to structures are in conformance with Regulatory Guide 1.23.

The influence of terrain near the base of the tower on temperature measurements is minimal. The tower is situated in a relatively flat area. A small climate controlled instrument shelter is located at the base of the onsite meteorological tower. The tower is situated in an area undisturbed by trees or bushes and is sufficiently close to the shoreline of Lake Erie such that it can measure the dynamic onshore flow conditions that could affect gaseous effluent releases. This effect on the dispersion conditions is representative of the site since the facility itself is located along the western shoreline of Lake Erie.

2.3.3.1.2 Instrumentation and Their Accuracies and Thresholds

Meteorological Sensors

The instrumentation on the meteorological tower consists of the following: wind speed and wind direction sensors at the 10- and 60-m levels, a 10-m air temperature sensor, a 10- to 60-m vertical air temperature difference system (ΔT), and a dewpoint temperature sensor at the 10-m level. In addition, a heated tipping bucket rain gauge monitors precipitation at ground level at the base of the meteorological tower. Table 2.3-288 provides a listing of the meteorological parameters monitored on the Fermi onsite meteorological tower, the sampling height(s), as well as the sensing technique for the primary and secondary systems.

To minimize data loss due to ice storms, external heaters are installed on the primary wind sensors. The heaters are thermostatically controlled and are of the slip-on/slip-off design for easy attachment. The wind sensor specifications are not affected by these heaters. A windscreen is mounted around the precipitation gage to minimize the amount of windblown snow and debris deposited in the gage.

the proposed Revision 1 to

The accuracies and thresholds for the meteorological sensors located on the meteorological tower are presented in Table 2.3-289. The accuracies and thresholds for each sensor are within the limitations specified in Regulatory Guide 1.23.

(September 1980)

Data Recording Equipment

After the data are collected by the sensors the output is routed through signal conditioning equipment and then directed to digital data recorders.

The signal conditioning equipment and digital recorders are located at the base of the 60-m meteorological tower in an environmentally controlled instrument shelter. An analog backup recorder also records the output from the sensors in the event that the primary digital recorder fails. A computer that is connected to the digital recorder, located in the instrument shelter, collects the data from the recorders and sends it to the control room computer system for analysis and archiving. The computer also has the ability to provide an instantaneous readout from the digital recorders so that it can be compared to sensor readings.

The accuracies for the primary and secondary recording devices are presented in Table 2.3-289. ~~The accuracies for each recorder conform to the guidance specified in Regulatory Guide 1.23.~~

Electrical power is supplied to the primary and secondary systems by independent power supplies. One source of power is Fermi 2; the other is an offsite source. If one supply fails, the other automatically supplies the necessary power for both systems. Two precautions are taken to minimize lightning damage to the system. Two of the three legs of the tower are grounded and the signal cables are routed through a lightning protection panel. Each signal line is protected by transient protection diodes specifically designed to stay below the individual line voltage breakdown point.

2.3.3.1.3 **Instrument Calibration**

Analog Instrumentation

The sensors, electronics, and recording equipment are calibrated on a six month basis. More frequent onsite calibrations are performed if the past operating history of the sensor indicates it is necessary. Any necessary adjustments are made onsite and the equipment that malfunctioned is either corrected onsite or replaced with similar spare equipment. After any adjustments or repairs, the calibration is repeated. Electronic calibrations are performed by simulating the output of each of the sensors with precision test equipment and monitoring the recorded values for each parameter. Wind speed sensors are replaced by a square wave frequency generator (with its output monitored by a frequency counter) that is adjusted to provide frequencies corresponding to known wind speeds. Wind direction sensors are replaced by a stable voltage source (with its output monitored by a digital voltmeter), which is adjusted to provide an output corresponding to known wind vane orientations.

Add Insert "1" Here

Table 2.3-289 Accuracies and Thresholds for the Fermi Onsite Meteorological Monitoring Program Instruments (Sheet 1 of 2) [EF3 COL 2.0-9-A]

Wind Speed Sensors: All Levels		
Sensor:	Climet Instruments model #WS-011-1. Wind speed transmitter and cup assembly.	
	Distance constant:	5 ft maximum
	Threshold wind:	0.6 mph
	Accuracy:	±0.1% or 0.15 mph, whichever is greater
Electronics:	Analog signal conditioner constructed by EG&G, Albuquerque.	
	Accuracy:	±0.1% full scale
Recorder:	Digital representation of Datel Systems, Inc. model #ADC-E 3-digit (BCD) analog to digital converter.	
	Overall System Accuracy:	±1% or 0.15 mph
Recorder: (Backup)	Esterline Angus Model #EAL1102S dual analog recorder	
	Accuracy:	±0.25% full scale
	Overall System Accuracy:	±1.04% or 0.38 mph, whichever is greater
Wind Direction Sensors: All Levels		
Sensor:	Climet Instruments model #WD-012-30 wind direction transmitter and wind vane assembly.	
	Distance constant:	1 m maximum
	Damping ratio:	0.4 standard
	Threshold:	0.75 mph
	Accuracy:	±3°
Electronics:	Analog signal conditioner constructed by EG&G, Albuquerque.	
	Accuracy:	±0.10% full scale
Recorder:	Digital representation of Datel Systems, Inc. model #ADC-E 3-digit (BCD) analog to digital converter.	
	Accuracy:	±1/2 LSB
Recorder: (Backup)	Esterline Angus model #EAL1102S dual analog recorder.	
	Accuracy:	±0.25% full scale
	Overall System Accuracy:	±3.2°

Table 2.3-289 Accuracies and Thresholds for the Fermi Onsite Meteorological Monitoring Program Instruments (Sheet 2 of 2) [EF3 COL 2.0-9-A]

Temperature Sensors: All Levels		
Sensors:	Rosemount Engineering model #171BM platinum resistance thermometer.	
	Linearity:	0.01% full scale
	Stability:	0.01°C per year
	Stability:	24 ft/sec flow over sensor
Electronics:	Analog signal conditioner constructed by EG&G, Albuquerque.	
	Accuracy:	±0.10% full scale
Recorder:	Digital representation of Datel Systems, Inc. model #ADC-E 3-digit (BCD) analog to digital converter.	
	Accuracy:	±1/2 LSB
Recorder: (Backup)	Esterline Angus model #EAL1102S dual analog recorder.	
	Accuracy:	±0.25% full scale
	Overall System Absolute Accuracy:	±0.2°C
	Overall System Difference Accuracy:	±0.1°C
Dewpoint Sensor:		
Sensor:	Environmental Equipment Division of EG&G, model #110S-M dewpoint measuring set.	
	Range:	-80°F to +120°F
	Accuracy:	±0.5°F maximum
Electronics:	Analog signal conditioner constructed by EG&G, Albuquerque.	
	Accuracy:	±0.1% full scale
Recorder:	Digital representation of Datel Systems, Inc. model #ADC-E 3-digit (BCD) analog to digital converter.	
Recorder: (Backup)	Esterline Angus model #EAL1102S dual analog recorder	
	Accuracy:	±0.25% full scale
	Overall System Accuracy:	±0.35°C
Precipitation Sensor:		
Sensor:	Fisher & Porter Company model #35-1559 EA10, precipitation gage recorder.	
	Range:	0 to 19.5 in. precipitation
	Accuracy:	±0.015 in. of range span
	Sensitivity:	0.025 in. response
	Overall System Accuracy:	±0.1 in.

Source: Reference 2.3-262

Insert 1)

Equipment	Manufacturer and Model	Range	System Accuracy	Starting Threshold	Measurement Resolution
Wind Speed	Climatronics Model F460-100075	0 to 125 mph	0.15 mph	1.0 mph	0.1 mph
Wind Direction	Climatronics Model F460-100076	0° to 540°	±3.2 degree	1.0 mph	1.0 degree
Temperature	Omega OL-703 Linear Thermistor Probe	-22°F to 212°F	0.4°F	N/A	0.1°C
Dewpoint Temperature	Climatronics Model 101197	-22°F to 122°F	±2.7°F	N/A	0.1°C
Differential Temperature	N/A	N/A	0.15°C	N/A	0.01°C
Precipitation	Fisher & Porter Company Model 35-1559 EA10	0 to 19.5 inches	±0.1 in	N/A	0.01 in
Recorder	Thermo Westronics Model SV180	N/A	±0.05% of programmed range	N/A	0.006% of full scale

Attachment 23
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4123)

RAI Question No. 02.03.03-3

NRC RAI 02.03.03-3

Section C.I.2.3.3 of Regulatory Guide 1.2.06 states that the FSAR should describe the meteorological measurements program calibration and maintenance procedures. Please describe the calibration practices (e.g., bearing torque measurements, wind tunnel testing) used to ensure that the wind sensors starting thresholds meet the starting threshold criteria presented in Regulatory Guide 1.23.

Response

The meteorological sensors on the Fermi meteorological tower are required to undergo calibrations and maintenance as recommended in Reg Guide 1.23. Detailed instrument calibration procedures and acceptance criteria are followed during calibration of the Fermi onsite meteorological system components. As described in FSAR Section 2.3.3.1.3, the meteorological sensors are calibrated every six months.

The resistance response to specified temperatures for the temperature thermistors is performed in the laboratory, currently the Fermi 2 Metrology Laboratory, using calibrated measurement equipment and a "Report of Calibration" issued. The "calibrated" temperature thermistor is then used to replace the existing sensor installed on the meteorological tower. The response of the "calibrated" temperature thermistor is then compared to an ambient temperature measurement taken at the sensor with a calibrated thermometer.

The dew point sensor is calibrated by comparing the result reported by the dew point sensor against the dew point measured by a calibrated, portable a dew point hygrometer at the aspirator inlet.

The precipitation sensor is calibrated by comparing the result reported by the precipitation sensor to a known volume of liquid.

The calibration of the wind speed sensors is performed in a wind tunnel by an outside vendor, currently Climatronics, Corp. using procedure 600023, using calibrated measurement equipment and a "NIST Traceable Wind Tunnel Anemometer. Calibration" issued. In the wind tunnel the wind velocity is calibrated at three points, 5, 10, and 15 miles per hour and the starting threshold is determined. The "calibrated" wind speed sensor is then used to replace the existing sensor installed on the meteorological tower. Review of the results documented in recent calibration procedures shows that the actual starting thresholds for both the primary and secondary wind speed sensors at both the 10 meter and 60 meter elevations, with a few noted exceptions, were always less than 0.75 miles/hr. Typically, the starting thresholds were on the order of 0.5 miles/hour. This is described in more detail in the response to RAI 02.03.04-3 in Attachment 29.

The calibration of the wind direction sensor is performed by an outside vendor, currently Climatronics, Corp. using procedure 600027, using calibrated measurement equipment and a "Wind Direction Calibration" issued. The calibration by the outside vendor does not include specific test of the threshold for wind direction. The starting threshold of the calibrated wind direction sensor is assessed at the time of installation by rotating the wind direction sensor body with the shaft in the horizontal plane and observing that the vane remains stationary. A new bearing is installed in the wind direction sensor if required. After installation of the new wind direction sensor, the directional alignment of the wind direction sensor is checked by sighting a known alignment point and comparing the result reported by the wind direction sensor to a known response. Examination of the meteorological data indicates that there is variability in the wind direction measurements during calm conditions, providing assurance that the sensor is functioning under the low wind speed occurrences.

FSAR Section 2.3.3.1.3 will be revised to include discussion of the calibration methods for meteorological sensors and equipment for the current Fermi site meteorological monitoring system.

Proposed COLA Revision

FSAR Section 2.3.3.1.3 will be revised as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 4 page(s))

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

Table 1.9-202 Conformance with Regulatory Guides (Sheet 3 of 24)

[EF3 COL 1.9-3-A]

RG Number	Title	Revision	Date	RG Position	Evaluation
1.22	Periodic Testing of Protection System Actuation Functions	Rev. 0	Feb-72	General	Conforms. Operational program implementation is described in Section 13.4.
1.23	Meteorological Monitoring Programs For Nuclear Power Plants	Rev. 1	Mar-07	General	Exception: The RG in part requires that sensors should be located … at a distance of at least 10 times the height of any nearby obstruction if the height of the obstruction exceeds one-half the height of the wind measurement. This criterion is not met for the existing meteorological tower at Fermi 2 and relocation of the tower would be required for construction of Fermi 3
1.24	Assumptions Used for Evaluating the Potential Radiological Consequences of a Pressurized Water Reactor Radioactive Gas Storage Tank Failure	Rev. 0	Mar-72	All	Not applicable
1.25	Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors	Rev. 0	Mar-72	General	Not applicable. RG 1.183 is used.
1.26	Quality Group Classifications and Standards or Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants	Rev. 4	Mar-07	All	Exception: The requirements for quality group classifications and standards are defined by the DCD which implements Rev. 3. Refer to DCD Tables 1.9-21, 1.9-21a, 1.9-21b.
		Rev. 3	Feb-76	All	Conforms. Refer to DCD Tables 1.9-21, 1.9-21a, 1.9-21b.

Calibration of wind direction sensor does not include test for starting threshold. Refer to Section 2.3.3.1.3 for discussion.

The signal conditioning equipment and digital recorders are located at the base of the 60-m meteorological tower in an environmentally controlled instrument shelter. An analog backup recorder also records the output from the sensors in the event that the primary digital recorder fails. A computer that is connected to the digital recorder, located in the instrument shelter, collects the data from the recorders and sends it to the control room computer system for analysis and archiving. The computer also has the ability to provide an instantaneous readout from the digital recorders so that it can be compared to sensor readings.

The accuracies for the primary and secondary recording devices are presented in Table 2.3-289. The accuracies for each recorder conform to the guidance specified in Regulatory Guide 1.23.

Electrical power is supplied to the primary and secondary systems by independent power supplies. One source of power is Fermi 2; the other is an offsite source. If one supply fails, the other automatically supplies the necessary power for both systems. Two precautions are taken to minimize lightning damage to the system. Two of the three legs of the tower are grounded and the signal cables are routed through a lightning protection panel. Each signal line is protected by transient protection diodes specifically designed to stay below the individual line voltage breakdown point.

2.3.3.1.3 Instrument Calibration

~~Analog Instrumentation~~

The sensors, electronics, and recording equipment are calibrated on a six month basis. More frequent onsite calibrations are performed if the past operating history of the sensor indicates it is necessary. Any necessary adjustments are made onsite and the equipment that malfunctioned is either corrected onsite or replaced with similar spare equipment. After any adjustments or repairs, the calibration is repeated. Electronic calibrations are performed by simulating the output of each of the sensors ~~with~~ precision test equipment and monitoring the recorded values for each parameter. ~~Wind speed sensors are replaced by a square wave frequency generator (with its output monitored by a frequency counter) that is adjusted to provide frequencies corresponding to known wind speeds. Wind direction sensors are replaced by a stable voltage source (with its output monitored by a digital voltmeter), which is adjusted to provide an output corresponding to known wind vane orientations.~~

Insert 1 Here

~~Temperature sensors are replaced with a stable decay resistance box, which is adjusted to provide accurate resistances corresponding to known temperatures. The test instrument settings used are those for which the sensor manufacturer published calibration equivalents. Nuclear Instrumentation and Control (NI&C) technicians perform sensor calibrations recommended by the manufacturer. The records documenting results of calibrations, drift from calibrations, and corrective action taken for the analog instrumentation are kept and filed onsite.~~

~~Digital Instrumentation~~

~~The digital instrumentation system is calibrated on a six-month basis. Electronics calibrations are performed in virtually the same manner as are performed on the analog system. Dewpoint sensor calibrations are performed in the same manner as those for air temperature sensors. With the exception of precipitation, sensor calibrations are performed in accordance with the manufacturer recommendations by NI&C technicians. The precipitation sensor and electronics are calibrated by placing known weights in the emptied weighing bucket corresponding to a known amount of rainfall.~~ The records documenting results of calibrations, drift from calibrations, and corrective action taken for the digital instrumentation are kept and filed onsite.

2.3.3.1.4 Instrument Service and Maintenance

Visits are made twice a week to the 60-m tower to make a visual inspection of the sensors, as well as the data output and recording equipment in the instrument shelter, to see if they are damaged and need maintenance. In the event the sensors or monitoring equipment is found damaged or malfunctioning, the equipment is replaced or corrected in a timely fashion. A stock of spare parts and equipment is maintained to minimize and shorten the periods of outages. Using the same precision test equipment used for calibration, the instrumentation is checked to ensure reliable operation. Records documenting results of major causes of instrument sensor outages and other malfunctions of the meteorological monitoring system are kept and filed onsite. A similar inspection and maintenance program is in place for the computers and equipment located in the control room.

Insert 1

The resistance response to specified temperatures for the temperature thermistors is performed in the laboratory using calibrated measurement equipment. The calibrated temperature thermistor is then used to replace the existing sensor installed on the meteorological tower. The response of the calibrated temperature thermistor is then compared to an ambient temperature measurement taken at the sensor with a calibrated thermometer.

The dew point sensor is calibrated by comparing the result reported by the dew point sensor against the dew point measured by a calibrated, portable dew point hygrometer at the aspirator inlet.

The precipitation sensor is calibrated by comparing the result reported by the precipitation sensor to a known volume of liquid.

The calibration of the wind speed sensors is performed in a wind tunnel by an outside vendor using calibrated measurement equipment and a NIST Traceable Wind Tunnel Anemometer. In the wind tunnel the wind velocity is calibrated at specific points and the starting threshold is determined. The calibrated wind speed sensor is then used to replace the existing sensor installed on the meteorological tower.

The calibration of the wind direction sensor is performed by an outside vendor using calibrated measurement equipment. The calibration does not include a specific test of the starting threshold for wind direction. The starting threshold of the calibrated wind direction sensor is assessed at the time of installation by rotating the wind direction sensor body with the shaft in the horizontal plane and observing that the vane remains stationary. A new bearing is installed in the wind direction sensor if required. After installation of the new wind direction sensor, the directional alignment of the wind direction sensor is checked by sighting a known alignment point and comparing the result reported by the wind direction sensor to a known response.

Attachment 24
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4123)

RAI Question No. 02.03.03-4

NRC RAI 02.03.03-4

FSAR Section 2.3.3.1.2 states that sensor accuracies are within the limits specified in Regulatory Guide 1.23. During the February 2-6, 2009 Fermi 3 environmental site audit, the Fermi meteorological system engineer indicated that the secondary delta-temperature (delta-T) channel (ΔT = T60m – T10m) recorded values were consistently 0.2 °C higher than the primary delta-temperature channel. The staff also observed this offset in the primary and secondary delta-T channel readouts during the site audit. This 0.2 °C "offset" appears to be greater than the ±0.1 °C delta-T channel accuracy specified in Regulatory Guide 1.23 and could affect stability class determination.

a. *Please indicate which delta-T channel appears to have the more accurate measurements.*
b. *Please describe the impact of this delta-T channel offset on the atmospheric dispersion and deposition factors presented in FSAR Sections 2.3.4 and 2.3.5.*
c. *Please describe the correction actions to be taken to address this apparent deviation from Regulatory Guide 1.23 criteria.*

Response

The atmospheric stability classifications presented in FSAR Section 2.3.1.9 were determined based on the temperature difference with height (°C/100m) measured by the Fermi 2 meteorological tower from 2002 through 2007 as per Reg Guide 1.23. At the Fermi site, this temperature difference is determined by doubling the measured temperature difference (ΔT) between the temperature indication at 60 meters and the temperature indication at 10 meters.

The Fermi meteorological data system has redundant instrumentation (i.e., primary and secondary channels). The primary ΔT data is normally reported within the plant computer system. However, when the plant computer system detects a problem with the primary channel, or when the primary channel is not otherwise available (e.g., maintenance, calibration) the secondary ΔT is used. Operability of specific meteorological monitoring instrumentation (including the ΔT indications) is controlled by the Fermi 2 Technical Requirements Manual (TRM). Daily channel checks and semi-annual (frequency of 184 days) calibrations are specified to satisfy the associated TRM surveillance requirements. A review of historical data, surveillances, calibrations, and preventative maintenance records, indicate that the calibrations for the ΔT instruments have been completed satisfactorily.

A review of meteorological data was performed to evaluate the difference between the primary ΔT and secondary ΔT data. The instantaneous data vary between the primary and secondary ΔT channels due to expected variability in instrumentation measurements. The data review indicated that there is not a consistent variance between the primary and secondary ΔT indications. That is, the secondary ΔT does not always indicate higher than the primary ΔT. Instead, the data review indicates that the instantaneous readings from the primary and secondary ΔT indications consistently follow each other over time and any difference in temperature indications is random as expected. The instantaneous primary and secondary ΔT data can be locally displayed in the meteorological tower shack. At any given time period, the primary ΔT may be different from the secondary ΔT as indicated in the display at the tower shack. At times, the primary is higher than the secondary and other times the secondary is higher than the primary. The ΔT instantaneous data are compiled into hourly averages. The primary and secondary instantaneous channel indications consistently follow delta temperature over time. The hourly average ΔT values are used for determining the stability class, which is then input into atmospheric dispersion models. Given that the primary and secondary ΔT indications follow reliably over time and do not exhibit a consistent difference between the two indications, the hourly average values for the primary or secondary channels are reliable.

Review of ΔT data, system configurations, and discussions with the Fermi 2 Systems Engineer and instrument vendors provided further details about the temperature instruments and software used to record onsite meteorological data. These system details were also discussed during the site audit with the Fermi 2 Systems Engineer. Delta temperature is calculated from 60 meter and 10 meter temperature measurements. The ambient temperature sensors are Omega 700 series linear thermistors. Although output from the thermistors are referred to as "linear," there is an approximately +/- 0.2°C wobble within the operating range of -30 to +50°C. This wobble is linearized using a sixth order polynomial within the plant computer software. Figure 1 shows the meteorological system software coding, including the linearization function, and a description of the flowchart. The objective of the linearization equation is to apply a correction factor to both the 10 meter and 60 meter air temperatures prior to deriving the ΔT parameter for determining stability. This correction is applied to both primary and secondary data, and does not propagate variance between the channels.

Review of ΔT data, meteorological instrumentation, calibration and surveillance requirements and historical records, and system configuration identified no consistent data variance in primary and secondary channel measurements. This analysis confirms that the meteorological data obtained from the onsite meteorological tower for the time period 2001-2007, and reported in the Fermi 3 COLA, sufficiently characterizes the conditions at the Fermi site and surrounding region.

<u>Proposed COLA Revision</u>

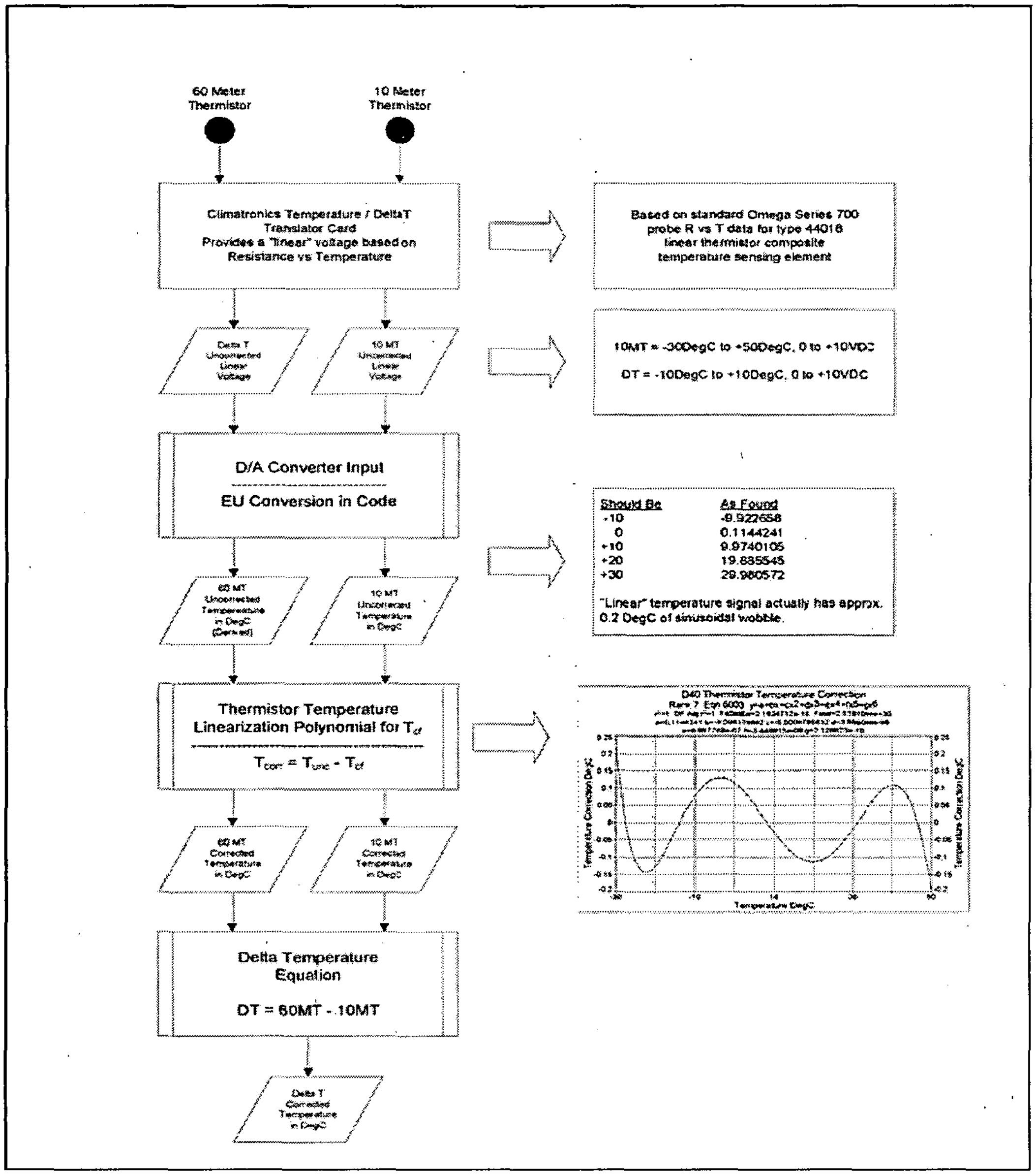
None

NRC3-10-003
RAI 02.03.04-4

Enclosure 1

Figure 1
(following 1 page(s))

Figure 1



Description: The ambient temperature sensors are Omega 700 series linear thermistors. Although output from the thermistors are referred to as "linear," there is an approximate +/- 0.2°C wobble within the operating range of -30 to +50°C. This wobble is linearized using a sixth order polynomial within the plant computer software. The objective of the linearization equation is to apply a correction factor to both the 10 meter and 60 meter air temperatures prior to deriving the delta temperature parameter for determining stability.

The output from the 60 meter and 10 meter thermistors is fed into a translator card that provides a "linear" voltage based on the probe resistance vs. temperature data. The output from the translator card is an uncorrected delta temperature and 10 meter ambient temperature. The corrected temperature is equal to the uncorrected temperature minus the calculated correction factor. The corrected ΔT is then the difference between the corrected 60 meter ambient temperature and the corrected 10 meter ambient temperature.

Attachment 25
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4123)

RAI Question No. 02.03.03-5

NRC RAI 02.03.03-5

FSAR Tables 2.3-269 through 2.3-284 supposedly present joint frequency distributions of wind speed and direction by stability class at the 10-meter and 60-meter levels of the Fermi onsite meteorological tower for the five-year period 2003 through 2007. Please explain the following apparent discrepancies.

a. *This five-year period contains 43,842 hours, yet the number of observations reported in FSAR Tables 2.3-269 (10-meter level, all stability categories) and 2.3-277 (60-meter level, all stability categories) are 17,533 and 17,520, respectively.*

b. *The number of occurrences of stability classes A, B, C, D, E, F, and G reported in FSAR Tables 2.3-270 through 2.3-276 are 3043, 955, 937, 5867, 3932, 1655, and 802, respectively. The sum of these number of occurrences (17,191) is different from number of occurrences for all stability classes shown in FSAR Table 2.3-269 (17,533). Likewise, the number of occurrences of stability classes A, B, C, D, E, F, and G reported in FSAR Tables 2.3-278 through 2.3-284 are 3043, 955, 937, 5865, 3931, 1650, and 797, respectively. The sum of these number of occurrences (17,178) is different from number of occurrences for all stability categories shown in FSAR Table 2.3-277 (17,520).*

Response

FSAR Tables 2.3-270 through 2.3-284 containing the joint frequency distributions of wind speed and direction by stability class at the 10-meter and 60-meter levels are incorrect. The FSAR Table 2.3-270 through 2.3-284 will be revised so that they include the available observations from the Fermi site meteorological tower for the entire 5-year time period from 2003-2007. At the 10-meter level a total of 806 hours out of the 43,824 hours in the five year period contained a missing stability, wind speed, or wind direction and was not accounted for in the joint frequency distribution tables. For the 60-meter level a total of 868 hours contained a missing stability, wind speed, or wind direction. In addition, the tables will be revised so the number of occurrences for Pasquill stability classes A, B, C, D, E, F, and G sum to the total number of occurrences for all Pasquill stability classes.

Proposed COLA Revision

FSAR Tables 2.3-269 through 2.3-284 will be revised as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 32 page(s))

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

Table 2.3-269 Annual JFD of Wind Direction, Wind Speed, and Stability Class [EF3 COL 2.0-8-A]

Add Insert "1" Here

Fermi Site

2003-2007

10-m Level

All Pasquill Stability Categories

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm	18	27	23	25	26	21	47	92	40	17	28	71	85	155	179	121	976
Calm-2	45	56	84	180	67	152	258	370	137	93	94	182	282	334	429	455	3219
2-4	139	100	196	227	171	177	296	282	236	293	241	309	309	303	292	318	3894
4-6	170	187	267	143	222	99	209	200	254	293	281	300	277	177	222	274	3637
6-8	168	176	180	107	156	86	107	108	146	120	140	302	264	136	124	197	2521
8-10	158	130	131	103	101	85	87	57	89	43	50	291	251	79	99	112	1866
10-13	66	76	37	43	22	47	21	12	20	4	8	120	169	11	26	29	711
13-17	18	10	5	1	2	10	1				2	14	27	3	3	2	98
17-21	6			494					11	2	1	9	11	2	1	2	539
21+	4	1	3	1	3	1	1	1	6	10	4	5	6	5	3	5	59
All Speeds	792	763	926	1324	770	678	1027	1122	939	875	849	1663	1681	1205	1378	1515	17520

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 976

Number of Variables: 13

Number of Observations: 17533

Insert 1)

All Pasquill Stability Classes

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	4	338	319	483	323	351	130	56	5	0	2009
NNE	1	252	327	433	225	240	127	41	10	0	1656
NE	9	144	157	538	554	415	116	4	2	0	1939
ENE	9	107	103	362	480	523	193	66	9	0	1852
E	10	70	129	375	436	515	322	146	33	4	2040
ESE	7	115	222	641	697	529	171	54	1	0	2437
SE	18	111	226	773	767	337	55	13	0	0	2300
SSE	11	166	224	657	587	293	48	6	3	0	1995
S	11	291	301	688	597	362	89	11	0	0	2350
SSW	21	397	371	997	1045	1035	366	120	7	0	4359
SW	19	631	552	826	782	878	459	205	41	1	4394
WSW	17	1015	652	867	648	462	90	27	2	0	3780
W	17	981	481	669	483	321	92	11	3	0	3058
WNW	8	1321	502	683	469	332	136	20	2	0	3473
NW	8	836	542	639	455	291	61	15	0	0	2847
NNW	5	478	453	734	455	277	99	28	0	0	2529
TOTAL	175	7253	5561	10365	9003	7161	2554	823	118	5	43018

Notes:
Data from 10 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-270 Annual JFD of Wind Direction, Wind Speed, and Stability Class [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

10-m Level

Add Insert "2" Here

Pasquill Stability Class A

Extremely Unstable (ΔT ≤ -1.9°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm	3	17	3	1	6		1	2	5	6	4	7	5	4	1	1	66
Calm-2	9	16	7	4	12	2	8	21	10	11	14	17	11	22	32	18	214
2-4	30	22	46	13	36	10	27	48	57	84	54	45	29	67	66	34	668
4-6	47	29	99	20	32	8	47	76	77	126	122	83	35	49	72	59	981
6-8	54	30	69	17	24	11	38	45	24	37	50	78	33	35	36	49	630
8-10	45	21	48	9	8	9	34	21	12	4	4	52	39	15	10	19	350
10-13	12	12	7	2	2	4	6	4	2		2	13	12	1	5	1	85
13-17												3					3
17-21				14					2	1		3	1				21
21+	3	1			3				4	5	2	2	3	1		1	25
All Speeds	203	148	279	80	123	44	161	217	193	274	252	303	168	194	222	182	3043

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 66

Number of Variables: 0

Number of Observations: 3043

Insert 2)

Class A Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	10	19	47	62	62	5	9	0	0	214
NNE	0	7	27	56	31	42	11	7	0	0	181
NE	5	20	30	86	96	80	15	1	0	0	333
ENE	3	36	24	96	113	108	33	10	0	0	423
E	5	8	36	99	118	159	97	28	2	1	553
ESE	1	12	41	233	276	188	49	8	0	0	808
SE	9	7	49	313	377	107	5	0	0	0	867
SSE	6	18	44	222	283	96	7	1	0	0	677
S	6	11	48	202	188	58	6	1	0	0	520
SSW	4	16	57	181	282	226	54	8	3	0	831
SW	4	14	42	111	138	148	53	9	0	0	519
WSW	2	24	57	136	165	122	13	1	0	0	520
W	3	31	68	159	138	98	27	0	0	0	524
WNW	0	40	73	198	189	111	23	5	0	0	639
NW	0	30	73	176	175	101	24	4	0	0	583
NNW	0	15	34	128	135	93	29	6	0	0	440
TOTAL	48	299	722	2443	2766	1799	451	98	5	1	8632

Notes:
Data from 10 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Add Insert "3" Here

Table 2.3-271 Annual JFD of Wind Direction, Wind Speed, and Stability Class [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

10-m Level

Pasquill Stability Class B

Moderately Unstable (-1.9°C/100m < ΔT ≤ -1.7°C/100m)

Wind Speed (mph) (1)	Wind Direction From E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm		1	1					1	1		2	3	4	1	2		16
Calm-2		2	1	5	4	6	12	15	4	5	2	7	4	16	13	8	104
2-4	6	7	16	15	8	6	21	15	13	27	15	13	17	31	22	16	248
4-6	8	8	14	14	5	7	15	17	11	20	23	25	18	14	17	20	236
6-8	7	10	8	10	1	7	15	8	2	3	5	25	25	13	8	18	165
8-10	12	9	6	5	5	5	6	8	4	2	1	18	22	4	7	8	122
10-13	1	4	1	6	1	2	3			1	1	11	14	1	3	3	52
13-17																	
17-21				9						1		1	1				12
21+																	0
All Speeds	34	41	47	64	24	33	72	64	35	59	49	103	105	80	72	73	955

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 16
Number of Variables: 0
Number of Observations: 955

Insert 3)

Class B Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	12	17	32	28	19	7	6	0	0	121
NNE	0	6	14	20	13	21	9	1	0	0	84
NE	0	1	9	24	16	11	4	0	0	0	65
ENE	1	5	10	15	19	26	13	2	0	0	91
E	0	1	5	15	22	33	16	5	0	0	97
ESE	1	4	10	29	30	20	13	1	0	0	108
SE	0	4	23	58	43	17	4	0	0	0	149
SSE	0	8	9	44	20	8	2	0	0	0	91
S	0	6	17	37	20	14	2	0	0	0	96
SSW	1	7	11	39	71	57	29	10	0	0	225
SW	0	10	16	42	45	67	44	23	4	1	252
WSW	0	10	21	47	68	28	12	2	0	0	188
W	0	15	23	70	48	31	6	0	0	0	193
WNW	0	19	24	58	38	20	13	1	0	0	173
NW	0	17	19	45	40	23	6	2	0	0	152
NNW	0	8	22	51	36	30	9	0	0	0	156
TOTAL	3	133	250	626	557	425	189	53	4	1	2241

Notes:
Data from 10 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-272 Annual JFD of Wind Direction, Wind Speed, and Stability Class [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

10-m Level

Add Insert "4" Here

Pasquill Stability Class C

Slightly Unstable (-1.7°C/100m < ΔT ≤ -1.5°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm		3							2			3	1	1	3	1	14
Calm-2	3	3	4	7	4	6	7	13	5	2	6	8	11	17	15	15	126
2-4	9	1	12	10	7	15	21	16	12	19	8	13	19	16	29	22	229
4-6	6	10	5	16	9	8	18	13	7	9	10	19	18	17	8	15	188
6-8	6	14	8	8	10	9	8	8	11	3	1	17	20	12	6	18	159
8-10	8	11	5	6	10	10	6	1	4	4	1	26	12	6	15	12	137
10-13	4	8		2	1	2	1	2	1		2	11	16	4	4	7	65
13-17	2	3		1								1	1				8
17-21				8													8
21+			1									1	1				3
All Speeds	38	53	35	58	41	50	61	53	42	37	28	99	99	73	80	90	937

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 14
Number of Variables: 0
Number of Observations: 937

Insert 4)

Class C Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	9	16	41	19	19	9	6	0	0	119
NNE	0	3	15	27	16	16	18	0	0	0	95
NE	0	8	6	23	23	25	6	0	0	0	91
ENE	0	5	3	8	21	42	15	6	2	0	102
E	0	3	2	17	12	22	12	9	1	0	78
ESE	1	2	9	29	20	27	9	2	0	0	99
SE	0	3	9	32	26	12	3	1	0	0	86
SSE	0	3	11	25	22	4	6	1	0	0	72
S	1	11	10	28	19	19	4	0	0	0	92
SSW	2	10	16	35	45	45	23	7	0	0	183
SW	1	15	21	35	58	56	31	38	6	0	261
WSW	0	15	22	50	37	46	15	6	0	0	191
W	0	19	29	41	39	22	15	0	0	0	165
WNW	0	22	26	46	19	21	18	2	0	0	154
NW	0	18	18	37	26	18	9	4	0	0	130
NNW	0	14	12	49	31	15	7	2	0	0	130
TOTAL	5	160	225	523	433	409	200	84	9	0	2048

Notes:
Data from 10 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-273 Annual JFD of Wind Direction, Wind Speed, and Stability Class

Fermi Site

2003-2007

10-m Level

[Add Insert "5" Here]

Pasquill Stability Class D

Neutral (-1.5°C/100m < ΔT ≤ -0.5°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm	3	5	5	3	8	2	6	7	6	5	3	12	13	9	18	17	122
Calm-2	11	12	31	35	26	54	54	69	29	24	22	21	39	82	73	95	671
2-4	28	35	51	58	74	63	83	110	45	67	45	59	108	105	88	158	1178
4-6	63	98	74	36	136	48	91	68	57	61	41	84	129	79	92	162	1319
6-8	73	95	60	57	109	46	42	40	41	41	33	69	158	71	56	100	1092
8-10	72	72	50	79	68	55	40	21	25	16	15	118	156	50	55	64	956
10-13	27	49	12	31	17	35	11	3	7	2	1	51	117	4	11	12	390
13-17	8	6	1		2	10	1				2	8	22	1	2	1	64
17-21				52					1			2	9				64
21+			1						1	3		1		1	1	1	9
All Speeds	285	372	285	351	434	313	328	318	212	219	162	425	751	402	396	610	5865

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 122
Number of Variables: 2
Number of Observations: 5867

Insert 5)

Class D Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	1	73	66	120	121	196	95	30	4	0	706
NNE	0	68	96	153	115	127	83	32	10	0	684
NE	1	32	60	219	328	268	83	3	2	0	996
ENE	1	21	30	119	210	271	120	46	4	0	822
E	1	11	29	85	155	200	137	72	20	1	711
ESE	2	27	47	132	167	190	60	29	1	0	655
SE	6	26	35	145	136	88	23	9	0	0	468
SSE	1	22	42	89	83	65	15	2	2	0	321
S	2	36	50	118	134	111	32	4	0	0	487
SSW	6	41	54	171	226	288	146	70	1	0	1003
SW	7	70	106	305	394	499	297	125	28	0	1831
WSW	4	130	209	410	327	234	47	13	0	0	1374
W	4	129	171	252	202	157	40	8	0	0	963
WNW	3	146	114	234	165	143	75	11	0	0	891
NW	0	92	127	240	160	112	16	4	0	0	751
NNW	0	87	118	253	193	115	46	17	0	0	829
TOTAL	39	1011	1354	3045	3116	3064	1315	475	72	1	13492

Notes:
Data from 10 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-274 **Annual JFD of Wind Direction, Wind Speed, and Stability Class** [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

10-m Level

Add Insert "6" Here

Pasquill Stability Class E

Slightly Stable (-0.5°C/100m < ΔT ≤ 1.5°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm	8		7	6	6	8	14	23	12	3	6	23	26	37	28	40	248
Calm-2	12	16	19	69	21	56	84	119	50	25	23	58	114	96	112	161	1035
2-4	42	31	51	62	39	55	92	80	82	54	77	129	112	76	70	76	1128
4-6	31	37	64	48	34	24	33	23	77	53	50	111	70	18	30	18	721
6-8	18	21	28	15	12	12	4	7	51	32	38	90	18	5	17	8	376
8-10	17	14	21	4	10	6	1	6	30	12	23	57	18	4	12	4	239
10-13	21	3	12	2	1	4		3	5	1		25	9		3		89
13-17	7	1	4									1	4	1	1		19
17-21	6			46					7		1	3		1	1		65
21+	1						1		1	2	1	1	1	1	1	1	11
All Speeds	163	123	206	252	123	165	229	264	315	182	219	498	372	239	275	308	3931

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 248

Number of Variables: 1

Number of Observations: 3932

Insert 6)

Class E Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	2	105	89	143	80	47	13	5	1	0	485
NNE	0	95	135	138	41	31	6	1	0	0	447
NE	2	48	42	174	86	31	8	0	0	0	391
ENE	3	21	28	113	103	68	10	2	3	0	351
E	4	27	39	117	102	78	50	24	9	2	452
ESE	0	36	63	152	156	78	34	13	0	0	532
SE	2	35	52	135	130	75	10	2	0	0	441
SSE	1	52	66	165	108	81	10	0	1	0	484
S	1	106	116	230	187	118	30	4	0	0	792
SSW	7	124	136	420	325	343	102	21	2	0	1480
SW	3	239	249	294	130	94	31	10	3	0	1053
WSW	5	380	252	216	46	22	1	0	0	0	922
W	5	294	140	138	47	12	4	2	1	0	643
WNW	3	332	165	129	55	31	6	1	2	0	724
NW	4	261	228	125	47	35	6	1	0	0	707
NNW	2	121	158	187	55	18	8	3	0	0	552
TOTAL	44	2276	1958	2876	1698	1162	329	89	22	2	10456

Notes:
Data from 10 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-275 Annual JFD of Wind Direction, Wind Speed, and Stability Class

[EF3 COL 2.0-8-A]

Fermi Site

2003-2007

10-m Level

Add Insert "7" Here

Pasquill Stability Class F

Moderately Stable (1.5°C/100m < ΔT ≤ 4.0°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm	3	1	3	12	5	9	15	21	11	2	7	17	25	60	69	36	296
Calm-2	8	5	12	50	8	22	58	76	33	11	21	53	84	65	101	107	712
2-4	17	4	15	58	6	19	31	12	23	23	35	35	18	6	13	7	325
4-6	8	4	7	9	6	2	3	3	21	16	21	31	7		3		142
6-8	5	6	5			1			16	3	9	18	4			2	70
8-10	4	3							14	5	6	17	1			3	53
10-13	1		4						5		1	9	1	1		5	27
13-17	1											1		1		1	4
17-21				7					1					1		2	11
21+			1	1		1					1		1	2	1	2	10
All Speeds	47	23	47	137	23	54	107	112	124	60	101	181	141	136	187	165	1650

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 296

Number of Variables: 5

Number of Observations: 1655

Insert 7)

Class F Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	1	88	84	85	11	8	1	0	0	0	278
NNE	1	55	35	29	9	3	0	0	0	0	132
NE	1	25	10	10	5	0	0	0	0	0	51
ENE	1	17	6	9	12	8	2	0	0	0	55
E	0	16	11	32	17	15	8	8	0	0	107
ESE	2	20	32	42	31	16	5	0	0	0	148
SE	1	17	32	55	34	18	7	1	0	0	165
SSE	2	49	39	82	47	26	6	2	0	0	253
S	1	97	51	55	41	37	15	2	0	0	299
SSW	1	150	73	124	82	63	11	4	1	0	509
SW	3	212	101	26	13	7	2	0	0	0	364
WSW	5	291	69	6	5	5	1	5	2	0	389
W	3	266	42	7	9	1	0	1	2	0	331
WNW	2	350	72	15	2	6	1	0	0	0	448
NW	2	218	65	15	6	2	0	0	0	0	308
NNW	3	135	69	47	5	6	0	0	0	0	265
TOTAL	29	2006	791	639	329	221	59	23	5	0	4102

Notes:
Data from 10 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-276 Annual JFD of Wind Direction, Wind Speed, and Stability Class [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

10-m Level

Add Insert "8" Here

Pasquill Stability Class G

Extremely Stable (ΔT > 4.0°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm	1		4	3	1	2	11	38	3	1	6	6	11	43	58	26	214
Calm-2	2	2	10	10		6	35	57	6	15	6	18	19	36	83	51	357
2-4	7		5	11	1	9	21	1	4	19	7	15	6	2	4	5	118
4-6	7	1	4			2	2		4	8	14	7					50
6-8	5		2						1	1	4	5	6		1	2	29
8-10			1									3	3			2	9
10-13			1								1					1	3
13-17																	0
17-21				16													16
21+								1									1
All Speeds	22	3	27	40	2	19	69	97	18	44	38	54	45	81	146	87	797

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 214

Number of Variables: 5

Number of Observations: 802

Insert 8)

Class G Pasquill Stability Class

					Wind Speed (Miles/Hour)						
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	41	28	15	2	0	0	0	0	0	86
NNE	0	18	5	10	0	0	0	0	0	0	33
NE	0	10	0	2	0	0	0	0	0	0	12
ENE	0	2	2	2	2	0	0	0	0	0	8
E	0	4	7	10	10	8	2	0	1	0	42
ESE	0	14	20	24	17	10	1	1	0	0	87
SE	0	19	26	35	21	20	3	0	0	0	124
SSE	1	14	13	30	24	13	2	0	0	0	97
S	0	24	9	18	8	5	0	0	0	0	64
SSW	0	49	24	27	14	13	1	0	0	0	128
SW	1	71	17	13	4	7	1	0	0	0	114
WSW	1	165	22	2	0	5	1	0	0	0	196
W	2	227	8	2	0	0	0	0	0	0	239
WNW	0	412	28	3	1	0	0	0	0	0	444
NW	2	200	12	1	1	0	0	0	0	0	216
NNW	0	98	40	19	0	0	0	0	0	0	157
TOTAL	7	1368	261	213	104	81	11	1	1	0	2047

Notes:
Data from 10 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-277 **Annual JFD of Wind Direction, Wind Speed, and Stability Class** [EF3 COL 2.0-8-A]

Add Insert "9" Here

Fermi Site

2003-2007

60-m Level

All Pasquill Stability Categories

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm	9	7	13	2	10	2	3	2	4	12	9	5	7	4	2	7	98
Calm-2	25	38	27	27	33	25	36	26	27	19	24	23	18	27	35	28	438
2-4	48	69	71	58	79	68	80	76	75	71	81	69	49	39	53	51	1037
4-6	89	77	113	61	133	84	127	97	127	154	148	129	80	107	112	68	1706
6-8	113	141	146	73	179	79	140	144	180	175	170	153	144	180	163	131	2311
8-10	178	227	175	112	215	118	265	284	200	178	171	318	304	328	303	336	3712
10-13	213	198	208	125	176	135	257	270	192	127	133	338	406	377	403	474	4032
13-17	127	87	128	55	75	66	93	138	94	47	68	233	235	204	163	305	2118
17-21	104	60	51	535	19	34	47	90	67	18	19	189	257	153	181	239	2063
21+	1	2					1						1				5
All Speeds	907	906	932	1048	919	611	1049	1127	966	801	823	1457	1501	1419	1415	1639	17520

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 98

Number of Variables: 0

Number of Observations: 17520

Insert 9)

All Pasquill Stability Classes

					Wind Speed (Miles/Hour)						
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	48	84	161	183	371	350	231	91	26	1545
NNE	0	45	80	195	222	335	298	247	111	38	1571
NE	0	60	84	236	350	656	485	320	121	8	2320
ENE	2	56	64	185	282	519	485	342	199	61	2195
E	2	37	60	156	272	389	389	475	370	200	2350
ESE	2	40	70	237	383	510	431	432	216	65	2386
SE	2	39	57	264	430	570	359	255	84	44	2104
SSE	3	48	77	251	420	543	328	236	88	24	2018
S	0	43	58	245	337	607	470	385	197	81	2423
SSW	1	37	62	198	331	746	813	853	562	189	3792
SW	3	41	52	175	298	714	885	834	579	306	3887
WSW	1	61	51	169	258	789	1027	1092	533	254	4235
W	0	56	47	168	314	757	927	712	420	203	3604
WNW	0	65	83	162	268	721	869	695	369	257	3489
NW	1	57	54	180	254	702	681	419	253	115	2716
NNW	1	52	89	195	300	602	604	299	138	41	2321
TOTAL	18	785	1072	3177	4902	9531	9401	7827	4331	1912	42956

Notes:
Data from 60 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-278 **Annual JFD of Wind Direction, Wind Speed, and Stability Class** [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

60-m Level

Add Insert "10" Here

Pasquill Stability Class A

Extremely Unstable (ΔT ≤ -1.9°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm	4	5	3		7	1			1	4	2	2	2	1		3	35
Calm-2	4	11	3	2	6	1	2	4	5	4	3	5	3	3	5	2	63
2-4	16	14	15	8	10	4	7	12	20	13	11	20	11	14	11	14	200
4-6	35	20	53	5	17	6	14	16	43	83	66	34	14	24	35	13	478
6-8	45	29	69	7	28	5	10	21	67	69	77	37	23	32	31	14	564
8-10	41	33	59	7	30	9	42	48	56	34	42	72	39	46	39	26	623
10-13	52	19	48	8	17	9	28	60	17	10	9	78	39	57	73	51	575
13-17	27	10	33		7	6	18	40	5	1	4	26	16	48	55	39	335
17-21	7	6	7	18		3	10	20	2	2	1	12	13	18	26	23	168
21+		1											1				2
All Speeds	231	148	290	55	122	44	131	221	216	220	215	286	161	243	275	185	3043

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 35

Number of Variables: 0

Number of Observations: 3043

Insert 10)

Class A Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	4	8	25	29	41	33	12	4	4	160
NNE	0	4	8	23	26	38	31	22	10	4	166
NE	0	16	12	41	47	94	94	40	15	0	359
ENE	1	24	20	46	78	113	86	42	27	5	442
E	1	7	11	62	113	113	122	93	95	20	637
ESE	1	8	18	110	197	221	118	82	33	2	790
SE	1	7	18	108	237	222	65	12	3	0	673
SSE	0	6	16	91	212	217	61	11	5	0	619
S	0	9	8	85	146	225	73	35	6	0	587
SSW	0	6	14	61	98	228	183	121	42	8	761
SW	2	7	9	47	53	106	101	85	33	12	455
WSW	0	10	3	31	45	93	122	169	69	19	561
W	0	5	6	43	75	135	119	146	114	45	688
WNW	0	5	12	42	77	160	145	184	111	50	786
NW	0	6	9	34	68	138	128	117	70	28	598
NNW	0	6	6	32	44	86	79	32	21	4	310
TOTAL	6	130	178	881	1545	2230	1560	1203	658	201	8592

Notes:
Data from 60 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-279 **Annual JFD of Wind Direction, Wind Speed, and Stability Class** [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

60-m Level

Add Insert "11" Here

Pasquill Stability Class B

Moderately Unstable (-1.9°C/100m < ΔT ≤ -1.7°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm			1									1				1	3
Calm-2	1	1		4	1		2	3	2	1	1			1	4	1	22
2-4	2	5	7	3	1	6	8	9	6	11	9	15	2	2	4	5	95
4-6	2	3	8	2	2	4	16	5	9	11	11	7	8	7	5	7	107
6-8	4	6	9	4	9		12	8	14	8	14	8	11	17	18	7	149
8-10	8	7	9	6	5	5	15	18	8	6	4	18	18	20	18	13	178
10-13	12	11	11	4	4	5	14	16	4	2	3	25	19	17	17	20	184
13-17	4	5	3	2	3	3	4	14	2	1	2	12	16	23	7	19	120
17-21	3	3	2	13	1		5	8	1	1	1	6	12	8	13	20	97
21+																	0
All Speeds	36	41	50	38	26	23	76	81	46	41	45	92	86	95	86	93	955

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 3

Number of Variables: 0

Number of Observations: 955

Insert 11)

Class B Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	2	9	14	11	15	12	4	4	3	74
NNE	0	2	3	14	8	8	15	14	6	0	70
NE	0	1	6	2	11	23	16	9	4	1	73
ENE	0	3	5	8	6	19	14	17	9	4	85
E	0	1	5	9	13	20	13	25	20	4	110
ESE	0	1	7	16	14	20	19	17	14	1	109
SE	0	3	4	22	25	22	17	6	1	1	101
SSE	0	4	6	21	27	23	14	3	1	0	99
S	0	3	3	14	24	34	16	10	4	0	108
SSW	0	1	6	22	23	35	41	43	23	7	201
SW	0	0	5	10	22	36	37	48	34	23	215
WSW	0	4	1	11	15	38	39	65	29	30	232
W	0	3	3	7	24	51	45	59	41	15	248
WNW	0	6	9	7	14	41	31	39	30	16	193
NW	0	6	4	9	14	43	34	23	36	6	175
NNW	0	3	5	18	26	42	24	18	12	1	149
TOTAL	0	43	81	204	277	470	387	400	268	112	2242

Notes:
Data from 60 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Add Insert "12" Here

Table 2.3-280 Annual JFD of Wind Direction, Wind Speed, and Stability Class [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

60-m Level

Pasquill Stability Class C

Slightly Unstable (-1.7°C/100m < ΔT ≤ -1.5°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm																1	1
Calm-2	1	4	1	3	1	1	2	3	2		2	1	3	3	3	1	31
2-4	3	3	5	5	3	4	4	2	4	3	4	3	7	2	4	4	60
4-6	6	1	4	4	3	5	6	8	8	7	8	7	6	4	4	4	85
6-8	4	3	7	6	9	9	15	6	9	11	1	12	4	14	15	9	134
8-10	6	10	2	7	7	4	16	14	6	6	5	14	16	11	25	16	165
10-13	11	16	7	5	13	10	12	9	12	4	3	17	17	16	21	23	196
13-17	6	9	3	8	5	6	9	9	4	1	3	18	8	19	9	19	136
17-21	6	7		12	2			6			1	10	16	16	21	32	129
21+																	0
All Speeds	43	53	29	50	43	39	64	57	45	32	27	82	77	85	102	109	937

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 1

Number of Variables: 0

Number of Observations: 937

Insert 12)

Class C Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	3	6	15	14	20	12	14	7	5	96
NNE	0	2	5	8	13	18	14	13	7	0	80
NE	0	1	2	9	13	24	24	14	8	0	95
ENE	0	2	4	5	7	19	32	28	11	7	115
E	0	2	2	6	9	10	8	23	14	11	85
ESE	0	1	4	7	12	17	14	22	9	0	86
SE	0	0	1	15	17	16	14	7	3	0	73
SSE	0	2	6	14	17	15	12	6	7	1	80
S	0	1	4	15	17	18	21	14	3	0	93
SSW	0	2	5	4	10	42	31	36	21	4	155
SW	0	4	4	15	15	27	34	35	30	35	199
WSW	0	1	3	9	18	33	41	60	42	43	250
W	0	6	2	10	21	33	41	41	31	21	206
WNW	0	5	3	9	13	34	33	33	24	29	183
NW	0	4	2	10	15	30	23	16	15	13	128
NNW	0	3	7	10	15	36	31	15	11	1	129
TOTAL	0	39	60	161	226	392	385	377	243	170	2053

Notes:
Data from 60 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-281 Annual JFD of Wind Direction, Wind Speed, and Stability Class

Fermi Site

2003-2007

60-m Level

Add Insert "13" Here

Pasquill Stability Class D

Neutral (-1.5°C/100m < ΔT ≤ -0.5°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm	5	1	5	1	1	1			1	2			1	1	1		20
Calm-2	9	3	10	4	6	7	10	9	3	2	8	5	6	11	7	9	109
2-4	4	8	17	18	20	28	19	17	19	18	27	7	6	6	14	9	237
4-6	22	12	20	24	35	33	34	22	22	16	25	20	12	27	23	17	364
6-8	21	45	35	20	71	31	45	35	28	40	19	25	31	64	38	57	605
8-10	60	121	64	17	106	44	82	80	29	63	33	80	65	92	77	128	1141
10-13	90	131	68	54	128	56	99	91	55	45	28	79	145	122	111	222	1524
13-17	54	50	45	41	53	43	50	50	25	10	12	71	136	93	62	201	996
17-21	49	42	14	73	14	30	30	42	12	2	2	53	175	90	88	152	868
21+		1															1
All Speeds	314	414	278	252	434	273	369	346	194	198	154	340	577	506	421	795	5865

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 20

Number of Variables: 0

Number of Observations: 5865

Insert 13)

Class D Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	13	24	44	53	88	107	128	59	12	528
NNE	0	15	23	74	81	113	101	133	83	34	657
NE	0	12	12	59	79	280	261	226	84	6	1019
ENE	1	3	7	38	56	177	239	213	124	43	901
E	0	10	16	24	47	98	127	186	168	105	781
ESE	1	7	18	32	67	133	138	155	72	19	642
SE	0	6	8	41	50	114	100	69	19	6	413
SSE	0	8	14	40	55	79	59	47	12	2	316
S	0	7	13	37	41	89	103	103	46	13	452
SSW	0	10	5	31	45	133	194	206	166	63	853
SW	0	7	9	19	63	155	273	387	349	185	1447
WSW	0	23	9	39	83	277	351	516	346	154	1798
W	0	16	10	35	60	219	271	250	187	103	1151
WNW	0	22	20	33	55	149	211	215	138	135	978
NW	0	13	15	35	57	171	182	155	94	45	767
NNW	0	8	23	40	85	181	196	148	81	30	792
TOTAL	2	180	226	621	977	2456	2913	3137	2028	955	13495

Notes:
Data from 60 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-282 Annual JFD of Wind Direction, Wind Speed, and Stability Class [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

60-m Level

Add Insert "14" Here

Pasquill Stability Class E

Slightly Stable (-0.5°C/100m < ΔT ≤ 1.5°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm		1	2	1	2				2	4	5	1	1				19
Calm-2	6	11	6	8	5	7	7	3	1	4	5	5	4	2	9	8	91
2-4	9	18	9	15	19	14	21	10	14	12	17	4	12	9	12	6	201
4-6	15	22	17	11	47	20	24	19	19	25	25	24	20	19	22	12	341
6-8	32	37	20	21	42	25	34	38	35	38	35	34	31	34	29	32	517
8-10	50	41	31	44	40	33	71	69	64	57	62	96	88	108	71	101	1026
10-13	36	18	53	31	9	37	67	47	75	46	51	106	129	112	100	119	1036
13-17	31	9	31	4	7	7	9	24	34	22	27	66	52	21	28	15	387
17-21	31	2	21	52	2	1	2	14	30	7	4	61	35	11	33	7	313
21+																	0
All Speeds	210	159	190	187	173	144	235	224	274	215	231	397	372	316	304	300	3931

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 19

Number of Variables: 0

Number of Observations: 3931

Insert 14)

Class E Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	13	21	34	39	125	108	50	16	2	408
NNE	0	9	18	41	59	111	83	53	4	0	378
NE	0	10	20	70	115	180	67	27	10	1	500
ENE	0	10	13	40	67	148	101	35	25	2	441
E	0	7	9	29	65	124	93	126	62	42	557
ESE	0	7	10	27	72	98	117	99	52	24	506
SE	0	8	15	37	65	151	119	92	20	7	514
SSE	1	20	14	56	59	127	114	92	20	4	507
S	0	6	13	44	54	151	163	151	80	37	699
SSW	0	10	11	26	66	195	276	334	210	74	1202
SW	1	9	14	37	73	214	301	217	102	50	1018
WSW	0	11	12	38	56	234	341	240	36	6	974
W	0	9	12	34	76	199	279	155	40	11	815
WNW	0	10	17	37	59	187	205	152	62	24	753
NW	0	12	14	38	51	193	185	77	38	21	629
NNW	0	15	22	48	67	154	175	58	13	5	557
TOTAL	2	166	235	636	1043	2591	2727	1958	790	310	10458

Notes:
Data from 60 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-283 Annual JFD of Wind Direction, Wind Speed, and Stability Class [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

60-m Level

Add Insert "15" Here

Pasquill Stability Class F

Moderately Stable (1.5°C/100m < ΔT ≤ 4.0°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm							3	2		1		1		1	1	1	10
Calm-2	1	6	3	5	5	3	7	2	8	4	2	2		5	4	4	61
2-4	9	16	10	3	14	5	12	13	3	9	6	8	5	1	2	7	123
4-6	6	13	9	8	20	10	19	19	20	10	10	22	13	16	13	10	218
6-8	5	17	6	5	17	6	16	18	18	7	22	22	32	7	24	9	231
8-10	11	11	6	27	21	16	27	41	25	7	25	26	59	28	56	37	423
10-13	8	2	15	16	4	15	28	30	16	12	26	24	40	40	67	30	373
13-17	4	4	8			1	2	1	16	10	12	34	5		2	7	106
17-21	5		7	7					19	5	6	41	2	10		1	103
21+	1						1										2
All Speeds	50	69	64	71	81	56	115	[illegible]	125	65	109	180	156	108	169	106	1650

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 10

Number of Variables: 0

Number of Observations: 1650

Insert 15)

Class F Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	8	10	11	21	59	55	16	0	0	180
NNE	0	5	7	21	20	36	41	8	0	0	138
NE	0	6	16	35	66	43	19	3	0	0	188
ENE	0	6	9	32	51	31	10	6	3	0	148
E	1	6	11	15	17	17	17	19	8	13	124
ESE	0	7	8	28	18	16	22	43	16	13	171
SE	0	11	7	25	32	32	25	45	21	11	209
SSE	0	5	9	19	43	68	54	48	21	12	279
S	0	12	6	29	39	64	63	51	39	25	328
SSW	1	3	4	23	54	79	63	90	86	28	431
SW	0	4	4	24	47	137	93	46	18	0	373
WSW	0	9	11	20	25	70	100	35	5	0	275
W	0	11	6	17	26	74	117	48	7	8	314
WNW	0	7	12	19	31	102	182	58	4	3	418
NW	1	8	5	32	30	76	88	23	0	2	265
NNW	1	10	10	28	40	61	71	22	0	0	243
TOTAL	4	118	135	378	560	965	1020	561	228	115	4084

Notes:
Data from 60 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Table 2.3-284 Annual JFD of Wind Direction, Wind Speed, and Stability Class [EF3 COL 2.0-8-A]

Fermi Site

2003-2007

60-m Level

Add Insert "16" Here

Pasquill Stability Class G

Extremely Stable (ΔT > 4.0°C/100m)

Wind Direction From

Wind Speed (mph) (1)	E	ENE	ESE	N	NE	NNE	NNW	NW	S	SE	SSE	SSW	SW	W	WNW	WSW	All Directions
Calm			2							1	2		3	1		1	10
Calm-2	3	2	4	1	9	6	6	2	6	4	3	5	2	2	3	3	61
2-4	5	5	8	6	12	7	9	13	9	5	7	12	6	5	6	6	121
4-6	3	6	2	7	9	6	14	8	6	2	3	15	7	10	10	5	113
6-8	2	4		10	3	3	8	18	9	2	2	15	12	12	8	3	111
8-10	2	4	4	4	6	7	12	14	12	5		12	19	23	17	15	156
10-13	4	1	6	7	1	3	9	17	13	8	13	9	17	13	14	9	144
13-17	1		5				1		8	2	8	6	2			5	38
17-21	3			18					3	1	4	6	4			4	43
21+																	0
All Speeds	23	22	31	53	40	32	59	72	66	30	42	80	72	66	58	51	797

1. Calm represents wind speeds less than or equal to 0.50 mph

Number of Calms: 10

Number of Variables: 0

Number of Observations: 797

Insert 16)

Class G Pasquill Stability Class

	Wind Speed (Miles/Hour)										
Direction	**<0.75**	**0.75-3.36**	**3.361-4.5**	**4.51-6.5**	**6.51-8.5**	**8.51-11.5**	**11.51-14.5**	**14.51-18.5**	**18.51-23.5**	**>23.51**	**Total**
N	0	5	6	18	16	23	23	7	1	0	99
NNE	0	8	16	14	15	11	13	4	1	0	82
NE	0	14	16	20	19	12	4	1	0	0	86
ENE	0	8	6	16	17	12	3	1	0	0	63
E	0	4	6	11	8	7	9	3	3	5	56
ESE	0	9	5	17	3	5	3	14	20	6	82
SE	1	4	4	16	4	13	19	24	17	19	121
SSE	2	3	12	10	7	14	14	29	22	5	118
S	0	5	11	21	16	26	31	21	19	6	156
SSW	0	5	17	31	35	34	25	23	14	5	189
SW	0	10	7	23	25	39	46	16	13	1	180
WSW	1	3	12	21	16	44	33	7	6	2	145
W	0	6	8	22	32	46	55	13	0	0	182
WNW	0	10	10	15	19	48	62	14	0	0	178
NW	0	8	5	22	19	51	41	8	0	0	154
NNW	0	7	16	19	23	42	28	6	0	0	141
TOTAL	4	109	157	296	274	427	409	191	116	49	2032

Notes:
Data from 60 meter level
Data from 2003-2007
Calm is defined as a wind speed less than 0.75 mph

Attachment 26
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4123)

RAI Question No. 02.03.03-6

NRC RAI 02.03.03-6

A comparison of stability class frequency distributions (based on the onsite meteorological tower 60m-10m delta-temperature measurements) between 1974-1975 (from Fermi 2 UFSAR Table 2.3-11) and 2002-2007 (from Fermi 3 FSAR Tables 2.3-292 through 2.3-298) is shown below:

Stability Class Frequency Distribution (Values in Percent)

Stability Class	*Period of Record*	
	1974-1975	*2002-2007*
A	*9.2*	*20.1*
B	*2.1*	*5.4*
C	*2.4*	*5.2*
D	*30.3*	*30.7*
E	*40.5*	*24.5*
F	*10.3*	*9.4*
G	*5.3*	*4.6*

a. *Please explain the 11.0 percent annual increase in A stability occurrences (from 9.2 percent to 20.1 percent) and the 15.9 percent annual decrease in E stability occurrences (from 40.5 percent to 24.5 percent) between these two periods of record.*

b. *A review of the 2001-2007 hourly delta-temperature measurements provided to the staff in the response to environmental RAI AQ2.7-3 (dated October 30, 2009) indicates that during the period 2004-2007 approximately 420 occurrences per year on average were recorded when the autoconvective lapse rate of -3.4 °C/100 meters was exceeded (i.e., the density of the atmosphere increases with height). Many of these hours exceeded a lapse rate of -5.0 °C/100 meters. Please explain the relatively frequent occurrence (~5 % of the time annually) of such extreme unstable conditions during this period.*

Response

a. *Please explain the 11.0 percent annual increase in A stability occurrences (from 9.2 percent to 20.1 percent) and the 15.9 percent annual decrease in E stability occurrences (from 40.5 percent to 24.5 percent) between these two periods of record.*

The atmospheric stability class frequency distribution during each year for the time period 1995-2007 was evaluated. This was an effort to correlate any possible data inconsistencies with instrumentation replacements or modifications, as might be expected if instrumentation was malfunctioning. Table 1 displays the frequency of occurrence of the unstable, neutral, and stable Pasquill stability categories.

**Table 1
Frequency Distribution of Stability Categories for Fermi Site**

Year	All Unstable	Neutral	All Stable
1995	18.78	48.13	33.09
1996	30.40	38.75	30.85
1997	21.73	46.88	31.39
1998	20.31	42.53	37.16
1999	27.32	37.03	35.64
2000	24.51	36.53	38.96
2001	25.80	36.84	37.37
2002	33.57	31.16	35.28
2003	24.07	29.56	46.38
2004	33.12	35.06	31.82
2005	31.24	29.87	38.89
2006	30.68	31.30	38.03
2007	30.50	27.50	41.99
% Change*	7.17	-15.03	7.86

*Represents the average value of the last 3 years minus the average of the first 3 years.

There is no correlation or data shifts identified with the Fermi onsite meteorological data, however a noticeable decreasing trend is obvious in the frequency of neutral (Pasquill Stability Classification D) stability classification with a corresponding increasing trend in both the stable (Pasquill Stability Classification E, F and G) and unstable (Pasquill Stability Classification A, B and C) classifications.

Stability information from the Detroit Metropolitan Airport for the same time period is displayed in Table 2, and shows similar trends as the Fermi site data; i.e., decreasing trend in the frequency of neutral stability classifications with corresponding increase in the frequency of stable and unstable classifications. Although a trend in Fermi onsite stability frequencies is identified, no correlations with instrumentation change-outs or data step changes were evident, and the stability classification trend was verified to be consistent with other local meteorological data.

Table 2
Frequency Distribution of Stability Categories for Detroit Metropolitan Airport

Year	All Unstable	Neutral	All Stable
1995	12.95	62.87	24.18
1996	10.53	64.46	25.01
1997	11.72	63.93	24.35
1998	14.31	57.35	28.34
1999	16.14	52.68	31.18
2000	15.19	54.30	30.50
2001	15.70	56.67	27.63
2002	15.28	55.15	29.57
2003	16.31	52.76	30.94
2004	14.98	55.87	29.15
2005	17.67	49.41	32.92
2006	16.94	53.25	31.96
2007	17.74	49.73	32.53
% Change*	5.72	-12.96	8.35

*Represents the average value of the last 3 years minus the average value of the first 3 years.

b. *A review of the 2001-2007 hourly delta-temperature measurements provided to the staff in the response to environmental RAI AQ2.7-3 (dated October 30, 2009) indicates that during the period 2004-2007 approximately 420 occurrences per year on average were recorded when the autoconvective lapse rate of -3.4 °C/100 meters was exceeded (i.e., the density of the atmosphere increases with height). Many of these hours exceeded a lapse rate of -5.0 °C/100 meters. Please explain the relatively frequent occurrence (~5 % of the time annually) of such extreme unstable conditions during this period.*

The hourly meteorological temperature and wind data measured at the 10 and 60-meter levels at the Fermi site for the years 2001 through 2007 were reviewed. Out of the 61,344 observations that were reported there were 2,401 occurrences when the vertical temperature gradient was equal to or less than -3.4°C/100 meters. Seventy four percent (1,774) of the 2401 occurrences were at times when the wind direction was onshore from Lake Erie (between 50 and 190 degrees). Such wind directions can occur during a lake breeze, or during onshore gradient flow, when the large scale weather pattern leads to winds from lake towards land. The lake breeze occurs in the late morning and afternoon hours primarily during the late spring, summer, and early fall months at the Fermi site. Therefore, a majority of the occurrences when the vertical lapse rate exceeds -3.4°C/100 meters can be attributed to situations of strong cold advection that affects the 60m level temperature data more than the 10m level.

The remaining 627 occurrences do not correlate with cold air advection occurrences; however, although these remaining 627 hourly observations are questionable and are 7%

(627/10,082) of the Class A hours presented in Table 2.3-292, these hourly observations only account for 1% (627/50,072) of the total hourly observations in the meteorological data.

Proposed COLA Revision

None

Attachment 27
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4123)

RAI Question No. 02.03.03-7

NRC RAI 02.03.03-7

In accordance with criteria specified in Section C.8 of Regulatory Guide 1.23, please discuss any provisions that will be in place to obtain representative meteorological data (e.g., wind speed and direction representative of the 10-meter level and an estimate of atmospheric stability) from alternative sources during an emergency if the site meteorological monitoring system should be unavailable.

Response

The meteorological monitoring system for Fermi 3 as described in FSAR Section 2.3.3 measures ambient temperature, wind speed, and wind direction at the 10 meter level, as well as the ΔT between the 10 and 60 meter level to estimate stability. The data collected at the meteorological tower is acquired and archived by the Integrated Plant Computer System (IPCS). The IPCS provides real-time meteorological data for calculating offsite radiological dose assessment. The emergency response function of the system interfaces with the Meteorological Data Acquisition System (MDAS) to provide and retain data needed to project offsite doses. Computer terminals are located in the Control Room, as well as other onsite locations. In addition, the IPCS has the capability of being remotely interrogated on a simultaneous basis by multiple users. Sufficient redundancy is built into the system so only under the most unusual circumstances would data be unavailable from the meteorological system. Should any of the parameters required for dose assessment become unavailable, supplementary meteorological data is available via the corporate computer system.

As indicated in Section H, Subsections 6 and 7 of the Fermi 3 Emergency Plan, in the unlikely event that both the primary and backup meteorological systems become inoperable during an emergency, Detroit Edison maintains a contract with a vendor to provide pertinent weather and forecast data. In addition, ambient temperature, wind direction, wind speed, and an estimated atmospheric stability data are available by contacting the nearest National Weather Service office. These measures ensure sufficient provisions are in place for Fermi 3 to obtain representative meteorological data from alternative sources in the event of an emergency when meteorological data from the site is unavailable.

Proposed COLA Revision

None

Attachment 28
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4125

RAI Question No. 02.03.04-2

NRC RAI 02.03.04-2

Portions of the EAB and outer boundary of the LPZ extend over Lake Erie. Revise the FSAR as necessary to discuss the impact of changes in surface temperature and roughness resulting from overwater trajectories on the resulting offsite short-term atmospheric dispersion estimates.

Response

Atmospheric dispersion factors (X/Q values) provided in FSAR Section 2.3.4 were determined for short term potential accident consequence assessments using the PAVAN computer code (NUREG/CR-2858) with meteorological input from the Fermi 2 meteorological tower from 2002 through 2007.

As discussed in the response to RAI AQ2.7-2 in Detroit Edison letter NRC3-09-0016 (ML093380331), the short term X/Q values determined for Fermi use standard default correction factors to account for recirculation or stagnation effects. The standard default correction was implemented in lieu of the other option available for such corrections, specific site measurements. The implementation of the standard default correction factor is intended to account for spatial and temporal variations in airflow, such as may occur at shorelines.

As described in FSAR Section 2.3.4, the EAB is a circle centered at the Reactor Building with a radius of 892 meters. The LPZ is a 4828 meter (3 miles) radius circle centered at the Reactor Building. As described in the response to RAI 02.03.04-1 in Detroit Edison letter NRC2-09-0036 (ML093130117), a smaller radius is used for calculating the EAB and LPZ atmospheric dispersion factors to account for possible release locations. As shown on FSAR Figure 2.1-203, the majority of the EAB compromises by the land on Detroit Edison property. The area of the EAB that extends into Lake Erie is encompassed by the Security Boundary established by 33 CFR 165.915. As shown in FSAR Figure 2.1-203, the EAB approaches the site boundary in the WNW and NW directions. As shown on FSAR Figure 2.1-206, at three miles from the center of the Reactor Building, the NE, ENE, E, ESE, SE, SSE, S, SSW, and SW direction are in Lake Erie which are not habitable areas.

The maximum predicted atmospheric dispersion values are compared to the DCD values in FSAR Table 2.0-201 to demonstrate that the site is bounded by the DCD. The site specific atmospheric dispersion values selected for this comparison were chosen without regard to direction. That is, the maximum values were used without considering if the location could be habitable or not. For Fermi 3, the maximum atmospheric dispersion values are predicted in the ESE direction. As discussed above, this direction is in Lake Erie and not habitable in either the EAB or LPZ distances. Therefore, this approach is conservative.

Based on this conservative approach, and given the correction factors that are already applied, it is not considered necessary to specifically account for potential impacts to the atmospheric dispersion factors due to surface temperature and roughness resulting from over-water trajectories.

Proposed COLA Revision

None

Attachment 29
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4125

RAI Question No. 02.03.04-3

NRC RAI 02.03.04-3

FSAR Section 2.3.4.1 states the PAVAN computer code (NUREG/CR-2858) was used to generate the offsite (EAB and LPZ) short-tem (accident) atmospheric dispersion (CHI/Q) estimates. FSAR Tables 2.3-292 through 2.3-299 present the 2002-2007 joint frequency distribution (JFD) of wind direction and wind speed by atmospheric stability class used by the applicant to execute PAVAN. Copies of the applicant's PAVAN input and output files were also provided in response to environmental RAI AQ2.7-4 dated September 30, 2009.

The staff performed an independent evaluation of the applicant's PAVAN results by generating a JFD from the 2002-2007 hourly onsite meteorological database provided in response to environmental RAI

AQ2.7-3 dated October 30, 2009 and rerunning the PAVAN computer code. The staff's JFD was based on the wind speed classes presented in Table 3 of Revision 1 to RG 1.23 (i.e., calm, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0, 10.0 and > 10.0 m/s). The staff's results were more conservative (i.e., higher) than those generated by the applicant's PAVAN run. The staff believes its more conservative results are primarily due to the difference in the frequency of calm winds between the applicant's JFD and the staff's JFD

The staff agrees with the applicant's results in that the ESE sector has the maximum sector CHI/Q values that also bound the 5 percent overall site CHI/Q values. FSAR Tables 2.3-292 through 2.3-299 show a total of 212 hours of calm wind were recorded during 2002-2007, with a total of 9 of the 212 hours of calm winds being assigned to the WNW sector (which is the upwind sector to the ESE sector). On the other hand, the staff's analysis of the 2002-2007 hourly database identified a total of 464 hours of calm wind, with approximately 82 of the 464 hours calm winds being assigned to the WNW sector based on the RG 1.145 criterion that wind directions during calm conditions should be assigned in proportion to the directional distribution of non-calm winds with speeds less than 1.5 meters per second.

a. *Please explain why there are differences in the number of hours of calm winds presented in FSAR Tables 2.3-292 through 2.3-299 versus the number of hours of calm winds reported during 2002- 2007 in the hourly database provided in response to environmental RAI AQ2.7-3.*
b. *Please explain how the calm winds were assigned to wind direction sectors in FSAR Tables 2.3-292 through 2.3-299 and justify any deviations from the methodologies presented in RG 1.23 and RG 1.145.*

Response

As described in FSAR, Section 2.3.4.1, joint frequency distributions (JFDs) of wind direction and wind speed by atmospheric stability were input to the PAVAN computer code (NUREG-2858, 1982) to determine the atmospheric dispersion factors (X/Qs) at the Exclusion Area Boundary (EAB) and the Low Population Zone (LPZ). The meteorological data used for these analyses was collected from onsite monitoring equipment from 2002 through 2007. The data was binned into wind speed intervals by stability class and reported in FSAR Tables 2.3-292 through 2.3-299.

Reg Guide 1.23 defines a Calm as "Any wind speed below the starting threshold of the wind speed or direction sensor, whichever is greater." and defines starting threshold as "The minimum wind speed above which the measuring instrument is performing within its minimum specification."

FSAR Tables 2.3-292 through 2.3-299 show the number of occurrences by wind direction and wind speed for each stability class. The lowest wind speed bin is 0.75 miles/hr (0.334 m/s) in the JFD tables shown in FSAR Tables 2.3-292 through 2.3-299, based on a calm condition threshold of less than 0.75 miles/hr. The 2002-2007 hourly onsite meteorological database was binned into slightly different wind speed intervals for purposes of displaying wind rose figures in FSAR Section 2.3. In the data file included in the response to Environmental Report RAI AQ2.7-3 in Detroit Edison letter NRC3-09-0015 dated October 30, 2009 (ML093090165), Detroit Edison identified that wind speeds less than 0.5144 m/s (1 knot) are considered calm. As noted in FSAR Section 2.3.2.1.5, calm hours are counted when wind speeds are less than 1 knot at the Fermi site, explaining the large drop in percentage when compared to annual calm hours at Detroit Metropolitan Airport. The 1 knot criteria in Section 2.3.2.1.5 is consistent with the value used to generate the wind roses provided in FSAR Section 2.3. Binning the number of calms based on the 1 knot (0.5144 m/s) threshold will result in a greater number of calms than using a threshold of 0.75 miles/hr (0.334 m/s).

The Fermi site wind speed transmitter is designed for a low threshold (0.6 miles/hr) and fast response time through a large dynamic wind speed (0-100 miles/hr) range. The wind speed transmitter is comprised of a photochopper assembly, a light emitting diode and a phototransistor (all housed in a cylindrical housing), and a three cup anemometer. As the cup assembly rotates, the photochopper rotates concurrently. The photochopper is in essence a disk having 30 evenly-spaced slot cutouts, and this disk's rotation is converted to an electrical signal. The signal results when the light path between the infrared light emitting diode and photochopper is alternatively blocked and left open by the rotation of the chopper. The resultant signal frequency (in Hz) sensed by the phototransistor is proportional to the wind speed. The proportionality relationship is as follows:

$$\text{Frequency (Hz)} = (\text{MPH} - 0.5) * 9.511$$

Thus, at wind speeds below the actual starting threshold of the sensor, the instrument will record a speed of 0.5 miles/hr. For wind conditions where the sensor generates a frequency signal, a wind speed greater than 0.5 miles/hr will be indicated corresponding to the above relationship without accounting for system accuracy.

The Fermi site wind speed and wind direction sensors are calibrated on a semi-annual basis. The sensors are removed and calibrated by Climatronics, Inc. In the calibration procedures, the limit that is used for the starting threshold for the wind speed sensors is 1.0 miles/hr. Review of actual calibration data corresponding to the time period of the data used in the PAVAN analysis (2002 through 2007) shows that the actual starting thresholds for both the primary and secondary wind speed sensors at both the 10 meter and 60 meter elevations were, with a few noted exceptions, less than 0.75 miles/hr. Typically, the starting thresholds were on the order of 0.5 miles/hr. Exceptions during the 2002 trough 2007 time frame shown in Table 1 below:

Table 1

Instrument	Date	Value (miles/hr)
10 meter Primary Wind Speed	June 2004	0.810 (As Found)
10 meter Secondary Wind Speed	Nov. 2007	0.898 (As Found)
60 meter Primary Wind Speed	May 2003	0.829 (As Found)
60 meter Secondary Wind Speed	May 2003	0.759 (As Found)
60 meter Secondary Wind Speed	June 2004	0.88 (As Found)

For conditions where the "As Found" condition exceeded 0.75 miles/hour, the "As-Left" was returned to less than 0.5 miles/hr. It should be noted that only wind data from the 10 meter instrumentation is used in the PAVAN analysis.

Thus, for the majority of the 2002 through 2007 time period, the actual threshold value was less than 0.75 miles per hour. Furthermore, as shown by the above noted instrument proportionality relationship, as soon as the photochopper disk is rotating, a wind speed (in miles/hr) is recorded. A condition where the disk is not rotating would be recorded as a calm. For instances where the "As-Found" condition was greater than 0.75 miles/hr, wind speeds less than the "As Found" value would have been recorded as a calm. This would result in a higher number of total calms being recorded in the JFD data than would have actually existed; which would provide conservative X/Q values.

It is noted that calibrations of the meteorological tower instrumentation include checks of freedom of movement for the wind direction sensor. Examination of the meteorological data indicates that there is variability in the wind direction measurements during calm conditions, providing some assurance of the accuracy of the indicated direction.

During the evaluation as part of developing the response to this RAI, it was identified that the calm wind conditions were assigned based on the indicated wind direction from the meteorological data base which is inconsistent with the guidance in Reg Guide 1.145.

New, preliminary JFDs were developed using a threshold of 0.75 miles per hour but assigning the calm wind conditions consistent with Reg Guide 1.145. These new, preliminary JFDs were then input to the PAVAN code to calculate X/Qs at the EAB and the LPZ. This determination using these new, preliminary JFDs showed that the maximum X/Qs are in the ESE direction (same direction as the previous results) and all remained well below the limiting X/Q values in the ESBWR DCD, Revision 5.

Detroit Edison is developing new short term and long term X/Qs based on the following:

- A starting threshold of 1.0 miles per hour will be used, consistent with the starting thresholds for wind speed and wind direction in Reg Guide 1.23, Revision 1, Table 2 (refer to the response to RAI 02.03.03-3 in Attachment 23 for further discussion).
- Wind directions during calm conditions will be assigned consistent with Reg Guide 1.145 as discussed in this response.
- Determination of long term X/Qs will be based on distances from the source to the receptors using a circle that encompasses possible release locations (refer to the response to RAI 02.03.05-2 in Attachment 31 for further discussion).
- Analyses that use the site-specific X/Q values as input parameters will be updated, as necessary, based on the results.

Detroit Edison expects to supplement this response and provide updates to affected information in the Fermi 3 COLA either in conjunction with the next COLA revision or as a supplemental response to this RAI. The next Fermi 3 COLA revision is scheduled to be submitted by March 25, 2010. If a supplemental response to this RAI is necessary, it will also be submitted by that date.

<u>Proposed COLA Revision</u>

None

Attachment 30
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4125)

RAI Question No. 02.03.04-4

NRC RAI 02.03.04-4

FSAR Section 2.3.4.3 states the onsite atmospheric dispersion (CHI/Q) estimates were generated using the ARCON96 computer code in accordance with the guidance provided in RG 1.194. Please provide in electronic form the meteorological input file and all the output files associated with these ARCON96 computer code runs. These data are required by the staff to perform independent evaluations and assessments of the resulting onsite CHI/Q estimates.

Response

The meteorological input file and all the output files associated with the ARCON96 computer code runs to support FSAR Section 2.3.4.3 are provided in electronic form on the CD enclosed with this letter. The contents of the ARCON CD are provided in Enclosure 1 with this response.

Proposed COLA Revision

None

NRC3-10-003
RAI 02.03.04-4

Enclosure 1

Inventory of ARCON96 CD
(following 4 page(s))

Volume in drive D is 100111_1427
Volume Serial Number is 13C5-5D69

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     Total Files Listed:
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Attachment 31
NRC3-10-0003

Response to RAI Letter No. 21
(eRAI Tracking No. 4126)

RAI Question No. 02.03.05-2

NRC RAI 02.03.05-2

FSAR Section 2.3.5 provides estimates of long-term CHI/Q and D/Q values extending to a distance of 80 km (50 mi) from the station. Some of these CHI/Q and D/Q values represent plume transport over water for significant distances. Revise the FSAR as necessary to discuss the impact of changes in surface temperature and roughness resulting from over-water trajectories on the resulting long-term atmospheric dispersion and deposition estimates.

Response

Atmospheric dispersion factors (X/Q values) provided in FSAR Section 2.3.5 were determined for long term routine releases using the XOQDOQ computer code (NUREG/CR-2919) with meteorological input from the Fermi 2 meteorological tower from 2002 through 2007. As discussed in the response to NRC RAI AQ2.7-2 in Detroit Edison letter NRC3-09-0016 (ML093380331), the long term X/Q values determined for Fermi 3 use standard default correction factors to account for recirculation or stagnation effects. The standard default correction was implemented in lieu of specific site measurements. The implementation of the standard default correction factor is intended to account for spatial and temporal variations in airflow, such as may occur at shorelines.

Reg Guide 1.111 provides guidance for determining atmospheric dispersion and deposition estimates for routine releases of radiological effluents to the atmosphere. Reg Guide 1.111, Regulatory Position C.3.d, "Deposition Over Water," states:

> "For dispersion over small bodies of water, deposition may be assumed to occur at the, same rate as over land. For calculations involving radionuclide transport over large bodies of water, deposition should be considered on a case-by-case basis."

The long term atmospheric dispersion results from the XOQDOQ code are used in the GASPAR computer code (NUREG -0597) to determine the predicted dose to the maximum exposed individual (MEI) and the collective dose to the population within 50 miles of the site. Potential impacts of the over-water trajectories are addressed for both the MEI and the population dose below.

- FSAR Table 12.2-18bR shows the predicted gaseous pathway dose to the MEI. As shown the maximum site boundary plume dose is in the SSE direction and the other contributions to the total exposure to the MEI are in the WNW direction. As shown on FSAR Figure 2.1-203, these exposure pathways are directly over land. The SSE direction touches the near the point where Pointe Aux Peaux Road nears Lake Erie. At these relatively small distances, this would be considered a small body of water per Reg Guide 1.111, Regulatory Position C.3.d, and using the same rate of deposition as over land would be appropriate. Therefore, there is no potential impact to the atmospheric dispersion and deposition factors used for determining the long term dose to the MEI.
- FSAR Table 12.2-204 shows the collective dose to the population within 50 miles of the site. The collective dose is determined based on the total population estimates for the year 2060 within 50 miles of the site. FSAR Figure 2.1-207 depicts the regional population distribution, by segment, to 50 miles from the site for the year 2000. Based on the segments shown on Figure 2.1-207 and using the associated population distributions for the year 2060 from Tables 2.1-210 and 2.1-212, the majority (approximately 85%) of the

collective population within 50 miles of the site resides in areas where the trajectory would not be over water. As shown on FSAR Figure 2.1-207, the trajectory over water in the NE, ENE, S and SSW directions is 20 miles or less (depending on direction). Less than 20 miles could be considered as a small water body in lieu of a large water body, and thus, using the same rate of deposition as over land is consistent with Reg Guide 1.111. The trajectory over water in the E, ESE, SE and SSE directions could extend up to the 50 mile radius. The population within the E, SSE and SE directions is less than 2% of the total collective population within 50 miles of the site for the year 2060. Therefore, the potential impact to the collective population dose is very small.

These long term X/Q models are conservatively determined to apply broadly within compass sector and radial ring regions; thus, the very local impacts of over-water wind trajectory changes around these distant coastal regions will not have a significant impact on the X/Q values determined using XOQDOQ for the stated analysis purposes. Therefore, as the only potential impact of the trajectories over Lake Erie is to the collective dose for the population within 50 miles of the site, and based on the small percentage of the population that is potentially impacted by this trajectory, the current modeling remains acceptable.

Proposed COLA Revision

FSAR Section 2.3.5 will clarify how the trajectories over Lake Erie are considered in the long term dispersion values as shown in the proposed markup.

Markup of Detroit Edison COLA
(following 3 page(s))

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

Fermi 2 and Fermi 3 was conservatively assumed (actual distance is approximately 421 m [1381 ft]). The release height and receptor height were both assumed to be 10m (32.8 ft). The methodology uses a "safety factor" of 1.5 to account for any variations in release locations.

EF3 COL 2.0-11-A

2.3.5 Long-Term (Routine) Diffusion Estimates

For a routine release, the concentration of radioactive material in the surrounding region depends on the amount of effluent released, the height of the release, the momentum and buoyancy of the emitted plume, the wind speed, atmospheric stability, airflow patterns of the site, and various effluent removal mechanisms. Annual average relative concentration, X/Q, and annual average relative deposition, D/Q, for gaseous effluent routine releases were, therefore, calculated.

Long term X/Q models are conservatively determined to apply broadly within compass sector and radial ring regions; thus, the very local impacts of over-water wind trajectory changes will not have a significant impact on the X/Q values. The only potential impact of the trajectories over Lake Erie is to the collective dose for the population within 50 miles of the site, and based on the small percentage of the population that is potentially impacted by this trajectory, no specific modeling conditions are included for this trajectory condition.

2.3.5.1 Calculation Methodology and Assumptions

The XOQDOQ computer program, NUREG/CR-2919, which implements the assumptions outlined in Regulatory Guide 1.111, was used to generate the annual average relative concentration, X/Q, and annual average relative deposition, D/Q. Values of X/Q and D/Q were determined at the site boundary, at points of maximum individual exposure, and at points within a radial grid of sixteen 22.5 degree sectors and extending to a distance of 80 km (50 mi). Radioactive decay and dry deposition were considered.

Meteorological data from 2002 through 2007 was used in the analysis. Receptor locations were based on the site boundary in each of the 16 directions as well as the nearest residences, gardens, sheep, goat, meat cow, and milk cow receptor locations in each of the 16 directions based on 2005 through 2007 Land Use Census. Meteorological data in joint frequency distributions format consistent with the Fermi 3 short-term (accident) diffusion X/Q calculation discussed above was utilized.

For this analysis, both ground-level and mixed-mode releases were considered. A ground-level release was considered for releases from the Radwaste Building, while mixed-mode releases were considered for releases from the Reactor Building/Fuel Building Stack and the Turbine Building Stack based on the criteria set forth in Regulatory Guide 1.111. At ground-level locations beyond several miles from the plant, the annual average concentration of effluents are essentially independent of release mode; however, for ground-level concentrations within a few miles, the release mode is important. Gaseous effluents released from tall stacks generally produce peak ground-level air concentrations near or beyond the site boundary. Near ground-level releases usually produce concentrations that decrease from the release point to locations downwind. Guidance for selection of the release mode is provided in Regulatory Guide 1.111.

The following input data and assumptions are used in the analysis:

- Meteorological data: 6-year (2002-2007) composite onsite joint frequency distributions of wind speed, wind direction, and atmospheric stability
- Type of release: Ground-level (Radwaste Building Stack); mixed-mode (Reactor Building/Fuel Building and Turbine Building Stacks)
- Wind sensor height: 10 m
- Vertical temperature difference: between 10 m to 60 m
- Number of wind speed categories: 9
- Release height: 10 m (default height) for ground-level release; 52.62 m for Reactor Building/Fuel Building Stack (mixed-mode); 71.30 m for Turbine Building Stack (mixed-mode)
- Building area: 350 m^2 for ground-level release, conservatively set to zero to neglect the building wake credit for the mixed-mode releases
- Adjacent building height: N/A for ground-level release; 48.05 m for Reactor Building/Fuel Building Stack (mixed-mode); 52.0 m for Turbine Building Stack (mixed-mode)
- Average Vent Velocity: N/A for ground-level release; 17.78 m/s for Reactor Building/Fuel Building Stack (mixed-mode); 17.78 m/s for Turbine Building Stack (mixed-mode)
- Inside Vent Diameter: N/A for ground-level release; 2.40 m for Reactor Building/Fuel Building Stack (mixed-mode); 1.95 m for Turbine Building Stack (mixed-mode)
- Distances from release point to site boundary, nearest residence, nearest garden, neatest sheep, nearest goat, nearest meat cow, and nearest milk cow for all downwind sectors
- Dry deposition is considered for all releases
- Continuous release is assumed

- Site and regional topography are included

Consistent with Regulatory Guide 1.111 guidance regarding radiological impact evaluations, radioactive decay and deposition were considered. Terrain recirculation was considered consistent with Regulatory Guide 1.111 by employing the default terrain correction option.

2.3.5.2 Results

Receptor locations for Fermi were evaluated. Values of X/Q and D/Q were determined at the site boundary, at points of maximum individual exposure, and at points within a radial grid of sixteen 22.5 degree sectors (centered on true north, north-northeast, northeast, etc.) and extending to a distance of 80 km (50 mi) from the station. Receptor locations included in the evaluation are given in Table 2.3-305 and Table 2.3-306. A set of data points were located within each sector at increments of 402 m (0.25 mi). to a distance of 1609 m (1 mile) from the plant, at increments of 805 m (0.5 mile) from a distance of 1609 m to 8000 m (1 mile to 5 mi), at increments of 4023 m (2.5 mi) from a distance of 8 km to 16 km (5 mile to 10 mile), and at increments of 16 km (5 mi) thereafter to a distance of 80 km (50 mi). Table 2.3-328 through Table 2.3-339 summarize annual average X/Q values (no decay and undepleted; 2.26 day decayed and undepleted; 8 day decayed and depleted) and D/Q values at each of these grid points. The results of the analysis, based on meteorological data collected onsite from 2002 through 2007, are presented in Table 2.3-307 through Table 2.3-327.

2.3.6 References

2.3-201 National Climatic Data Center, "2006 Local Climatological Data Annual Summary with Comparative Data for Detroit Metropolitan Airport," January 2007.

2.3-202 National Climatic Data Center, "2006 Local Climatological Data Annual Summary with Comparative Data for Flint, Michigan," January 2007.

2.3-203 National Climatic Data Center, "2006 Local Climatological Data Annual Summary with Comparative Data for Toledo, Ohio," January 2007.

2.3-204 National Climatic Data Center, "Climatography of the United States No. 20 for Monroe, Michigan 1971-2000," February 2004.