Exelon Generation

Order No. EA-12-049

RS-16-216
TMI-16-099

December 1, 2016

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

Three Mile Island Nuclear Station, Unit 1
Renewed Facility Operating License No. DPR-50
NRC Docket No. 50-289

Subject: Supplemental Information - Final Integrated Plan in Response to the Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order No. EA-12-049)

References:

1. Exelon Generation Company, LLC Letter to USNRC, Report of Full Compliance with March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated June 29, 2016 (RS-16-087 and TMI-16-039)
2. NRC Order Number EA-12-049, Issuance of Order to Modify Licenses with Regard to Mitigation Strategies for Beyond-Design-Basis External Events, dated March 12, 2012
3. NRC Email J. Hughey to D. Distel - FIP Checklists and Need For TMI Supplement, dated August 9, 2016
4. NRC Email from J. Hughey to D. Distel – Balance of Plant Questions, dated August 23, 2016
5. NRC Email from J. Hughey to D. Distel – Request For Additional Information - TMI Mitigating Strategies Final Integrated Plan, dated September 22, 2016
6. NRC Email from J. Hughey to D. Distel – Request For Additional Information - TMI Mitigating Strategies Final Integrated Plan, dated October 6, 2016
7. NRC Email from J. Hughey to D. Distel – Request For Additional Information - TMI Mitigating Strategies Final Integrated Plan, dated October 17, 2016

In Reference 1, Exelon Generation Company, LLC (EGC) provided the Three Mile Island Nuclear Station, Unit 1, Report of Full Compliance with the March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, pursuant to NRC Order No. EA-12-049 (Reference 2). Reference 1 included the Three Mile Island Nuclear Station, Unit 1 Mitigating Strategies Final Integrated Plan (FIP) document as an enclosure.

The purpose of this letter is to provide additional supplemental information supporting the Three Mile Island Nuclear Station, Unit 1 Mitigating Strategies Final Integrated Plan (FIP). The need for

this information was identified based on Exelon review of the NRC SER checklists provided in Reference 3, and based on NRC staff requests for additional information described verbally on August 16, 2016 and provided in References 4, 5, 6 and 7.

The supplemental information in the enclosure to this letter will be integrated into the Three Mile Island Nuclear Station, Unit 1 Mitigating Strategies Program Document No. CC-TM-118-1001. The new procedure, OP-TM-919-942, "FLEX Containment Cooling," as described in Item 13 of the enclosure to this letter, will be implemented by February 24, 2017.

This letter contains no new regulatory commitments. If you have any questions regarding this report, please contact David P. Helker at 610-765-5525.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 1st day of December 2016.

Respectfully submitted,

James Barstow
Director - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

Enclosure: Supplemental Information - Final Integrated Plan in Response to the Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order No. EA-12-049)

cc: NRC Regional Administrator - Region I
NRC Senior Resident Inspector – Three Mile Island Nuclear Station
NRC Project Manager, NRR – Three Mile Island Nuclear Station
Mr. John D. Hughey, NRR/JLD/JOMB, NRC
Director, Bureau of Radiation Protection - Pennsylvania Department of Environmental Resources
Chairman, Board of County Commissioners of Dauphin County, PA
Chairman, Board of Supervisors of Londonderry Township, PA
R. R. Janati, Chief, Division of Nuclear Safety, Pennsylvania Department of Environmental Protection, Bureau of Radiation Protection

Enclosure

Three Mile Island Nuclear Station, Unit 1

Supplemental Information - Final Integrated Plan in Response to the Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order No. EA-12-049)

(9 pages)

The following supplemental information provides details which revise the FIP. For each item the topic addressed is described and followed by a reference to the request for this information (in brackets). The nature of the revision (e.g., addition, deletion, etc.) and affected section of the FIP is identified. Additional references are added to FIP Section 12 (the list of new references follows the list of changes).

Item 1: Required quantity of spare cables and hoses [Reference 3: "PM" checklist for SER Section 3.7]

Add the following sentences to FIP Section 2.3.1.4:

For hoses and cables required for FLEX strategies, the alternate approach endorsed in Reference 145 was applied. Spare hoses and cables are stored in protected facilities. The requirements for spares is satisfied by having at least one spare section of each type of hose and cable, and an excess of at least 10% of the total length required for all concurrently required functions.

Item 2: Basis for not requiring Spent Fuel Pool Spray capability [Reference 4]

Revise the references in FIP Sections 4.3.1 and 5.3.2 as follows:

The spent fuel pool is a seismic class I structure located within a seismic class I aircraft impact hardened structure. The BDBEE will not adversely affect the integrity of the spent fuel pool, and therefore, spent fuel pool spray is not a required mitigating strategy (Reference 142 and 146).

Item 3: Boron mixing questions [Reference 3: "RS" checklist Section 1.e]

Add a reference in FIP Section 4.1.6 as follows:

A strategy which maintains single phase natural circulation in both loops ensures adequate boron mixing within the RCS (Reference 143).

Item 4: Connection points [Reference 3: "BOP" checklist item for SER Section 3.7.3.1 and "ELEC" checklist item for SER Section 3.7.3.2]

Add new FIP Section 8.8 as follows:

8.8 Connection Points
As described in Section 2.2.1, an alternate approach to NEI 12-06 was required to provide a successful implementation plan. New installed redundant equipment protected from BDBEE hazards is available to mitigate an ELAP/LUHS with a BDBEE hazard. There are no connections required to establish the FLEX AC power supply or to provide FLEX RCS Makeup (high pressure). Contingency strategies described in

Sections 4.11 were implemented in response to concerns that the installed equipment approach did not provide connection points.

8.8.1 Phase 2 Connection point:

- FLEX Diesel Generator Fuel Supply:
  A connection is available to provide a method to obtain fuel oil from DF-T-1 using DF-P-1C or DF-P-1D and transfer that fuel to FX-T-3 (or to other FLEX tanks). A 1.5-inch low leakage style quick disconnect isolated by DF-V-41 is located south of DF-T-2B in the "B" ES Diesel Generator room at approximately 307 ft elevation. This connection is located inside a Seismic Class I tornado protected structure. The connection at DF-V-41 is designed to meet Seismic Class I requirements. This connection is not used after flood water enters the site. There are two access paths to this connection point: (1) through the service building and through the door in the east wall of DGB or (2) from outside of plant structures through the door in the DGB north wall. This connection is shown on Attachment 4, Sheet 1.

- OTSG Feedwater connection:
  A connection is available to provide a path to feed one or both OTSGs through the EFW nozzles, and also provides a path to connect a pump for Spent Fuel Pool makeup. A 4-inch STORZ connector isolated by FX-V-205 is located on the exterior of the Intermediate Building east wall in the Turbine Building at approximately 307 ft elevation. This connection is located inside the Turbine Building which will maintain its structural integrity after a BDBEE and provide protection from tornado missiles. The connection at FX-V-205 is designed to meet Seismic Class SIf requirements. This connection is established before flood water enters the site. There are at least two access paths to this connection point: (1) through the TB 322 ft elevation and down the stairs or (2) through the TB 305 ft elevation. This connection is shown on Attachment 4, Sheet 3.

- OTSG Feedwater connection :
  A connection is available to provide a path to feed one or both OTSGs through the Main FW nozzles, as described in section 4.11.5. A 4-inch STORZ connector isolated by FW-V-13 is located on the main Feedwater Header west of the Main Feedwater pumps in the Turbine Building at approximately 330 ft elevation. This connection is located inside the Turbine Building which will maintain its structural integrity after a BDBEE and provide protection from tornado missiles. This connection is above the FLEX design flood elevation. There are at least two access paths to this connection point: (1) through the TB 305 ft elevation and up the stairs or (2) through the TB 322 ft elevation. This connection is shown on Attachment 4, Sheet 3.

- Spent Fuel Pool Makeup connection:
  A connection is available to provide a path for Spent Fuel Pool makeup. A 3-inch STORZ connector isolated by FX-V-113 is located on the exterior of the Fuel Handling Building east wall in the Turbine Building at approximately 324 ft elevation. This connection is located inside the Turbine Building which will

maintain its structural integrity after a BDBEE and provide protection from tornado missiles. The connection at FX-V-113 is designed to meet Seismic Class SIf requirements. This connection is above the FLEX design flood elevation. There are at least two access paths to this connection point: (1) through the TB 305 elevation and up the stairs or (2) through the TB 322 elevation. This connection is shown on Attachment 4, Sheet 4.

- Spent Fuel Pool Makeup connection:
  A connection is available to provide a flow path from hose on the discharge of FX-P-3A (or B) to the SFP, as described in section 4.11.6. The SFP makeup standpipe (Reference 87) has a connection at 308' elevation which provides the flow path to a hose routed from the standpipe into the Spent Fuel pool. These connections on the standpipe are located inside the Fuel Handling Building. This connection and access to these connections are located within a Seismic Class I aircraft hardened structure. This connection is shown on Attachment 4, Sheet 5.

- RCS makeup connection:
  Connection points are available to provide a path to makeup to the RCS through the HPI lines, as described in section 4.11.2. Two parallel ¾-inch NPT connections isolated by MU-V-143C and MU-V-143D are located on the Reactor Building exterior wall in the Fuel Handling Building at approximately 315 ft elevation. These connections and access to these connections are located within Seismic Class I aircraft hardened structures. The connections at MU-V-143C and MU-V-143D are designed to meet Seismic Class I requirements. Operators do not leave these structures to use this connection. Therefore, access is not challenged by a BDBEE. These connections are shown on Attachment 4, Sheet 4.

8.8.2 Phase 3 Connections:

- Long term fuel supply connection:
  A connection is available to refill FX-T-2. FX-T-2 is only used during external flood events or if the fuel delivery vehicle cannot access the site and DF-T-1 is nearly depleted. A 1.5-inch low leakage style quick disconnect isolated by FX-V-7 can be used to connect fuel hose from a portable NSRC fuel container. This connection is located inside the Turbine Building which will maintain its structural integrity after a BDBEE and provide protection from tornado missiles. This connection is above the FLEX design flood elevation. There are at least two access paths to this connection point: (1) through the TB 305 ft elevation and up the stairs or (2) through the TB 322 ft elevation. This connection is shown on Attachment 4, Sheet 1.

- Long term condensate supply connection:
  A connection is available to refill CO-T-1B. CO-T-1B is the primary long term condensate source. An adaptor is connected to a 4-inch flange on CO-T-1B to allow connection of a hose with a 3-inch STORZ connector. This connection is used to add fire service water or river water from FX-P-3 or FX-P-6 to CO-T-1B. This connection is located at the top of CO-T-1B in the yard outside plant structures. The connection on CO-T-1B is designed to meet Seismic Class I

requirements. This connection may be used after flood water recedes from the site. This connection is shown on Attachment 4, Sheet 3.

- Long term condensate supply connection:
  A connection is available to refill the hotwell. If CO-T-1B is not available due to tornado damage, the alternate long term condensate supply path is through EX-T-1 to the hotwell. An inspection port on EX-T-1 can be removed to allow a 3-inch hose to be inserted into the tank and secured. Flow into EX-T-1 will drain through EX-V-9 and into the hotwell. This connection is located inside the Turbine Building which will maintain its structural integrity after a BDBEE and provide protection from tornado missiles. This connection is above the FLEX design flood elevation. This connection is shown on Attachment 4, Sheet 5.

- 480 VAC connection points:
  Connection points are available to allow a NSRC diesel generator to supply power to the ES power trains and the FLEX 480V distribution panel (EE-PNL-FX). There are redundant connection panels (EE-PNL-FX-3A & EE-PNL-FX-3B) which have three 4/0 size PA22 series connectors for each phase and ground. The cable connections used are also compatible with the SAFER diesel generator. The plant side connections are located inside the Turbine Building which will maintain its structural integrity after a BDBEE and provide protection from tornado missiles. The connection panels EE-PNL-FX-3A & 3B are designed to meet Seismic Class SIf requirements. These connections are above the FLEX design flood elevation. There are at least two access paths to this connection point: (1) through the TB 305 ft elevation and up the stairs or (2) through the TB 322 ft elevation. There is an installed device (phase rotation relay) which is used to confirm the SAFER diesel connections are correct. This connection is shown on Attachment 4, Sheet 2.

Item 5: Use of SAFER equipment to backup FLEX equipment [Reference 3: "ELEC" checklist for SER Section 3.7.3.2)

Add new Section 10.5 (as described below) and add the row below to section 11.2::

10.5 Redundancy is provided for on-site equipment. Further defense in depth is provided by NSRC equipment which could be used to (1) substitute for FX-P-1A or B, (2) substitute for FX-P-3A or B, or (3) substitute for FX-Y-1A or B, as described in OP-TM-919-955 "Connection to SAFER Equipment". There are no plans or needs for a SAFER 4160V generator for ELAP mitigation. The recovery organization will determine if such equipment is needed for recovery.

Table in Section 11.2:

Procedure #	Title	Description of the FLEX Strategy elements implemented
OP-TM-919-955	Connections to SAFER Equipment	This procedure provides high level direction to use SAFER equipment as a backup for FLEX Diesels (FX-Y-1A & B), FLEX portable diesel driven pump (FX-P-3A & B) or FLEX RCS makeup pump (FX-P-1A & B). This use of SAFER equipment is beyond that which is required to implement the strategy.

Item 6: Ensure reactivity analysis remains current with each new core load [Reference 3: "RS" checklist Section 1.e]

Add a sentence to FIP Section 4.1.6 as follows:

4.1.6 Shutdown Margin Analysis
Cycle specific reactivity analysis has been completed (Reference 6) which demonstrates that when all control rods insert and RCS inventory is maintained during cooldown using borated water of at least 2500 ppmb, then the reactor will remain shutdown at cold (72F) conditions without any credit for Xenon. This analysis will be reviewed and revised as necessary to ensure it is valid for each core reload (Reference 144).

Item 7: Shutdown mode risk [Reference 5: Item PM-1]

Add the following as FIP Section 8.9 "Shutdown Mode Risk Evaluations"

The TMI-1 shutdown safety management process (Reference 149) is based on NUMARC 91-06 "Guidelines for Industry Actions to Assess Shutdown Management" and INPO 06-008 "Guidelines for the Conduct of Outages at Nuclear Power Plants" and directs actions during shutdown conditions to ensure compliance with 10CFR50.65(a)(4). Potential external event hazards, and the availability and utilization of FLEX equipment will be integrated into the TMI-1 shutdown safety management process (Reference 149). The ELAP and BDBEE mitigation strategies in Sections 5 (MODE D), 6 (MODE B) and 7 (MODE C) have been implemented. These strategies encompass all of the modes addressed in the NEI position paper (Reference 147). The "shutdown safety management" process (Reference 149) will recognize these hazards and mitigation strategies as part of the risk assessment process. The NRC-approved NEI position paper for shutdown modes (References 147 and 148) is being incorporated into the TMI FLEX program.

Item 8: Alternate Approach using installed equipment [Reference 5: Item RS-2, RS-3 & E-4b]

Add the following paragraph as the last paragraph of FIP Section 2.2.1:

Redundant active components were installed and the equipment was protected from all external hazards to provide equivalent or better reliability than required by NEI 12-06. The FLEX design hazards, and design requirements to meet those functional objectives are described in Reference 23. Where installed equipment is used in place of portable equipment, connections for portable equipment are not required. This installed capability provides the primary and alternate means to accomplish the post ELAP mitigation functions required by NRC Order EA 12-049.

Item 9: Environmental qualification of installed equipment [Reference 5: Items E-3 & E-5]

Add information to FIP Section 8.3 as shown below:

8.3 Equipment Operating Conditions

The post ELAP environmental effect on each installed electrical component used in the FLEX strategy was evaluated. The conclusion for each component is described in the "Environmental Availability" column in Attachment 2A.

Ambient temperatures for FLEX equipment operation in the Control Building (CB), Intermediate Building (IB) and Turbine Building (TB) will be maintained within acceptable limits using passive and active means of portable ventilation (Reference 13).

Fresh air from outside the facility will be circulated through each of the following areas to limit ambient temperature and prevent accumulation of undesired gases (e.g., CO2 in control room or hydrogen in battery rooms):

CB 355: Control Room
CB 338: Vital Instrument systems
CB 322: FLEX RCS makeup pumps, AC power distribution, AC and DC Instruments and power supplies
TB 322: FLEX Diesel Generators and electrical distribution equipment
IB 295/305: EFW and ADV (not required in MODE B, C or D)

The effect of the environment on electrical equipment prior to establishing the FLEX AC power supply and portable ventilation was reviewed to ensure the equipment credited in the FLEX strategy would perform reliably. The environment in the Steam Turbine Driven EFW Pump area in the Intermediate Building will not adversely affect any electrical equipment required for FLEX (Reference 123). All areas within the Control Building, including vital instrument system areas and ac power distribution/switchgear rooms/areas, were found to be acceptable based on prior design analysis for Appendix R (Reference 150). That analysis showed that with reduced control room lighting and passive ventilation paths on the CB 322, temperatures remained within acceptable limits for 72 hours. The ELAP will de-energize all control room AC lighting and operators will

establish a passive ventilations path on CB 322 elevation after an ELAP (Reference Appendix 5A).

The containment temperature analysis (case 1 in Reference 11) used a conservative RCS leak rate and took no credit for isolation of the leakage which is expected within six hours. The analysis showed that after seven days without any active means of cooling temperature was less than 220F and rising slowly. Components in the Reactor Building which must continue to function with elevated RB temperature were evaluated in Reference 76. This evaluation used the Arrenhius method to compare the ELAP temperature profile (from Reference 11) to the component qualification test results. The margin in the comparison performed after seven days supports a conclusion that the components would be expected to reliably perform well past this time period.

Item 10: Spent Fuel Cooling Strategy [Reference 5: Item E-2]

Add the sentences shown below to the beginning of FIP Sections 4.3.1 and 4.3.3:

4.3.1 Phase 1
There are no Phase 1 actions.

4.3.3 Phase 3
Spent Fuel Pool cooling is provided by maintaining SFP level using the same methods as described for Phase 2.

Item 11: FLEX injection path to the RCS [Reference 7]

Add the following sentences to FIP Section 2.3.4.2:

There are two flow paths from the FLEX RCS makeup pump discharge into the RCS, one through MU-V-16C and one through MU-V-16D. The FLEX RCS makeup flow (40 GPM) can be achieved using a single pump with a flow path through either one of these two valves and the associated flow path to the RCS.

Item 12: Seismic Design Requirements for FLEX [Reference 6: Item BOP-4a]

Add new FIP Section 2.3.1.5:

Section 2.3.1.5 "Seismic Design Requirements for FLEX equipment":

Installed and pre-staged SSC relied upon to meet the FLEX system performance requirements during seismic events will be designed to support that function after a safe shutdown earthquake (SSE) as defined in UFSAR section 5.1.2.1.2. Piping and pipe Supports relied upon to meet the FLEX system performance requirements in a seismic event are classified "SI" and designed in accordance with UFSAR Section 5.4.4.1, or are classified "SIf" and designed in accordance with FLEX Design Specification Appendix 6. Structures which are relied upon to support the FLEX strategy in a seismic event are classified "SI" and designed in accordance with UFSAR Section 5.4.1.2.e or are

classified "SIf" and designed in accordance with FLEX Design Specification Appendix 6. FLEX Design Specification Appendix 6 requirements ensure the functional capability of an SSC for its FLEX application is maintained after a Safe Shutdown Earthquake (SSE).

Item 13: Restoration of containment cooling [Reference 6: Item E-3d]

Add new section to FIP:

Section 4.11.9 "Containment Cooling"

If a Reactor Building Emergency Cooling water pump (RR-P-1A or B) and it's associated AC power source (1D or 1E 4160V Bus) are not available and not expected to be recovered within seven days after an ELAP or if RB temperature is projected to exceed 220F or if RB pressure is projected to exceed 20 psig, then a portable diesel driven pump will be configured to pump river water through the Reactor Building Emergency Coolers, and a RB fan (AH-E-1A,B or C) will be operated to control RB temperature (Reference 151).

Add the following to Table in Section 11.2

Procedure #	Title	Description of the FLEX Strategy elements implemented
OP-TM-919-942	FLEX Containment Cooling	This procedure provides direction to use a portable diesel driven pump (either NSRC low pressure medium flow pump or Godwin HL130M obtained from another Exelon site) to establish flow through the Reactor Building Emergency Coolers and operate an RB fan to control RB temperature. This use of SAFER equipment is beyond that which is required to implement the strategy.

Addition to FIP Section 12 "References"

12.142: Exelon Generation Company, LLC letter to the NRC, Spent Fuel Pool Evaluation Supplemental Report, Response to NRC Request for Information Pursuant to 10CFR50.54(f) Regarding Recommendation 2.1 of the Near Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, RS-16-126 TMI-16-051, August 31, 2016

12.143: AREVA, ANP-3288, "Response to Boron Mixing Issues for B&W Designed Plants"

12.144: Exelon, NF-AP-100-8000, "AREVA PWR RELOAD CONTROL IMPLEMENTATION – B&W METHODS"

12.145: NRC letter (J. R. Davis) to NEI (J. E. Pollock), dated May 18, 2015 on the subject of spare hose & cables for FLEX strategies (ML 15125A442)

12.146: 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, Rev. 1, dated January 22, 2016

12.147: NEI Position Paper: "Shutdown / Refueling Modes", September 18, 2013 (ADAMS ML 13273A514)

12.148: NRC endorsement of NEI Position Paper: "Shutdown / Refueling Modes", September 30, 2013 (ADAMS ML 13267A382)

12.149: Exelon, OU-TM-103 "TMI-1 Shutdown Safety Management"

12.150: Exelon, TDR 900 "Reconciliation of Loss of Ventilation Analysis and Tests"

12.151: Technical Evaluation ECR 16-00391 "FLEX Containment Cooling Plan"