APPENDIX F

REPORT BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

September 22, 2014

The Honorable Allison M. Macfarlane
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: REPORT ON THE SAFETY ASPECTS OF THE DTE ELECTRIC COMPANY COMBINED LICENSE APPLICATION FOR FERMI UNIT 3

Dear Chairman Macfarlane:

During the 617th meeting of the Advisory Committee on Reactor Safeguards (ACRS), September 4-6, 2014, we reviewed the NRC staff's Advanced Safety Evaluation Report (ASER) for the DTE Electric Company (DTE or the applicant) combined license application (COLA) for Fermi Unit 3. This application conforms to the design-centered review approach (DCRA).[1] DCRA, which is Commission policy, allows the staff to perform one technical review and reach a decision for a reference COLA addressing issues outside the scope of the design certification and to use this review and decision as a reference to support decisions on other subsequent COLAs. The reactor design selected for Fermi Unit 3 is the 1520 MWe passive Economic Simplified Boiling Water Reactor (ESBWR). Fermi Unit 3 is the reference COLA for that design.

Our ESBWR Subcommittee held six meetings (May 26, 2011; October 21, 2011; November 30, 2011; August 16, 2012; July 7, 2014; and August 20, 2014) to review the COLA and the staff's ASER. During our meetings, we met with representatives of the NRC staff, DTE and its vendors, and the public. We also had the benefit of the documents referenced. This letter fulfills the requirement of 10 CFR 52.87 that the ACRS report on those portions of the application that concern safety.

CONCLUSIONS AND RECOMMENDATION

1. There is reasonable assurance that Fermi Unit 3 can be built and operated without undue risk to the health and safety of the public. The COLA for Fermi Unit 3 should be approved following its final revision.

1 The DCRA is described in Regulatory Issue Summary (RIS) 2006-06, "New Reactor Standardization Needed to Support the Design-Centered Licensing Review Approach," as endorsed by the Commission's Staff Requirements Memorandum in response to SECY-06-0187, "Semiannual Update of the Status of New Reactor Licensing Activities and Future Planning for New Reactors," dated November 16, 2006.

2. There is reasonable assurance that the ESBWR design and the Fermi Unit 3 site satisfy the requirements resulting from the Fukushima Near-Term Task Force recommendations. However, this review has identified generic issues related to seismic reevaluations, mitigating strategies, and spent fuel pool instrumentation. Further action by the staff is needed to resolve these issues not only for Fermi Unit 3, but also for currently operating plants and other combined license applicants.

BACKGROUND

On September 18, 2008, DTE submitted an application to the NRC for a combined license to construct and operate Fermi Unit 3 in accordance with the requirements of 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." In the application, DTE stated that the Fermi Unit 3 reactor will be an ESBWR located at the existing site. The Fermi application is based on Revision 10 of the ESBWR design control document (DCD).

DISCUSSION

The Fermi site is located in Monroe County, Michigan, 30 miles southwest of Detroit. Fermi Unit 1 is decommissioned and is in a SAFESTORE status. Fermi Unit 2 is an operating boiling water reactor. Fermi Unit 3 is proposed to be located on the same site, southwest of Fermi Unit 2.

DEPARTURES FROM THE ESBWR DCD

The Fermi Unit 3 COLA identified only one departure from the ESBWR design. The ESBWR DCD states that on-site storage space for a six-month volume of packaged waste is provided in the Radwaste Building. The Fermi Unit 3 Radwaste Building is configured to accommodate a minimum of ten years volume of packaged Class B and C waste, while maintaining space for at least three months of packaged Class A waste. This departure involves a redesign of the Radwaste Building that affects the arrangement of systems and components within the building volume. The systems and components requiring modifications are associated with the liquid waste management system and the solid waste management system. The applicant stated that the existing Radwaste Building fire protection and HVAC systems have sufficient capacity to accommodate the extra volume of Class B and C wastes, and require no modification. The staff has approved this departure and we concur.

SITE CHARACTERISTICS

Site characteristics include potential hazards in proximity of the plant as well as meteorology, hydrology, geology, seismology, and geotechnical parameters. An applicant must show that the actual site characteristics are bounded by the site parameters for the certified design.

Water Sources

There are two categories of surface water use: withdrawal [2] (non-consumptive) and consumption.[3] Groundwater is not used at Fermi. Lake Erie is the principal source of water for the operation of Fermi Unit 3. The most important Lake Erie parameter with respect to water use is the lake water level. Fermi Unit 3 has been designed to operate at full capacity assuming the lowest historical water level at the plant intake basin. In addition, the safety-related ultimate heat sink does not require makeup for at least 72 hours, and the onsite fire protection system contains sufficient supplemental water to maintain core cooling and spent fuel pool cooling for at least 7 days.

Flooding

The applicant followed current regulatory guidance to determine the probable maximum flood, the probable maximum precipitation, and flood design considerations for the site and showed that the maximum flood level for Fermi Unit 3 satisfies the enveloping site parameters in the DCD. The Fermi site is located outside the realm of significant impact due to flooding from local streams and rivers. The most severe potential flooding condition at the Fermi Unit 3 site involves a storm-related high surge from Lake Erie.

According to ANS/ANSI-2.8-1992, the calculated probable maximum water surge and seiche is based on a probable maximum wind storm (PMWS). The standard indicates that analysis parameters for the PMWS should be determined by a meteorological study. In lieu of a study, the following standard values may be used for the area of the Great Lakes in the vicinity of the site:

- set maximum over-water wind speed to ~ 160 km/hr (100 mph),
- set lowest pressure within the PMWS to ~ 950 mbar,
- apply a most critical, constant translational speed during the life of the PMWS,
- assume that wind speeds over water vary diurnally from 1.3 (day) to 1.6 (night) times the overland speed, and
- assume that winds blow 10 degrees across the isobars over the water body.

In order to determine the maximum postulated flood level at the site, the predicted storm surge was combined with the Lake Erie 100-year high water level. Storm simulation and coastal engineering models were used to calculate the run-up that occurs when waves encounter a shoreline or embankment. The analysis shows that the maximum flood level for Fermi Unit 3 satisfies the enveloping site parameter in the ESBWR DCD.

[2] "Withdrawal" refers to water drawn from surface or groundwater sources that is eventually returned to the area from where it came.
[3] "Consumption" refers to water that is withdrawn but not returned to the region.

Historically, southwest-to-northeast winds have created seiches with large waves on Lake Erie, sometimes causing flooding on eastern shores. The staff examined the historical events and determined that such large waves do not affect southwestern areas of the coast. The staff reviewed the flooding analysis submitted by DTE and found it to be acceptable.

High Winds and Tornadoes

DTE performed an assessment of the tornado and hurricane wind speeds that may occur at the Fermi site. That assessment demonstrated that site-specific wind speeds are bounded by the wind loads that are applied for the ESBWR design. According to ESBWR DCD Table 2.0-1, hurricane-generated missiles must be evaluated for seismic Category NS and Category II structures that house Regulatory Treatment of Non-Safety Systems (RTNSS) equipment. The DTE analyses confirmed that the impacts from site-specific hurricane missiles are bounded by the ESBWR design parameters.

ESBWR DCD Table 2.0-1 also specifically notes that tornado missiles do not apply to seismic Category NS and Category II buildings. Therefore, tornado-generated missiles that may impact structures that contain RTNSS equipment are not evaluated for the ESBWR design, and they are not evaluated as part of the site-specific analyses. ESBWR DCD Table 19A-4 notes that the Ancillary Diesel Generator Building and the Turbine Building structures are designed for tornado wind loads. The Electrical Building, Service Water Building, and Plant Service Water Structures are designed for hurricane wind loads. However, for wind-driven missiles, all of these buildings are designed only to withstand the design-basis hurricane missiles.

Because the ESBWR design can maintain passive core cooling, containment functions, and spent fuel cooling for at least 72 hours without any AC power, operation of RTNSS equipment is not required until approximately 72 hours after the plant is shut down. However, because of this inconsistency in the wind-driven missile analyses, it is unclear that structures which house RTNSS equipment that is credited for mitigation of beyond-design-basis external events will survive site-specific tornado-generated missiles. We note that the FLEX national response centers are intended to provide support for defense-in-depth mitigating strategies if onsite RTNSS equipment is not available after 72 hours.

Local Geology

One topic of discussion was the approach that the applicant used to justify the low probability of potential dissolution voids (karst) in the bedrock at the Fermi Unit 3 site. The applicant noted that karst formation is less likely in areas that have been formerly covered by ice sheets and are now covered by glacial deposits, because glaciers typically eroded away carbonate material or filled in existing karst features. The applicant also noted the absence of large voids or cavities due to dissolution in the subsurface investigations at the Fermi 3 site and the absence of any large voids or cavities in bedrock exposures at the nearby Denniston Quarry. The staff determined that the applicant has adequately justified the conclusion that the evidence supports a low probability of karst formation at the site.

To further substantiate that there are no subsurface faults or deformation features that could cause a hazard, the staff developed a generic license condition that has been applied to all new plant COLAs, requiring the applicant to map and evaluate the bedrock surface exposed during site excavation. For Fermi Unit 3, this would involve all safety-related structures including the nuclear island excavations and should identify solutioned bedrock. The relief of the mapped bedrock surfaces will provide important evidence of the presence of hidden voids in these rocks. Any identification of potential solutioned bedrock will necessarily lead to further study by both direct sampling as well as remote sensing.

Offsite Power Supplies

Fermi Unit 3 is connected to the offsite power grid by three 345kV transmission lines. Fermi Unit 2 is connected to the grid by two 345kV transmission lines and three 120kV transmission lines. All of these transmission lines are routed through a common corridor for approximately four miles before the lines diverge and are routed to separate offsite power substations. The Unit 2 transmission lines also pass through the Unit 3 switchyard, but do not have any connections in that switchyard. The transmission line allocations to specific towers and the spacing of the 345kV towers and 120kV towers in the common corridor ensure that at least one 345kV power supply will remain available to each unit following structural damage to any tower line. This configuration satisfies current regulations for physical and electrical separation of redundant offsite power connections for each unit.

The offsite power transmission lines are vulnerable to damage by high winds or other storm-related conditions that may affect the common corridor. Damage to the offsite power supplies for Unit 3 is mitigated by the ESBWR design features that include two non-safety-related standby diesel generators and two non-safety-related ancillary diesel generators. The availability and reliability of these diesel generators are managed by RTNSS controls. Furthermore, the ESBWR design can maintain passive core cooling, containment functions, and spent fuel cooling for at least 72 hours without any AC power. Considering these design features, we conclude that there is reasonable assurance that plant safety can be maintained with this offsite power transmission line configuration.

FUKUSHIMA REQUIREMENTS

Seismic Reevaluation

In 2011, the NRC Near-Term Task Force (NTTF) issued a series of recommendations for improving nuclear power plant safety in the U.S. following the Fukushima earthquake and tsunami. Recommendation 2.1 stated that plants should reevaluate the seismic hazards at their sites against current NRC requirements and guidance. The NRC issued a letter dated March 12, 2012, requesting that all operating nuclear power plants in the U.S. reevaluate seismic hazards using the most recent information and methodologies available. The letter stated that nuclear power plant sites in the Central and Eastern U.S. (CEUS) should use the seismic source model in NUREG–2115, “Central and Eastern United States Seismic Source Characterization for Nuclear Facilities,” to characterize their seismic hazards. Following the issuance of this letter to the operating nuclear power plants, the staff also requested that all combined license and early site permit applicants address this issue.

To address NTTF Recommendation 2.1, the staff requested additional information from DTE pertaining to the seismic hazard evaluation. The staff asked DTE to reassess the calculated seismic hazard for the Fermi Unit 3 site using the NUREG-2115 seismic source model and to modify its ground motion response spectra and foundation input response spectra as needed.

To supplement the seismic sources that are evaluated in NUREG-2115, DTE compiled records of additional earthquakes that occurred within 320 km of the Fermi site between 2009 and 2012. In accordance with the methods in NUREG-2115, they then screened out earthquakes with moment magnitudes below 2.9. The compilation and screening assessments considered all possible causes for the earthquakes (e.g., natural ground motion, injection wells, hydraulic fracking). All earthquakes with moment magnitudes of 2.9 or above were included in the updated seismic catalog. DTE appropriately accounted for the additional earthquake experience during this interval.

In February 2013, the applicant submitted Revision 5 of the Fermi Unit 3 Final Safety Analysis Report that describes the updated seismic hazard analyses. The staff concluded that the applicant has adequately addressed the required information and has evaluated the seismic hazards at the Fermi Unit 3 site against the current state of knowledge and the NRC requirements.

We agree that the ESBWR seismic design requirements provide adequate margins above the Fermi Unit 3 site-specific hazard. However, we have observed anomalies in the calculated variations of uncertainty with ground motion frequency at Fermi and other sites. We will work with the staff to better understand the analysis methods and computations, since they can affect the seismic hazard assessments for currently operating plants and other combined license applicants.

Despite the ongoing discussions with the staff about the variation of uncertainty with ground motion frequency, the ESBWR seismic design requirements provide adequate margins above the Fermi Unit 3 site-specific seismic hazard. Therefore, we have reasonable assurance of Fermi Unit 3 safety against design basis seismic events.

Seismic Design and Category I Structures

Safety-related structures, systems, and components are designed to withstand safe-shutdown earthquake loads and other dynamic loads, including wind loads, missiles, and those due to reactor building vibration caused by suppression pool dynamics. The ESBWR standard plant design parameters envelope the Regulatory Guide 1.60, Revision 1, ground spectra anchored to 0.3 g and high-frequency hard rock spectra anchored to 0.5 g peak ground acceleration. Based on the updated seismic hazard and Fermi Unit 3 site-specific soil-structure interaction analyses, the applicant developed site-specific seismic inputs consisting of performance-based surface response spectra, foundation input response spectra, site-specific ground motion time histories, and subsurface material profiles with corresponding dynamic properties used in the site-specific soil-structure interaction analyses.

The site-specific foundation input response spectra are enveloped by the ESBWR certified seismic design response spectra in both horizontal and vertical directions. The applicant also performed analyses to address the following Fermi Unit 3 site-specific conditions: (1) to confirm that the ESBWR standard plant design is applicable to the Fermi Unit 3 site-specific conditions, where some structures are partially embedded in the rock base, with an engineered granular backfill surrounding the structures from the top of the rock to the grade level of the plant; and (2) to confirm that the standard plant design is applicable even though the DCD requirements for the engineered granular backfill that surrounds the seismic Category I structures are not met in all cases.

The site-specific structural models for the reactor and fuel buildings used accepted analytical practices (e.g., plate finite elements arranged in a uniform mesh that was used to represent the exterior walls below grade and basemats). The staff reviewed the seismic design and accepted the adequacy of the structural response to the revised seismic source term. All nuclear safety issues relating to the seismic design and the seismic Category I structural response have been resolved.

Mitigation Strategies for Beyond-Design-Basis External Events

To address NTTF Recommendation 4.2 regarding mitigation strategies for beyond-design-basis external events, NRC Order EA-12-049 outlines a three-phase approach. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment, and spent fuel pool cooling without AC power. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from offsite. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely. The staff has endorsed the methodologies described in Nuclear Energy Institute (NEI) 12–06, Revision 0, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,” to provide an acceptable approach for satisfying the applicable requirements.

The Fermi Unit 3 COLA references the ESBWR passive design features that provide core cooling, containment, and spent fuel pool cooling for 3 days without relying on AC power. The ESBWR design also includes available onsite equipment to maintain required safety functions in the longer term (from 3 to 7 days), which is controlled by RTNSS requirements. To ensure that there is an integrated approach for the mitigation strategies, the staff proposed the following license condition:

> At least one (1) year before the latest date set forth in the schedule for completing the inspections, tests, and analyses in the ITAAC submitted in accordance with 10 CFR § 52.99(a), DTE Electric Company shall use the guidance contained in JLD-ISG-2012-01, “Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,” Revision 0 and the information presented in Fermi FSAR Section 01.05 to complete the development of strategies and guidance for maintaining and, if necessary, restoring core

cooling, containment, and spent fuel pool cooling capabilities beginning 72 hours after loss of all normal and emergency ac power sources, including any alternate ac source under 10 CFR 50.63. These strategies must be capable of:

- Mitigating a simultaneous loss of all ac power sources, both from the onsite and offsite power systems, and loss of normal access to the normal heat sink,
- Maintaining core cooling, containment, and spent fuel pool cooling capabilities for Fermi Unit 3 during and after such an event affecting both Fermi Units 2 and 3, and
- Being implemented in all plant modes.

Before initial fuel load, DTE Electric Company shall fully implement the strategies and guidance required in this license condition, including procedures, training, and acquisition, staging or installing of equipment and consumables relied upon in the strategies.

We concur with this approach. However, we note that the staff is silent about how RTNSS equipment survivability and operability can be assured in the transition phase following an external event that involves beyond-design-basis conditions. This lack of guidance is a generic issue that needs to be clarified not only for this applicant, but also for all currently operating plants and future combined license applicants.

Reliable Spent Fuel Pool Instrumentation

The staff evaluated Fermi Unit 3 proposed spent fuel pool (SFP) level instrumentation with respect to NRC Order EA-12-051. The SFP level instrumentation meets the requirements of NRC Order EA-12-051. DTE will develop operating procedures, testing, and calibration requirements for the installed instrument channels. A proposed license condition ensures that personnel will be trained on how to establish alternate power connections to the level instruments.

Order EA-12-051 also requires that the primary and backup SFP water level instrument channels be reliable at temperature, humidity, and radiation levels consistent with the SFP water at beyond-design-basis accident conditions for an extended period of time. However, while it is clear that saturation temperature and humidity conditions would exist for the SFP, we note that the staff is silent about the actual radiation levels that are required for equipment qualification in beyond-design-basis conditions. This lack of guidance is another generic issue that needs to be clarified not only for this applicant, but also for operating plants and future combined license applicants.

Emergency Preparedness

The Fukushima accident highlighted the need to better determine the levels of plant and offsite staffing needed to respond to a multi-unit event. Additionally, there is a need to ensure that communication equipment has adequate power to coordinate the response to an event during an extended loss of AC power. The applicant proposed and the staff accepted the following license condition related to communications and staffing for emergency planning actions:

Communications:

At least two (2) years prior to scheduled initial fuel load, the licensee shall have performed an assessment of on-site and off-site communications systems and equipment required during an emergency event to ensure communications capabilities can be maintained during prolonged station blackout conditions. The communications capability assessment will be performed in accordance with NEI 12–01, "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities", Revision 0.

At least one hundred eighty (180) days prior to scheduled initial fuel load, DTE shall complete implementation of corrective actions identified in the communications capability assessment described above, including any related emergency plan and implementing procedure changes and associated training.

Staffing:

At least two (2) years prior to scheduled initial fuel load, the licensee shall have performed assessments of the on-site and augmented staffing capability to satisfy the regulatory requirements for response to a multi-unit event. The staffing assessments will be performed in accordance with NEI 12–01, "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities", Rev 0.

At least two (2) years prior to scheduled initial fuel load, the licensee shall revise the Fermi 3 Emergency Plan to include the following:

- Incorporation of corrective actions identified in the staffing assessments described above.
- Identification of how the augmented staff will be notified given degraded communications capabilities.

The proposed license condition ensures that communications and staffing will be adequate for emergency planning operations. We concur with this approach.

SUMMARY

There is reasonable assurance that Fermi Unit 3 can be built and operated without undue risk to the health and safety of the public. The Fermi Unit 3 COLA should be approved following its final revision.

Sincerely,

/RA/

John W. Stetkar
Chairman

REFERENCES

1. Detroit Edison Fermi Unit 3 COLA (Final Safety Analysis Report), Rev. 6 (ML14055A128)

2. GE-Hitachi ESBWR Design Control Document, Revision 10, (ML14104A929)

3. NRO Memorandum, Subject: "Fermi 3, Combined License Application – Advanced Final Safety Evaluation," (ML14237A090)

4. ANSI/ANS-2.8, "Determining Design Basis Flooding at Power Reactor Sites," 1992

5. NRC, Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," March 12, 2012, (ML12054A735)

6. NUREG-2115, Central and Eastern United States Seismic Source Characterization for Nuclear Facilities, February 17, 2012, (ML12045A776)

7. Regulatory Guide, 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Revision 2, July 2014 (ML13210A432)

8. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, August 2012

9. JLD-ISG-2012-01, "Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Revision 0, April 29, 2012, (ML12229A174)

10. NRC Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," March 12, 2012, (ML12056A044)

REFERENCES

1. Detroit Edison Fermi Unit 3 COLA (Final Safety Analysis Report), Rev. 6 (ML14055A128)

2. GE-Hitachi ESBWR Design Control Document, Revision 10, (ML14104A929)

3. NRO Memorandum, Subject: "Fermi 3, Combined License Application – Advanced Final Safety Evaluation," (ML14237A090)

4. ANSI/ANS-2.8, "Determining Design Basis Flooding at Power Reactor Sites," 1992

5. NRC, Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," March 12, 2012, (ML12054A735)

6. NUREG-2115, Central and Eastern United States Seismic Source Characterization for Nuclear Facilities, February 17, 2012, (ML12045A776)

7. Regulatory Guide, 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Revision 2, July 2014 (ML13210A432)

8. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, August 2012

9. JLD-ISG-2012-01, "Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Revision 0, April 29, 2012, (ML12229A174)

10. NRC Order EA-12-051, "Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation," March 12, 2012, (ML12056A044)

Accession No: ML14252A294 **Publicly Available Y** **Sensitive N**

Viewing Rights: ☒ NRC Users or ☐ ACRS Only or ☐ See Restricted distribution

OFFICE	ACRS	SUNSI Review	ACRS	ACRS	ACRS
NAME	CBrown	CBrown	CSantos	EMHackett	EMH for JWS
DATE	09/17/14	09/17/14	09/17/14	09/22/14	09/22/14

OFFICIAL RECORD COPY