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10 CFR 50.12

TMI-10-023

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

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

Subject: Response to Request for Additional Information
Request for Exemption from 10 CFR 50, Appendix R,
Section III.G, "Fire Protection of Safe Shutdown Capability"

References:

1. Letter from P. B. Cowan, Exelon Generation Company, LLC, to U.S. Nuclear Regulatory Commission, "Request for Exemption from 10 CFR 50, Appendix R, Section III.G, 'Fire Protection of Safe Shutdown Capability'," dated March 3, 2009.

2. Letter from P. Bamford, U.S. Nuclear Regulatory Commission, to C. G. Pardee, Exelon Generation Company, LLC, "Three Mile Island, Unit 1 - Request for Additional Information Regarding Request for Exemption from The Requirements of 10 CFR 50, Appendix R, 'Fire Protection of Safe Shutdown Capability' (TAC No. ME0771)," dated December 23, 2009.

3. Regulatory Guide 1.189, Revision 2, "Fire Protection for Nuclear Power Plants," dated October 2009.

4. NEI 00-01, "Guidance for Post-Fire Safe-Shutdown Circuit Analysis," Revision 2, Nuclear Energy Institute, Washington, DC, May 2009.

In Reference 1, Exelon Generation Company, LLC (Exelon) submitted a request for exemption from the provisions of 10 CFR 50, Appendix R, Section III.G, "Fire Protection of Safe Shutdown Capability," for the use of operator manual actions (OMAs) for Three Mile Island Nuclear Station, Unit 1, in lieu of the requirements specified in Section III.G.2. The NRC reviewed the exemption request and identified the need for additional information in order to complete their evaluation of the exemption request. Draft questions were sent to Exelon to ensure that the questions were understandable, the regulatory basis for the questions was clear, and to determine if the information was previously docketed. On December 17, 2009, a teleconference was held between the NRC and Exelon to further discuss the additional information requested by the NRC. In Reference 2, the NRC formally issued the request for additional information.

Attachment 1 to this letter provides a restatement of the questions along with Exelon's responses. Attachment 2 provides defense-in-depth information to support the responses to the RAI questions in Attachment 1.

Subsequent to the Reference 1 submittal, the NRC issued regulatory guidance clarifying when an exemption from Appendix R, Section III.G.2 is required. Specifically, in October 2009, Regulatory Guide (RG) 1.189, Revision 2 (Reference 3) was issued. RG 1.189, Rev. 2 provides guidance relative to equipment on the hot shutdown success path (i.e., equipment required to achieve and maintain hot shutdown), versus equipment that is important to safe shutdown. The RG states that OMAs may be credited with mitigating fire-induced operation or maloperation of components that are not part of the protected success path. Furthermore, the RG endorses Appendix H of NEI 00-01, Rev. 2 (Reference 4), which contains additional guidance. Based on this guidance, Exelon has re-evaluated the OMAs that were the subject of the original exemption request and determined that most OMAs are credited with mitigating fire-induced operation or maloperation of components that are not part of the protected success path, and as a result, are not within the scope of Appendix R, Section III.G.2. Therefore, Exelon hereby withdraws these OMAs from the exemption request. The specific OMAs being withdrawn and the reasons for their withdrawal are indicated in Attachment 3 to this letter. Since only one OMA remains applicable to the requirements of Appendix R, Section III.G.2, the RAI responses address only this one OMA.

Exelon has determined that the information provided in response to the request for additional information does not impact the conclusions of the exemption request for the OMA remaining in the exemption request as stated in Reference 1.

This response to the request for additional information contains no regulatory commitments.

If you have any questions or require additional information, please contact Glenn Stewart at 610-765-5529.

Respectfully,

DOR 

Pamela B. Cowan
Director - Licensing and Regulatory Affairs
Exelon Generation Company, LLC

Attachments:
1. Response to Request for Additional Information
2. Defense-in-Depth Safe Shutdown and Fire Hazards Analysis for MU-V-36 Operator Manual Action in Fire Zone AB-FZ-6
3. Withdrawal of Certain Operator Manual Actions from the Exemption Request

cc:	USNRC Regional Administrator - Region I	w/attachment
	USNRC Senior Resident Inspector - TMI-1	"
	USNRC Project Manager, NRR - TMI-1	"
	Director, Bureau of Radiation Protection, PA Department of Environmental Protection	"
	Chairman, Board of County Commissioners, Dauphin County, PA	"
	Chairman, Board of Supervisors, Londonderry Township, PA	"
	R. R. Janati, Commonwealth of Pennsylvania	"

ATTACHMENT 1

10 CFR 50.12 Exemption Request

Three Mile Island Nuclear Station, Unit 1
Docket No. 50-289

Request for Exemption from 10 CFR 50, Appendix R, Section III.G, “Fire Protection of Safe Shutdown Capability"

Response to Request for Additional Information

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
10 CFR 50, APPENDIX R, SECTION III.G.2 EXEMPTION REQUEST

In Reference 1, Exelon Generation Company, LLC (Exelon) submitted a request for exemption from the provisions of 10 CFR 50, Appendix R, Section III.G, “Fire Protection of Safe Shutdown Capability," for the use of operator manual actions (OMAs) for Three Mile Island Nuclear Station, Unit 1, in lieu of the requirements specified in Section III.G.2. The NRC reviewed the exemption request and identified the need for additional information in order to complete their evaluation of the exemption request. Draft questions were sent to Exelon to ensure that the questions were understandable, the regulatory basis for the questions was clear, and to determine if the information was previously docketed. On December 17, 2009, a teleconference was held between the NRC and Exelon to further discuss the additional information requested by the NRC. In Reference 2, the NRC formally issued the request for additional information (RAI). The questions are restated below along with Exelon's responses. Since only one OMA (OMA #8 in Reference 1) remains applicable to the requirements of Appendix R, Section III.G.2 (see Attachment 3), the RAI responses address only this one OMA.

RAI-01 Circumstances for Review

Section II of the submittal, Attachment 1, contains background information on the proposed OMAs but does not contain a technical justification for the application of special circumstances in accordance with 10 CFR 50.12. Since, according to Section II, it is the licensee’s position that the protective measures prescribed by III.G.2 represent an unwarranted burden on Exelon and are not necessary to meet the underlying purpose of the rule, provide the relevant details to support this position in response to RAI-01.1 and RAI-01.2 below. The response should demonstrate that defense-in-depth is provided such that operators are able to safely and reliably achieve and maintain safe shutdown capability. Note that it is the NRC staff's position that OMAs alone, regardless of their feasibility and reliability, do not meet the underlying purpose of the rule without specific consideration of the overall concept of defense-in-depth that is being applied in a particular fire area.

RAI-01.1: Provide a technical justification of how the proposed arrangement achieves the underlying purpose of the rule.

RESPONSE

Appendix R, Section III.G.2 requires the following, in part:

Except as provided for in paragraph G.3 of this section, where cables or equipment, including associated non-safety circuits that could prevent operation or cause maloperation due to hot shorts, open circuits, or shorts to ground, of redundant trains of systems necessary to achieve and maintain hot shutdown conditions are located within the same fire area outside of primary containment, one of the following means of ensuring that one of the redundant trains is free of fire damage shall be provided:

a. Separation of cables and equipment and associated non-safety circuits of redundant trains by a fire barrier having a 3-hour rating. Structural steel forming a part of or supporting such fire barriers shall be protected to provide fire resistance equivalent to that required of the barrier;

b. Separation of cables and equipment and associated non-safety circuits of redundant trains by a horizontal distance of more than 20 feet with no intervening combustible or fire hazards. In addition, fire detectors and an automatic fire suppression system shall be installed in the fire area; or

c. Enclosure of cable and equipment and associated non-safety circuits of one redundant train in a fire barrier having a 1-hour rating. In addition, fire detectors and an automatic fire suppression system shall be installed in the fire area.

The underlying purpose of the rule is to accomplish safe shutdown in the event of a fire and maintain the plant in a safe shutdown condition. In conjunction with the fire suppression and detection defense-in-depth capabilities, OMAs are shown to be a feasible and reliable way of ensuring plant safe shutdown. The OMA is required because the fire protection and/or suppression requirements in Appendix R, Section III.G.2 are not strictly met. Although the requirements of Appendix R, Section III.G.2 are not strictly met, Attachment 2 provides a significant defense-in-depth basis to support that the OMA will most likely not be required.

In addition to the defense-in-depth basis, Exelon has performed a feasibility review of the OMA in accordance with NUREG-1852, "Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire." Exelon's evaluation provided in the original submittal (Reference 1) concludes that the OMA is feasible, reliable, and not affected by environmental conditions associated with fires in the affected fire areas. This is supported by demonstrations, which have shown that adequate time is available to perform the OMA, and that time margin is available to account for uncertainties that may arise during a fire event. In addition, the equipment needed to implement the OMA remains available and the fire zone where the OMA occurs remains accessible during or following the event. The OMA is directed by plant procedures, and the operators are trained in the use of the procedures. The evaluation also concluded that staffing is adequate to perform the OMA. The OMA is similar to activities performed by plant operators as part of their normal work assignments, and as a result, is straightforward.

Appendix R continues to be satisfied by the requested exemption since the existing analysis described in the exemption request and in this response to request for additional information demonstrates that the plant can achieve safe shutdown in the event of a single fire and be maintained in a safe shutdown condition, and therefore, provides an equivalent level of safe shutdown capability through the combination of defense-in-depth fire protection features and the use of the OMA described in the exemption request. Therefore, the underlying purpose of the rule, to achieve safe shutdown in the event of a postulated fire, is met using the defense-in-depth and OMA described in the exemption request.

RAI-01.2: Provide an analysis that substantiates the claim of unwarranted burden and demonstrates that the hardship or other costs associated with the modifications noted as being required to achieve compliance are significantly in excess of those contemplated at the time the regulation was adopted, or are significantly in excess of those incurred by others similarly situated.

RESPONSE

In responding to this RAI, Exelon has reassessed the need for a number of OMAs and has withdrawn specific OMAs from the exemption request (see Attachment 3). As a result, only one OMA (OMA #8 in Reference 1) remains included in the exemption request. If the OMA is not credited to achieve safe shutdown in the event of a fire, modifications to reroute cables or wrap cables would be required. The costs associated with engineering, procurement of material, fabrication and installation of these modifications represent a burden on Exelon with negligible increase in safety.

The original exemption request intended to address the special circumstances from both 10 CFR 50.12(a)(2)(ii) [underlying purpose of the rule] and 10 CFR 50.12(a)(2)(iii) [undue hardship], even though demonstrating special circumstances in accordance with only one 10 CFR 50.12(a)(2) criterion is required. Exelon considers that the combination of defense-in-depth and the feasibility and reliability of the OMA, as described in the original exemption request and in the response to this RAI, including Attachment 1 and Attachment 2, demonstrates that the underlying purpose of the rule is met in accordance with 10 CFR 50.12(a)(2)(ii). Therefore, regardless of the burden on Exelon as described above, demonstrating undue hardship in accordance with 10 CFR 50.12(a)(2)(iii) is no longer considered necessary.

Based on the discussion above, special circumstances are present that warrant granting an exemption to 10 CFR 50, Appendix R, Section III.G.2.

RAI-02 Ensuring That One of the Redundant Trains Is Free of Fire Damage

Section II of Attachment 1, asserts that the OMAs discussed in the request provide assurance that one train of systems necessary to achieve and maintain hot shutdown remains available in the event of a fire. Section II.A contains a description of each of the OMAs and the time required to perform them, but does not state whether or how one of the redundant trains in a particular fire area is maintained free of fire damage. Section II.D states that the analysis assumes that fire damage may occur immediately upon first detection of the fire to all components in the fire area.

The method described in the request appears to demonstrate safe shutdown capability independent of the fire area of origin consistent with 10 CFR 50, Appendix R, Section III.G.3, yet the request is for an exemption from the requirements of III.G.2. Section III.G.2 of Appendix R specifically states that measures must be taken to ensure that one of the redundant trains remains free of fire damage within the fire area. Section III.G.3 of Appendix R addresses alternative or dedicated shutdown capability independent of the fire area of origin and establishes a series of requirements to achieve and maintain safe shutdown capability.

RAI-02.1: Confirm and state whether an exemption from III.G.2 requirements is the appropriate request, since safe shutdown capability is provided independent of the fire area of origin.

RESPONSE

Fire Zone AB-FZ-6 is the fire zone of origin for the OMA. Fire Zone AB-FZ-6 has been classified as a III.G.2 fire zone since the initial TMI Fire Hazards Analysis Report (FHAR)

was developed and submitted to the NRC. With the exception of a few OMAs, safe shutdown can be achieved from the control room. In the case of the exceptions, exemptions from III.G.2 requirements were previously approved. The OMA in this exemption request was previously submitted and approved (References 3 and 4); however, it is now being submitted for a revised required action time.

The OMA in this exemption request is not part of a methodology to shutdown the plant from outside the control room using dedicated or alternate shutdown panels. This OMA and other previously approved OMAs for this fire zone are taken to permit continued shutdown of the plant from the main control room.

RAI-02.2: State the specific requirements of III.G.2 that are not met for each of the requested exemptions, e.g., a lack of fire barriers, spatial separation, automatic suppression, etc.

RESPONSE

This information is provided as part of the defense-in-depth analysis of the OMA in Attachment 2.

RAI-02.3: Provide a summary of the plant specific features that compensate for the lack of III.G.2-required features, identified in RAI-02.2, for each of the requested exemptions. For example, note any enhanced defense-in-depth measures such as a lack of ignition sources and/or combustibles, more robust and/or supplemental detection and suppression systems and other physical or administrative controls.

RESPONSE

This information is provided as part of the defense-in-depth analysis of the OMA in Attachment 2.

RAI-02.4: Appendix R establishes the concept of defense-in-depth and III.G.2 requires operators be able to safely and reliably achieve and maintain hot shutdown capability from the control room. Provide a technical explanation that justifies how the proposed methods will result in a level of protection that is commensurate with that intended by III.G.2.

RESPONSE

The exemption request (Reference 1), which was prepared in accordance with NUREG-1852, describes how the OMA is feasible and reliable. Feasibility and reliability were validated through several simulator and plant walk down demonstrations using the worst-case fire scenario (set and sequence of failures) for the OMA. The OMA was shown to have 100% margin, without accounting for any of the defense-in-depth discussed in Attachment 2. The defense-in-depth discussion in Attachment 2 describes the existing cable spatial separation, existing fire protection features, low combustible loading, and fire protection program requirements that support the unlikelihood of requiring this OMA. The combination of the defense-in-depth discussed in Attachment 2 and the feasibility and

reliability discussed in Reference 1 result in a level of protection that is commensurate with that intended by III.G.2.

RAI-03 Other Evaluations

Fire areas may have other exemptions or engineering evaluations that affect fire protection systems or safe shutdown capabilities.

RAI-03.1: If applicable, provide a discussion of any other exemptions or evaluations, including licensee-developed evaluations, e.g., Generic Letter 86-10 evaluations that impact this request in any way and provide a justification for why such impact should be considered acceptable.

RESPONSE

A complete discussion of exemptions or evaluations applicable to each fire area/zone and OMA is maintained and/or referenced in the TMI FHAR, which is incorporated into the UFSAR. Exemptions or evaluations that address fire area/zone boundaries are based on assuring that the boundary is adequate for the hazard, and therefore, are not addressed in this response unless there is an impact to the OMA being addressed.

The following were identified as specific exemptions and evaluations that may have the potential to impact the OMA timeline, separation of cables within the fire area, or detection and suppression:

The OMA for opening MU-V-36 was previously submitted for exemption from Appendix R, Section III.G.2 by letter dated July 22, 1986 (Reference 3) and approved by SER dated December 30, 1986 (Reference 4). A typographical error in the submittal was later addressed in a GPU letter dated February 2, 1987 (Reference 5), changing the approved required action time to two hours. The time for this OMA has since been reduced to 40 minutes, as described in this exemption request (Reference 1). Therefore, an exemption request for this OMA was re-submitted to demonstrate that the OMA could be feasibly and reliably performed in the reduced allowable action time of 40 minutes.

An exemption from Appendix R, Section III.G.2 requirement for automatic suppression and one-hour fire barrier exists in Fire Zone AB-FZ-6 to open and throttle MU-V-16B if all makeup is lost (Reference 4). This OMA would be required after opening MU-V-36, and therefore, does not impact this exemption request. Since the MU-V-36 OMA was already part of the analysis reviewed in Reference 4, the addition of the MU-V-36 OMA does not adversely impact the timeline for the MU-V-16B OMA.

RAI-04 Fire Protection System and fire Barrier Design Criteria

Section II.B of Attachment 1 notes that several areas are equipped with various fire detection and suppression systems. However, the request does not state whether the systems have been designed and installed in accordance with recognized design standards.

RAI-04.1: Where fire protection features such as detection and suppression systems and fire rated assemblies are installed, describe the technical basis for such installations including the applicable codes, standards and listings.

For example:

Section II.B of Attachment 1, states that Fire Zone CB-FA-2a is equipped with HVAC [Heating, Ventilating and Air Conditioning] duct smoke detectors but does not state whether the detectors have been installed and maintained in accordance with a particular design standard or basis, e.g. National Fire Protection Association (NFPA) 72: National Fire Alarm Code, 1985 Edition.

Response: As stated in Attachment 3, Fire Area CB-FA-2a has been withdrawn as an initiating fire area.

Section II.B of Attachment 1, states that Fire Zone CB-FA-2b is equipped with an area-wide (incipient) detection system but does not state whether the system has been installed and maintained in accordance with a particular design standard or basis, e.g. NFPA 72: National Fire Alarm Code or NFPA 76: Standard for the Fire Protection of Telecommunication Facilities.

Response: As stated in Attachment 3, Fire Area CB-FA-2b has been withdrawn as an initiating fire area.

Section II.B of Attachment 1, states that Fire Zone AB-FZ-1 zone boundaries consist of reinforced concrete walls, floor, and ceiling but does not mention what the rating is or whether openings and penetrations in the assembly are protected.

Response: As stated in Attachment 3, Fire Zone AB-FZ-1 has been withdrawn as an initiating fire zone.

Section II.B of Attachment 1, states that Fire Zone AB-FZ-6 has an automatic pre-action type water curtain actuated by a cross-zone type smoke detection system but does not state how it is activated or whether the water curtain has been installed and maintained in accordance with a particular design standard or basis, e.g. NFPA 13: Standard for the Installation of Sprinkler Systems, 1985 Edition.

Response: The water curtain is only provided for fire protection of the zone boundary between Fire Zones AB-FZ-6 and AB-FZ-7, and is not credited for fire suppression within Fire Zone AB-FZ-6. As stated in Attachment 2, the pre-action system water curtain between Fire Zones AB-FZ-6 and AB-FZ-7 is actuated by the cross-zone smoke detection system. If smoke is detected in at least one group 1 detector and one group 2 detector (e.g., detectors on either side of the AB-FZ-6 and AB-FZ-7 zone boundary), deluge valve FS-V-399 opens and floods the closed sprinkler header with fire service water. Should a fire get sufficiently hot to melt a sprinkler head in the pre-action system, automatic water suppression will occur through the open sprinkler head(s). Alternatively, a hot fire directly under the sprinkler head will open the sprinkler head and also cause water flow. The pre-action system was built to NFPA 13 (1978), "Standard for the Installation of Sprinkler Systems," and NFPA 15 (1977), "Water Spray Fixed Systems for Fire Protection." The smoke detection portion of the system was built and designed to NFPA 72D (1975), "Proprietary Protective Signaling Systems for Guard, Fire Alarm and Supervisory Service," and NFPA 72E (1978), "Automatic Fire Detectors."

RESPONSE

The fire detection and suppression systems for Fire Zone AB-FZ-6 are described in detail in Attachment 2 along with the applicable design code of record. The codes of record for the pre-action system are also described in the response above.

RAI-04.2: Provide a technical justification for any deviations from codes, standards and listings by independent testing laboratories in the fire areas that could impact this evaluation.

RESPONSE

There are no deviations from codes, standards or listings by independent testing laboratories identified for the fire detection and suppression systems in Fire Zone AB-FZ-6.

RAI-04.3: Provide a technical justification for any non-rated fire protection assemblies.

RESPONSE

There are no non-rated fire protection assemblies credited to provide defense-in-depth for the OMA.

RAI-05 Ignition Sources and Combustible Fuel Load

Section II.B of Attachment 1, includes a description of the combustible fuel load in each of the fire areas in question and rates them as LOW or MEDIUM. Items such as cable insulation, lube oil, battery cases and Class C materials are stated as being present in many of the fire areas.

RAI-05.1: Provide critical details or assumptions regarding the in situ and transient fire hazards that could threaten redundant equipment for each fire area included in the requests. This information may include, but is not limited to:

- The number, type and location of potential ignition sources,
- The number and types of equipment that may exhibit high energy arcing faults, and the relationship between this equipment and any secondary combustibles,
- The quantity of cables and other secondary combustibles and their relationship to potential ignition sources,
- The cable type, e.g., thermoplastic or thermoset. If thermoplastic cables are used, provide a discussion of self-ignited cable fires,
- Ratings for cables, e.g., Institute of Electrical and Electronics Engineers (IEEE)-383, etc. If not rated, justify why fire spread would be assumed to be slow,
- Controls on hot work and transient combustibles in the area, and the proximity of secondary combustibles that could be impacted by a transient fire, and
- Dimensions of the rooms including ceiling heights.

RESPONSE

This information is provided as part of the defense-in-depth analysis of the OMA in Attachment 2.

RAI-06 Fire Scenarios

Section II.B of Attachment 1, describes each of the OMA procedures but does not state what fire scenarios have been considered for the postulated events. Also, the request includes discussions of equipment that may be available, but does not include a discussion of whether that equipment would be affected by the postulated events.

RAI-06.1: Provide a description of the proximity of the redundant train equipment to in situ hazards and the spatial relationship between the redundant trains in the fire area such that if they are damaged, manual actions would be necessary. Note that this question is distinct from the RAI-05, which is generally focused on the combustibles in an area, whereas, this RAI addresses the specific relationship between ignition sources and combustibles and the redundant trains.

For example:

For Fire Zone AB-FZ-7, no information is provided to describe the spatial relationship between the combustible materials (i.e. cables, lube oil, etc.) and the safe shutdown equipment located in the fire area. Also, missing is a discussion of the relationship between the two redundant trains in the area and whether they are located such that a single fire event could damage both trains.

RESPONSE

With respect to Fire Zone AB-FZ-7, as stated in Attachment 3, this fire zone has been withdrawn as an initiating fire zone.

For Fire Zone AB-FZ-6, this information is provided as part of the defense-in-depth analysis of the OMA in Attachment 2.

RAI-07 Initiation of Procedures

Section II.D.1 of Attachment 1, states that the initial time (T=0) for most actions was the time at which the failure occurred and that failure was assumed to occur simultaneous to the report of the fire. This section also states that operators will be fully aware of the fire location and conditions and will be ready to initiate OMAs very close to the start of the event but does not elaborate on how this will be accomplished.

RAI-07.1: Provide an analysis or technical justification that demonstrates that the ability to detect a fire is sufficient to provide notification of a postulated event before damage to the redundant trains occurs or provide an analysis or technical justification to evaluate scenarios where the redundant components are damaged before a fire has been reported.

RESPONSE

The exemption to allow the OMA in lieu of circuit protection is only required for a fire scenario where the fire begins in the MU-V-36 breaker compartment (Unit 2D) inside 1A Engineered Safeguards Valve (ESV) Motor Control Center (MCC), as described in Attachment 2. There are two smoke detectors monitoring the 1A ESV MCC area in Fire Zone AB-FZ-6. One detector is located on each side of the MCC. Either detector alone would actuate control room alarm “Aux Bldg Fire” (PLF-1-7) and the local fire panel alarm.

Testing of detectors with similar sensitivity (UL 268, "Flammable Liquid Fire Test") determined detection times for a hot, flaming fire. This test was performed in accordance with section 39.4 of UL 268 using 38 milliliters of a mixture of 65% heptane and 35% toluene by volume so as to produce a hot, flaming fire. The closest detector went into alarm in 31 seconds for an 8-foot high ceiling and 65 seconds for a 19.2 foot high ceiling. The detectors used for these tests were standard, commercially available, UL listed ionization detectors with the factory standard sensitivity settings of 1.3%/ft. The detectors in Fire Zone AB-FZ-6 are photoelectric type smoke detectors (FLAMEX INC, part number OMX 1001C) with sensitivity better than 1.5%/ft. The response time to a fire capable of causing circuit damage in 1A ESV MCC would be similar to the test condition. The two detectors in Fire Zone AB-FZ-6 are within a few horizontal feet from 1A ESV MCC and approximately 13 feet above the top of the MCC. The 1A ESV MCC area is in a relatively small room (approximately 14 feet X 20 feet).

The hot, flaming type of fire is used in this evaluation because this type of fire is necessary to cause significant damage to Appendix R cables in a short amount of time and to propagate beyond the MCC. Based on the available combustible materials in 1A ESV MCC (i.e., cables and dry transformers), a fire in 1A ESV MCC would develop slowly and the time between detection and cable failure would be greater than for a hot, flaming (oil or flammable liquid) fire. This evaluation is a conservative bounding assessment. Based on the test data, it is expected that the smoke detection system would identify an Appendix R hot, flaming fire in 1A ESV MCC in approximately one minute.

Cable fire testing has been performed by EPRI and the NRC, which shows that cables actually take several minutes at a minimum to fail after the onset of a fire. This testing consisted of hot, flaming, high-energy fires as opposed to a smoldering fire. TMI power and control cables are thermoset (Kerite with ethylene propylene rubber [EPR] insulation). Using EPRI document 1003326 (Reference 6) cable fire test results in "Characterization of Fire-Induced Circuit Faults," the minimum time to cable failure, which is dependent on the size of the fire and the cable configuration, was 3.1 minutes (Test 12) for thermoset cables. NRC testing ("NRC CAROLFIRE Testing") documented in NUREG/CR-6931 (Reference 7), shows that EPR cable failures could occur after approximately 2.5 minutes in the worst-case configuration (Test IT-7). The average time for cable failure, however, was more than 30 minutes. The time for spurious operation as a result of cable failure was generally longer.

In this specific fire scenario, the time to cable failure would be significantly longer than in the worst-case configuration. However, the evaluation does not credit this time, but relies on the easily defended conclusion that the fire would not propagate beyond the MCC and affect redundant trains within a few minutes after detection. Based on the detector sensitivity and location in proximity to the initiating event, assuming a rapid propagation of the fire, there

would be several minutes between the fire alarm and the potential propagation of the fire beyond the MCC. Therefore, at a minimum, detection would occur several minutes before redundant equipment (i.e., outside the MCC) could be affected.

RAI-07.2: Describe what systems or procedures will result in notifying operators of a fire location and the conditions at that location as well as a technical justification for why this approach would occur close to the start of the event.

RESPONSE

Smoke detectors located above 1A ESV MCC would actuate a control room alarm (PLF-1-7, “Aux Bldg Fire”) and the local fire panel alarm. Control room procedures direct sending an operator to the Aux Building fire panel. One of the two primary operators would be contacted by radio or page and sent to the fire panel. The Aux Building fire panel is located in the 1A ESV MCC room. The primary operator would report the fire in the 1A ESV MCC area to the control room. The control room operators would initiate the FIRE AOP (OP-TM-AOP-001, "Fire"), dispatch the fire brigade and initiate action in accordance with the zone specific fire mitigation procedure (OP-TM-AOP-001-A06, “Fire in Aux Bldg 305’ Demineralizer and 1A ESV MCC Area”).

Two operators are assigned each shift to primary operations. One of these two operators is normally in the Auxiliary Building. The primary operator work station in the Auxiliary Building is less than 100 feet south of the 1A ESV MCC. Independent of the detector and alarm, it is likely that an operator or security personnel who perform periodic (multiple times within a 12 hour shift) tours of this area would detect the smoke, hear the local fire panel alarm, or see the panel strobe light before the fire could propagate beyond the MCC.

The basis for concluding that detection would occur close to the start of the event is described in response to RAI-07.1.

RAI-08 Time and Sequence Assumptions

An action is considered feasible if it is shown that it is possible to be performed within the available time (considering relevant uncertainties in estimating the time available). The timeline graphics provided in the request do not appear to include the four segments (diagnosis time, travel time, action time and confirmation time) discussed in Section II.D.1 of the request.

RAI-08.1: Provide a justification that demonstrates that the proposed OMAs are feasible.

RESPONSE

OMA #8, opening the feeder breaker for the 1A ESV MCC and opening MU-V-36, has been demonstrated to be feasible by operator walk down and simulation of the OMA within the time period shown in Attachment 2, Scenario #6 of the exemption request. The overall philosophy of the timeline shown in Scenario #6 is described in Section II.C of the exemption request. The specific OMA involves opening a breaker and manually opening a valve, which are routine and well-trained actions performed by auxiliary operators. The timeline in Scenario #6 was conservative, because it accounts for the operator’s initial attempt to open the MU-V-36 breaker at the 1A ESV MCC, which adds time to the action sequence. The timeline also includes the time to perform the other actions in the procedure,

such as blocking open IC-V-3 and opening the breaker for MU-V-37, which also add time. Diagnosis is not required for the MU-V-36 OMA, as it is a directed action in the fire AOP (reference response to RAI-11.1). For opening the feeder breaker, the combined travel and action time is two minutes. This is conservative because the secondary Auxiliary Operator (AO) will already be on the second floor of the control building after performing an earlier action at the Remote Shutdown Transfer Switch Panel 'B' (RSTSP-B). Travel to the 1P switchgear will take less than a minute from this position, as will the time to open a breaker. For opening MU-V-36, the combined travel time and action time is four minutes. This is conservative because it assumes travel from the control room (two minutes), which is one of the farthest places from the action location. Typically, the primary AO performing the OMA would already be in the Auxiliary Building. Also, the action time of two minutes is conservative, as the valve is a small 2-inch valve that requires six handwheel turns and is easily accessible. Confirmation time for both actions is directly observable by the operator (i.e., breaker open light is on, valve opens), and therefore, does not require any additional time. Emergency lighting is provided and radio and page communications are available for this OMA. A fire in the 1A ESV MCC will not cause a loss of communications. The timeline is conservative because it assumes face-to-face communications. This demonstrates feasibility of the MU-V-36 OMA, as supported by the exemption request.

RAI-08.2: If a factor of safety or diagnosis time has been included in the stated times to complete the actions, provide an explanation for how it has been incorporated into the timelines. If not, justify why the stated times are sufficient to assure safety.

RESPONSE

No diagnosis time other than fire confirmation time is required for this OMA. Reference the response to RAI-08.3 below for a discussion of confirmation time. After entering the fire AOP for Fire Zone AB-FZ-6 based on a confirmed fire, the fire AOP directs performance of this OMA without any OMA specific diagnosis (i.e., there is a specific step to ensure MU-V-36 is open without any conditional statements). The timeline in Attachment 2, Scenario #6 of the exemption request (Reference 1) includes the time to communicate the procedural steps for the required OMA to the Auxiliary Operators performing the OMA.

RAI-08.3: Describe the relationship between the phrase "confirmation of a fire" noted in Section II.D.1 and the phrase "indication of a fire" noted in Attachment 2 and how any distinction between these two events are addressed in the timelines.

RESPONSE

Indication of a fire, which was the starting point for the timeline in Scenario #6 (MU-V-36 OMA), is the point at which the fire is first detected and results in the "Aux Bldg Fire (PLF-1-7)" alarm in the control room. The term 'confirmation' is used to distinguish a reliable report or visual confirmation of the fire from an alarm by itself. Confirmation of the fire would occur when the fire was confirmed in the specific fire zone and reported back to the control room. After confirmation, the fire AOP procedure for Fire Zone AB-FZ-6 would be entered. Although included in Scenario #6, fire confirmation time is not specifically shown in the scenario. Fire confirmation time was simulated and would occur between indication of a fire and the first OMA shown.

The timeline in Scenario #6 is conservative because it starts T=0 at detection of the fire and assumes all required failures occur concurrent with detection. The response to RAI-07.1 above describes that the fastest time for a single cable failure resulting from a hot fire would be at least 2.5 minutes. Detection of a hot fire is approximately one minute, as described in the response to RAI-07.1. Therefore, taking the failures listed in Scenario #6 concurrent with indication (detection) of a fire is conservative.

RAI-08.4: Clarify the fire area containing the proposed OMA versus the fire area containing the fire event in Table 1. For instance, OMAs 1 and 4 appear to contain the same fire areas for "OMA Location" and "Fire Areas/Zones Crediting OMA" indicating that operators are required to re-enter the fire area of fire origin to perform an OMA.

RESPONSE

As stated in Attachment 3, OMA #1 and OMA #4 have been withdrawn from the original exemption request.

For OMA #8 (fire in Fire Zone AB-FZ-6), re-entry into or through Fire Zone AB-FZ-6 is not required. Power is removed to MU-V-36 by opening the upstream breaker to the 1A ESV MCC, which is located in the Control Building (Fire Area CB-FA-2a).

RAI-09 Fire Area Proximity and Access

Section II.B of Attachment 1, describes each fire area and includes statements about the nature and rating of the fire area boundaries but does not mention whether openings and penetrations exist or whether they maintain the integrity of the rated barriers. Section II.D.3 notes that many of the fire areas have separate ventilation systems but does not discuss how and when these systems activate and whether they have been designed to transport products of combustion without causing additional damage to equipment or relocating the smoke to other fire areas.

RAI-09.1: Indicate whether the use of Self Contained Breathing Apparatus is necessary for each fire area or zone included in the request.

RESPONSE

The area of the initiating fire, 1A ESV MCC room on Auxiliary Building 305' elevation (Fire Zone AB-FZ-6) and the area where the OMA is required, makeup valve alley on Auxiliary Building 281' elevation (Fire Zone AB-FZ-3), are not separated by qualified Appendix R barriers. The boundaries between these and other Auxiliary Building fire zones were evaluated in the approved fire hazards analysis to ensure that the fire would be contained within that zone. The boundaries do not control the migration of smoke. For the OMA of concern (opening MU-V-36 in Fire Zone AB-FZ-3) for a fire in Fire Zone AB-FZ-6, use of a Self Contained Breathing Apparatus (SCBA) may be required.

When the primary safe shutdown (SSD) operator becomes aware of smoke in the Auxiliary Building, the operator will don an SCBA to perform actions when directed by the control room. Two SCBAs are staged near the primary operator station on Auxiliary Building 305' elevation. All operators assigned to fire brigade or SSD duties are qualified to use an

SCBA. Validation exercises have been performed to demonstrate that operators can reliably don an SCBA in less than three minutes.

The secondary SSD AO would open the feeder breaker to the 1A ESV MCC, which is located in the 1P Switchgear room in the Control Building (Fire Area CB-FA-2a). This will isolate power to the entire MCC (including MU-V-36). The Control Building is physically separated from the Auxiliary Building with Appendix R three-hour rated boundaries. Smoke would not migrate into the Control Building from a fire in the 1A ESV MCC area.

The Attachment 2, Scenario #6 timeline in the exemption request did not include an explicit time to don an SCBA. However, that timeline made several conservative assumptions which offset the additional time for the primary SSD AO (AO 1 on the timeline) to don an SCBA. The location and travel time for the primary SSD AO is conservative (as described in response to RAI-12.01 below). The validations assumed communications were not available and that operators traveled back to the control tower to report confirmation of the fire, IC-V-3 open, MU-V-36 breaker not open, etc. A fire in the 1A ESV MCC will not cause a loss of radio or page communications. There are no communication circuits located in this MCC or affected by loss of power at this MCC. The extra time associated with operators returning to the control room for direction offsets the additional time to don the SCBA. This evaluation does not credit the 21 minutes of margin identified in the timeline.

RAI-09.2: For adjacent fire areas or where operators will pass within close proximity of the fire affected area included in the request, provide a technical justification that demonstrates that a fire in the fire area of fire origin would not impact the performance of the OMA.

RESPONSE

As stated in Attachment 2, the only fire that could cause the sequence of events that require the OMA to open MU-V-36 is at the 1A ESV MCC. As stated in the response to RAI-09.1 above, the AO performing the OMA will don an SCBA at the primary operator station, Auxiliary Building 305’ elevation.

The operator would travel to the area to open MU-V-36 without needing to pass near the fire zone of origin, Fire Zone AB-FZ-6. The travel path for the AO will be down the staircase at the south end of the Auxiliary Building from Fire Zone FH-FZ-2 (305’ elevation) to Fire Zone FH-FZ-1 (281’ elevation). The operator continues north on 281’ elevation through Fire Zone FH-FZ-1, into Fire Zone AB-FZ-4, and into makeup valve alley, Fire Zone AB-FZ-3. The SCBA would protect the operator from any smoke that migrates down the stairs from Fire Zone AB-FZ-6 to Fire Zone AB-FZ-4. Smoke should be minimal as the traversal path and action location are below the fire zone of origin.

RAI-09.3: State whether identified ventilation systems are used for smoke evacuation or fire brigade operations and provide a justification for the systems capabilities.

RESPONSE

The Auxiliary Building ventilation system is not credited for smoke evacuation or fire brigade response. The operator performing the OMA and the fire brigade would don SCBAs to

perform their actions. If the Auxiliary Building ventilation system is not available, it does not adversely impact the ability to perform the required OMA, as described in the response to RAI-09.2 above. If the Auxiliary Building ventilation system is available, it is likely an SCBA would not be required, as this is a once-through ventilation system. This ventilation system is completely separate from other ventilation systems, including the Control Building ventilation system; therefore, smoke would not be transferred to the Control Building.

RAI-10 Fire Area of Origin Re-entry

Section II.B of Attachment 1, states that, depending on the fire scenario, operators may be required to re-enter certain fire areas such as AB-FZ-1, AB-FZ-5 and AB-FZ-6, to perform an action following a fire event. The request also indicates that all unprotected equipment located in a fire affected area or zone is assumed lost or damaged as a result of the fire.

RAI-10.1: Confirm whether reentry is required and whether unprotected equipment is assumed lost or provide a justification for why the assumption that all equipment located in the fire area of origin is lost during a fire does not apply.

RESPONSE

As stated in response to RAI-08.4 above, Fire Zone AB-FZ-6 does not require re-entry.

OMA #1 lists the breakers as located in Fire Zone AB-FZ-6 and Fire Zone AB-FZ-6a. However, Note 1 states that the feeder breakers for 1A and 1B ESV MCC would be opened for this OMA for a fire in Fire Zone AB-FZ-6, since the breakers on 1A ESV MCC may be inaccessible for a fire in Fire Zone AB-FZ-6. As shown in Attachment 3, OMA #1 has been withdrawn from the exemption request.

As shown in Attachment 3, the fire zones where re-entry was credited, including Fire Zones AB-FZ-5 and AB-FZ-1 for OMA #4, have been withdrawn as initiating fire zones.

RAI-10.2: Provide critical details or assumptions of the analysis that demonstrates that the required safe shut down equipment or component located within the area is maintained free of fire damage and remains accessible and operable following the fire event.

RESPONSE

See response to RAI-10.1 above. OMA #8 does not require re-entry into a fire area/zone.

RAI-10.3: Provide a technical justification for why the assumed reentry period is appropriate and an explanation for what is assumed to be included in this time.

RESPONSE

See response to RAI-10.1 above. OMA #8 does not require re-entry into a fire area/zone.

RAI-11 Reliability of Actions

Section II.D of Attachment 1, states that adequate margin exists for all the operator manual actions, which demonstrates feasibility and reliability. A "reliable action" is a feasible action that

is analyzed and demonstrated as being dependably repeatable within an available time, so as to avoid a defined adverse consequence, while considering varying conditions that could affect the available time or the time to perform the action.

RAI-11.1: Where a particular amount of time has been allocated for diagnosing an event, demonstrate that the additional uncertainties such as recovery from unexpected delays, environmental factors, operator response to stress, etc. are addressed by this time.

RESPONSE

In general, the need for diagnosis is addressed in the procedure development process. The emergency procedures are designed to minimize the reliance upon diagnosis. When applicable, diagnosis time is included in the procedure validation process.

For OMA #8 and Fire Zone AB-FZ-6, the need for diagnosis other than fire confirmation has been eliminated. The process and decisions required between detection and confirmation of the required action have been successfully accomplished and are described in the following outline. Where the action is contingent upon any judgment, that decision process is discussed.

1) Detection and alarm PLF-1-7
   - The alarm response procedure directs the following action.
2) Control room operator contacts auxiliary operator and sends operator to Auxiliary Building Fire Panel, located near 1A ESV MCC.
3) Auxiliary operator identifies that 1A ESV MCC area is inaccessible due to smoke/fire, and reports such to control room.
   - The fire AOP is initiated whenever “confirmed unexpected fire or smoke is observed.”
4) Control room initiates OP-TM-AOP-001, “Fire.”
   - Announcements are made to dispatch the fire brigade to 1A ESV MCC.
   - If the reactor coolant system (RCS) temperature is above 200°F, then OP-TM-AOP-001-A06, “Fire in AB 305' Demineralizer and 1A ESV MCC Area” is initiated.
5) Actions for fire in Fire Zone AB-FZ-6 (OP-TM-AOP-001-A06) have unambiguous performance criteria and use control room controls, except the following actions are performed outside the control room:
   a) If all reactor coolant pump (RCP) seal cooling has not been lost, or RCP seal temperature is verified below 235°F, then
      i) An operator is sent to select Remote Shutdown (RSD) control of intermediate closed cooling water (ICCW) valves and pump.
      ii) A second operator is sent to block IC-V-3 in the open position.
   b) If all RCP seal cooling has been lost, and any RCP seal temperature cannot be verified below 235°F, then
      i) An operator is contacted and sent to close MU-V-189.
   c) An operator is sent to open the breaker for MU-V-36 (Unit 2D on 1A ESV MCC). The step includes a Response Not Obtained (if 1A ESV MCC area is not accessible), to send an operator to open 1P ES 480V Switchgear Unit 4C (feeder breaker to 1A ESV MCC).
   d) An operator is sent to locally ensure MU-V-36 is open.

The OMA to ensure MU-V-36 is open is only conditional upon entering the procedure (i.e., if a fire is confirmed in Fire Zone AB-FZ-6, then these actions will be performed). Therefore, the uncertainty associated with diagnosis has been eliminated for this OMA.

RAI-11.2: Provide a clear description of how the time needed to perform potential corrective or reactive actions in the event the action did not accomplish the desired result (i.e., "response not obtained") was factored into the OMA performance time and provide the technical basis for the time allotted for each reactive action.

RESPONSE

The procedure (OP-TM-AOP-001-A06) includes action to de-energize the motor operator before the operator manually ensures that MU-V-36 is open. The preferred method is to open the breaker for the valve (1A ESV MCC Unit 2D). If the breaker is inaccessible due to the fire, then the feeder breaker for the MCC (1P ES 480V Switchgear Unit 4C) is opened to accomplish this requirement.

The validation sequence (Attachment 2, Scenario #6 of Reference 1) timeline includes the time required to attempt the preferred action, as well as the time to perform the Response Not Obtained (RNO) action.

RAI-12 Required Operator Stations

The request does not specify what has been assumed for the location from which operators are dispatched to perform the OMAs or whether scenarios were evaluated where operators were not at their assumed locations at the beginning of an event.

The location or activities of required plant personnel when the fire starts could delay their participation in executing the operator manual actions (e.g., they may be in a location that is on the opposite side of the plant from the main control room or may need to restore certain equipment before being able to participate or both).

RAI-12.1: Provide a justification for the assumption that operators will be located at an assumed location when the OMA procedure begins. If there isn't assurance that the operators will be at the assumed locations, provide the times required for them to reach the locations and indicate how these times are reflected in the analysis.

RESPONSE

Prior to assuming the duty each shift, operators are assigned specific roles to ensure proper emergency response. Two operators are assigned responsibility for activities on the primary side of the plant (Auxiliary and Fuel Handling Buildings). One of these two operators is the "primary fire brigade operator" and the other is the "primary SSD operator." The actions in the Auxiliary Building associated with this exemption request would be completed by the "primary SSD operator." Both primary operators spend the majority of their time performing rounds and other work activities in the Auxiliary and Fuel Handling Buildings. When not in the primary areas, these operators are normally on the 4th floor of the Control Building for

briefings or personal time (operator lunch room is the AO central area outside the control room). The primary operators are not excluded from tasks in the secondary side of the plant, but such activities are very limited.

These actions and emergency procedure actions are validated using operators initially located on the 4th floor of the Control Building. This location is conservative compared to any Auxiliary or Fuel Handling Building location since it: 1) bounds the possible operator initial location in almost all cases, and 2) in the unlikely event that the primary SSD AO is not in the Auxiliary or Fuel Handling Building, travel times are not significantly longer.

In the scenario of concern, one of these two operators would be called to confirm the fire (in 1A ESV MCC room). Upon confirmation, the control room would make an announcement, the operator assigned to the fire brigade initiates actions for fire suppression (under direction of the fire brigade leader), and the primary SSD operator would go to a pre-established area (Fire Zone AB-FZ-4) in the Auxiliary Building 281' elevation and await instruction from the control room.

The validation times assume the primary SSD operator is in the Control Building when directed to block open IC-V-3 (i.e., the first action for primary AO (AO-1) on the timeline in Scenario #6). However, the primary SSD operator will already be in the Auxiliary Building by the time the direction to perform the action is provided from the control room.

RAI-12.2: State whether the assumed times for operators to perform various tasks, such as 3 minutes for Auxiliary Operator (AO)-1 to close MU-V-189 shown in Attachment 2, are reasonable. For instance, provide a justification for assuming that it will take AO-1 3 minutes from the time they are directed to close MU-V-189 to travel to and close the valve and then confirm its closure.

RESPONSE

As stated in Attachment 3, OMA #9 (Closing MU-V-189) has been withdrawn from the original exemption request. The times for OMA #8 have been validated by multiple operators, and are conservative given the defense-in-depth discussion in Attachment 2.

RAI-13 Use of Water Curtains

Section II.B of Attachment 1, states that the fire protection for Fire Zone AB-FZ-6 includes the use of an automatic pre-action sprinkler system to provide a water curtain for the open passageway from Fire Zone AB-FZ-6 to Fire Zone AB-FZ-7.

It is not clear from this statement whether the fire zone is provided with an automatic fire suppression system or whether the water curtain is intended to serve as a suppression system.

RAI-13.1: State what the intended purpose of the water curtain is and how it is credited as part of the defense-in-depth concept, if at all. Also state whether the fire area is provided with an automatic suppression system in areas containing redundant equipment.

RESPONSE

The intended purpose of the water curtain is to provide a barrier of protection between Fire Zones AB-FZ-6 and AB-FZ-7 to prevent the spread of fire from one zone to the next. This water curtain is actuated by the pre-action sprinkler system described in response to RAI-04.1 above. The water curtain serves as a fire zone boundary protection feature only, and does not provide automatic suppression for Fire Zone AB-FZ-6 safe shutdown equipment. The smoke detectors associated with actuation of the pre-action system will, however, actuate an alarm in the control room as well as the local panel alarm and strobe light, as described in Attachment 2.

RAI-14 Smoke Detection Above Ceiling

Section II.B of Attachment 1, states that Fire Area CB-FA-1 is provided with an automatic ionization fire detection system above the suspended ceiling but does not indicate what the intended purpose of this system is or how it will be used to detect a fire in the fire area.

RAI-14.1: State what the intended purpose of the automatic ionization fire detection system is and explain whether the ceiling is open or how the system will detect a fire below the suspended ceiling.

RESPONSE

As stated in Attachment 3, Fire Area CB-FA-1 has been withdrawn as an initiating fire area.

RAI-15 Active Systems

Section II.B of Attachment 1, describes the fire protection features provided for Fire Zone FH-FZ-5 but it is not clear whether the fire zone is provided with automatic fire detection and suppression. This section states that a combination of area and HVAC duct smoke detectors is provided and 3-hour fire rated barriers are provided for circuits but it is not clear whether this statement only applies to the Instrument Shop and Repair Facilities or to FH-FZ-5 as a whole.

RAI-15.1: State which systems and barriers are provided in or around areas containing redundant equipment in Fire Zone FH-FZ-5.

RESPONSE

As stated in Attachment 3, Fire Zone FH-FZ-5 has been withdrawn as an initiating fire zone.

References:

1. Letter from P. B. Cowan, Exelon Generation Company, LLC, to U.S. Nuclear Regulatory Commission, “Request for Exemption from 10 CFR 50, Appendix R, Section III.G, ‘Fire Protection of Safe Shutdown Capability’,” dated March 3, 2009.

2. Letter from P. Bamford, U.S. Nuclear Regulatory Commission, to C. G. Pardee, Exelon Generation Company, LLC, "Three Mile Island, Unit 1 - Request for Additional Information Regarding Request for Exemption from The Requirements of 10 CFR 50, Appendix R, 'Fire Protection of Safe Shutdown Capability' (TAC No. ME0771)," dated December 23, 2009.

3. Letter from H. D. Hukill, GPU Nuclear Corporation, to J. F. Stoltz, U.S. Nuclear Regulatory Commission, “10 CFR 50 Appendix R Clarification or Compliance,” dated July 22, 1986.

4. Letter from John F. Stoltz, U.S. Nuclear Regulatory Commission, to Henry D. Hukill, GPU Nuclear Corporation, “Fire Protection for TMI-1,” dated December 30, 1986.

5. Letter from H. D. Hukill, GPU Nuclear Corporation, to U.S. Nuclear Regulatory Commission, “10 CFR 50 Appendix R Exemptions,” dated February 2, 1987.

6. EPRI Document 1003326, “Characterization of Fire-Induced Circuit Faults.”

7. NUREG/CR-6931, CAROLFIRE Test Report Volume 1, “General Test Descriptions and Analysis of Circuit Response Data.”

ATTACHMENT 2

10 CFR 50.12 Exemption Request

Three Mile Island Nuclear Station, Unit 1
Docket No. 50-289

Request for Exemption from 10 CFR 50, Appendix R,
Section III.G, "Fire Protection of Safe Shutdown Capability"

Defense-in-Depth Safe Shutdown and Fire Hazards Analysis for
MU-V-36 Operator Manual Action in Fire Zone AB-FZ-6

DEFENSE-IN-DEPTH SAFE SHUTDOWN AND FIRE HAZARDS ANALYSES FOR MU-V-36 OPERATOR MANUAL ACTION IN FIRE ZONE AB-FZ-6

This attachment describes the defense-in-depth basis that the MU-V-36 OMA will likely not be required. This is based on location of the circuits postulated to fail to require the OMA, existing fire protection features in the fire zone, low combustible loading and ignition sources within the zone, and fire protection administrative controls. This defense-in-depth information is used to respond generally to RAI 01 and more specifically to RAIs 02, 04, 05, and 06.

Operator Manual Action Background

The requested exemption, to credit an OMA in place of separation required in Appendix R, Section III.G.2 for a fire in Fire Zone AB-FZ-6, is for an operator to locally open MU-V-36 to establish a makeup pump recirculation flow path. The OMA is only required if the fire causes all of the following:

- spurious isolation of the makeup pump recirculation path,
- loss of the ability to remotely control the seal injection flow path,
- loss of the ability to remotely control the normal makeup flow path (MU-V-18), and
- loss of the ability to remotely control the emergency makeup flow paths (MU-V-16A, 16B, 16C or 16D).

If all of these failures occur, then this local action is required to maintain reactor coolant system (RCS) inventory.

Safe Shutdown Cables or Equipment of Concern

The scenario requiring the least number of independent failures is described below. Other less likely combinations of failures which could cause the conditions specified above are not described. A fire in Fire Zone AB-FZ-6 requires at least four independent failures to occur, two of which are sequence dependent (i.e., MU-V-36 hot short occurs prior to loss of MCC) as described below:

- While 1A ESV MCC is energized, the fire causes a hot short (within 1A ESV MCC), which establishes proper voltage in the closing circuit and causes MU-V-36 to travel closed (MU-V-36 control cable CQ232A).
- After MU-V-36 is closed, the fire causes loss of 1A ESV MCC (cable LP8 within MCC). This MCC is located in the fire zone. This eliminates remote control of MU-V-16A and MU-V-16B. This would isolate the 'A' train emergency makeup (High Pressure Injection [HPI]) flow path (valves normally closed).
- Fire causes a loss of integrity of ¼ inch outside diameter copper tubing which causes a sufficient reduction in the Auxiliary Building instrument air supply pressure for MU-V-18 to close and eventually for MU-V-20 to close. Loss of control of MU-V-18 eliminates use of the normal RCS makeup flow path. If MU-V-20 actuator is depressurized, seal injection flow to the RCP will be isolated.

- Fire causes loss of power to 1B ESV MCC (cable LS7A). This eliminates remote control of MU-V-16C and MU-V-16D. This would eliminate the 'B' train emergency makeup (HPI) flow path as an alternate means of RCS makeup (valves normally closed).

Appendix R, Section III.G.2 Barriers Not Met (RAI 02)

The following Section III.G.2 fire barriers are not met in Fire Zone AB-FZ-6:

1. There are no three-hour rated fire barriers to protect or separate the instrument air line, MU-V-36 control cable CQ232A, 1A ESV MCC power cable LP8, and 1B ESV MCC power cable LS7A.
2. The instrument air line, MU-V-36 control cable CQ232A, 1A ESV MCC power cable LP8, and 1B ESV MCC power cable LP7A are not separated by at least 20 feet with no intervening combustibles.
3. There are no one-hour fire barriers that protect or separate the instrument air line, MU-V-36 control cable CQ232A, 1A ESV MCC, and 1B ESV MCC power cable LS7A. There is no automatic fire suppression system in the MCC area.

Specific Failures and Separation (RAI 06)

Although there is not sufficient cable protection or separation to meet Appendix R, Section III.G.2 criteria, there is significant spatial separation between the instrument air line and control/power cables required to fail within Fire Zone AB-FZ-6. Based on the failure sequence required, the only credible area for the fire to start would be inside the 1A ESV MCC. Given the separation of cables described below and sequence of events required, it is unlikely that the OMA to open MU-V-36 would be required.

<u>Likelihood of MU-V-36 Hot Short Prior to Loss of 1A ESV MCC Power</u>

For the fire to cause MU-V-36 to close, the fire must cause an intra-cable hot short between a normally energized conductor in multi-conductor cable CQ232A and the conductor that picks up the closing coil. This would short out the remote control switch and energize the closing coil for MU-V-36. The fire must maintain this hot short without grounding the circuit and blowing the control power fuses or otherwise causing a loss of control power, such as loss of the main 1A ESV MCC power cable LP8. The MU-V-36 circuits of concern are located within the MCC breaker compartment along with the control power fuses. It is unlikely that a fire could sufficiently damage cable CQ232A insulation and short the proper conductors to energize the closing coil for MU-V-36 prior to blowing the control power fuses. Because the fire must cause a hot short to close MU-V-36 prior to loss of control power, the most likely fire ignition location within Fire Zone AB-FZ-6 is in the MU-V-36 breaker compartment. Fires in other areas of 1A ESV MCC would be likely to trip the main bus breaker or otherwise damage the 1A ESV MCC power cable LP8 prior to affecting MU-V-36 circuits.

<u>Separation between 1A ESV MCC and Instrument Air Supply</u>

The primary combustible in Fire Zone AB-FZ-6 is 1A ESV MCC and associated cables. The 1A ESV MCC is separated from the majority of the area within Fire Zone AB-FZ-6 by solid concrete walls with only passage way openings to Fire Zones FH-FZ-2, AB-FZ-7, and AB-FZ-9. Within the area around 1A ESV MCC and within those walls, the only copper instrument air lines are along the north wall (boundary with Fire Zone AB-FZ-7). The tubing closest to 1A ESV MCC is

¼ inch outside diameter tubing used for testing reactor building pressure switches. This tubing is at least six feet from the MCC with no intervening combustibles. The loss of integrity of these ¼ inch outside diameter tubing lines may not be sufficient to exceed the capacity of the instrument air supply and reduce the instrument air supply pressure to MU-V-18 (normal RCS makeup isolation valve) below 60 psig. Both instrument air compressors are unaffected by a fire in Fire Zone AB-FZ-6 and would attempt to maintain the instrument air supply to MU-V-18. The loss of instrument air system integrity occurs in a section supplied through 3/8 inch regulators and ¼ inch outside diameter tubing. The main instrument air system distribution headers are 2 inch lines. This specific failure may not be sufficient to reduce the air supply pressure to MU-V-18 enough to prevent adequate RCS makeup flow. The next closest copper tubing in Fire Zone AB-FZ-6 is against the containment wall. This tubing is further separated from 1A ESV MCC by at least 10 feet of distance with no intervening combustibles. Based on the existing separation with no intervening combustibles and outside diameter of the instrument air lines within Fire Zone AB-FZ-6, it is unlikely that a fire in 1A ESV MCC would cause a loss of Auxiliary Building instrument air pressure.

Separation between 1A ESV MCC and Power Supply Cable to 1B ESV MCC

The power cable for 1B ESV MCC (LS7A) is routed through Fire Zone AB-FZ-6. The cable comes through the one hour-rated wall (similar to UL-tested configuration U-410) separating Fire Zones AB-FZ-6a and AB-FZ-6 in 4 inch galvanized steel conduit as it passes through the area near 1A ESV MCC. As it turns away from 1A ESV MCC (at least 6 feet of separation with no intervening combustibles), it exits the conduit and enters a tray (via a splice box). There is at least 12 feet of vertical separation with no intervening combustibles between the top of 1A ESV MCC and the 4 inch conduit that holds LS7A. Based on the existing separation and conduit protection, it is unlikely that the 1B ESV MCC power cable would be damaged, even if 1A ESV MCC were fully consumed in a fire.

In summary, this OMA in lieu of cable protection is only required if all of the following improbable events occurred. The fire must initiate within the MU-V-36 breaker compartment of the 1A ESV MCC, cause a fault on an energized circuit to make MU-V-36 close, cause power failure of the 1A ESV MCC, spread to the instrument air tubing causing MU-V-18 and MU-V-20 to close, and cause failure of the 1B ESV MCC power circuit, which is contained within a conduit. If this improbable sequence occurs, then the OMA described will be used to reliably ensure RCS inventory is maintained.

Fire Detection / Suppression / Barriers and Codes of Record (RAI 04)

Fire detection in Fire Zone AB-FZ-6 is provided by ceiling-mounted photoelectric smoke detectors, which run to the Auxiliary Building fire detection panel (FS-PNL-AB-1), located near the 1A ESV MCC. If smoke is detected, then a local horn and strobe light are actuated at the fire alarm panel and the control room alarm “Aux Bldg Fire” (PLF-1-7) is actuated. An operator will confirm the specific fire location (i.e., 1A ESV MCC area or Fire Zone AB-FZ-6). As described above, a fire starting inside 1A ESV MCC would be required to create the conditions where the MU-V-36 OMA is required. For completeness, the fire panel is located within the fire zone of concern, but fire damage to the panel would trigger a control room alarm.

There are two detectors located within a few feet horizontally and approximately 13 feet vertically above the 1A ESV MCC, which will provide quick detection of a fire in or around the 1A ESV MCC. The detection system is designed and installed in accordance with NFPA 72D (1975), "Proprietary Protective Signaling Systems for Guard, Fire Alarm and Supervisory Service," and NFPA 72E (1978), "Automatic Fire Detectors."

Primary fire suppression for Fire Zone AB-FZ-6 is provided by a fire hose reel near the primary AO work station in adjacent Fire Zone AB-FZ-9. The hose reel is less than 100 feet from the 1A ESV MCC area or any other area in Fire Zone AB-FZ-6. The hose reel has at least 100 feet of hose, and additional hose is brought when the fire brigade responds. The fire brigade has easy access to suppress a fire in the 1A ESV MCC area. The hose reels were designed and installed in accordance with NFPA 14 (1978), "Standpipe and Hose Systems," and have installed electrically safe fog nozzles, which make them safe to use in the vicinity of electrical equipment. The site fire brigade has been trained in the use of these hose reels and nozzles.

Portable dry chemical and carbon dioxide fire extinguishers are also permanently mounted in Fire Zone AB-FZ-6 and adjacent fire zones to provide readily accessible suppression media. These extinguishers have been designed and installed in accordance with NFPA 10, "Standard for Portable Fire Extinguishers."

All fire protection equipment is maintained in accordance with the site Fire Protection Program to ensure operability.

Combustible Loading, Transient Combustibles, and Ignition Sources (RAI 05)

The TMI Fire Protection Program controls ignition sources, hot work activities, in-situ and transient combustibles, and fire system impairments. The program is subject to periodic review by NRC Regional Inspectors, insurance inspectors and Nuclear Oversight auditors.

Combustible loading in Fire Zone AB-FZ-6 consists primarily of cable insulation, which is located mainly in and around the 1A ESV MCC. There is approximately 16,365 BTU/ft^2 of permanent combustible loading in the entire fire zone, with most of it concentrated in the 1A ESV MCC area. This fire zone has a ‘low’ combustible material load. ‘Low” is defined in the FHAR as less than 80,000 BTU/ft^2 on the basis that such a fire load would not support combustion for more than one hour. Power and control cables in the fire zone are thermoset (Kerite EPR), which will smolder and produce slow developing fires if ignited. The entire fire zone is 124 feet long by 30 feet wide by 21 feet high, and consists of a total area of 3,779 ft^2 per the TMI FHAR. The smaller area around the 1A ESV MCC is approximately 20 feet long by 14 feet wide by 21 feet high.

Transient combustibles are restricted in Fire Zone AB-FZ-6 and particularly in the 1A ESV MCC area. If transient combustibles are required in the area for maintenance work, etc., a transient combustible permit is used to define the types and quantities of combustibles allowed in the area. The Fire Marshall performs walkdowns at least weekly to ensure the transient combustible program is properly implemented.

Possible ignition sources in this fire zone are: 1) control or power cables with potential voltage up to 480V AC, and 2) 480/120V control power transformers inside the 1A ESV MCC. The transformers are contained within the metal-clad MCC housing and contain no flammable fluids.

The 120V control cables are generally located in open trays. The 480V power cables are generally in conduit or use armor jacketed cable.

Low combustible loading, minimal transient combustibles with strict controls, and low voltage ignition sources all controlled by the TMI Fire Protection Program serve to provide additional defense-in-depth to prevent fires that have the potential to damage safe shutdown equipment.

ATTACHMENT 3

10 CFR 50.12 Exemption Request

Three Mile Island Nuclear Station, Unit 1
Docket No. 50-289

Request for Exemption from 10 CFR 50, Appendix R,
Section III.G, "Fire Protection of Safe Shutdown Capability"

Withdrawal of Certain Operator Manual Actions from the Exemption Request

WITHDRAWAL OF CERTAIN OPERATOR MANUAL ACTIONS FROM THE EXEMPTION REQUEST

The following requests for exemptions to allow use of operator manual actions (OMAs) (Table 1 of Reference 1) are being withdrawn based on re-evaluation of the OMAs in accordance with the guidance provided in NRC Regulatory Guide (RG) 1.189, Revision 2 (Reference 2), NEI 00-01, Revision 2 (Reference 3) and other NRC regulatory guidance (References 4 and 5), and additional control room capability not previously acknowledged.

Table 1. Operator manual actions (OMAs) hereby withdrawn from the exemption request. (Note: the numbering corresponds to original numbering on Table 1 of Reference 1.)

OMA	Fire Areas/Zones Crediting OMA
1. Open breakers, Ensure MU-V-36/37 open and locally close MU-V-16A/B	AB-FZ-6, CB-FA-1, CB-FA-2a, CB-FA-2d, CB-FA-2f, FH-FZ-1
2. Open 1P 480V Switchgear Unit 4C and Manually throttle MU-V-16B (Note 2)	AB-FZ-6
3. Open breakers, Ensure MU-V-36/37 open and locally close MU-V-16C/D	CB-FA-2b, CB-FA-2c, CB-FA-2e, CB-FA-2g, CB-FA-3b, FH-FZ-5
4. Open Breaker and Ensure NR-V-4A or NR-V-4B is Closed	AB-FZ-1, AB-FZ-5, FH-FZ-1
5. Energize 'A' DC Cross-tie	CB-FA-2a, CB-FA-3a
6. Energize 'B' DC Cross-tie	CB-FA-2b, CB-FA-3b
7. Select MU-P-1B for ES at 1E 4160V Switchgear	AB-FZ-5, AB-FZ-7, ISPH-FZ-1, ISPH-FZ-2
9. Close MU-V-189	AB-FZ-4, AB-FZ-6, CB-FA-1, CB-FA-2a, CB-FA-2b, CB-FA-2d, CB-FA-2f
10. Fail MU-V-26 Closed and Close IA-V-1214	FH-FZ-1

Note 2: OMA previously approved. Only change is in time required.

Subsequent to the Reference 1 submittal, the NRC issued regulatory guidance clarifying when an exemption from Appendix R, Section III.G.2 is required. Specifically, in October 2009, Regulatory Guide 1.189, Revision 2 was issued. RG 1.189, Rev. 2, Section 5.3.1.3 states, "When one of the redundant safe-shutdown trains in a fire area is maintained free of fire damage by one of the means specified in Regulatory Position 5.3.1.1, then the use of operator manual actions may be credited with mitigating fire-induced operation or maloperation of components that are not part of the protected success path." The RG also endorses Appendix H of NEI 00-01, Rev. 2, which provides additional guidance for this classification.

OMAs #1, #3, #5, #6, #9 (in Fire Areas/Zones AB-FZ-6, CB-FA-1, CB-FA-2d, and CB-FA-2f), and #10 are all actions required in response to fire-induced failures of important to safe shutdown components, as described in Section 5.3.1.5, "Examples of SSCs Important to Safe Shutdown," NEI 00-01, Appendix H.4.1, and SECY-08-0093, Table 1. OMAs #1, #3, #5, #6, #9 (in aforementioned fire areas/zones), and #10 are required as a result of spurious actuation of the Engineered Safeguard Actuation System (ESAS) system.

The ESAS system is not required to function to meet the Appendix R safe shutdown system performance goals (as described in RG 1.189, Rev. 2, Section 5.1). Spurious actuation of ESAS can affect safe shutdown and as such it is classified as a system "Important to Safe Shutdown." This distinction is further clarified in SECY-08-0093, Table 1, which states, "Equipment that is not part of the train necessary to achieve and maintain hot shutdown conditions or is not necessary to assure availability of the hot shutdown train's flow path, but could otherwise prevent safe shutdown must be protected against fires that affect the safe shutdown systems capability. This includes multiple spurious actuation of such equipment. Manual actions, fire modeling, and risk-informed approaches such as the NEI method, can be used to demonstrate compliance without NRC approval."

Fire damage could cause a spurious ESAS system actuation which isolates reactor coolant pump (RCP) thermal barrier cooling and, combined with additional failures, cause a loss of RCP seal cooling. The OMA to isolate seal return is required to prevent this condition from adversely affecting the reactor coolant system (RCS) makeup function (OMAs #9 and #10). Spurious ESAS actuation could also cause an undesirable overfill condition, which is prevented by OMAs #5 and #6 and mitigated by OMAs #1 and #3.

Based on revised NRC guidance, an exemption is not required for OMAs required to mitigate failures or spurious operation of important to safe shutdown equipment. Therefore, OMAs will be used to address failures of the credited hot shutdown train caused by the ESAS system (OMAs #1, #3, #5, #6, #9 [in aforementioned fire areas/zones], and #10). While these OMAs are still shown to be feasible and reliable, an exemption from Appendix R, Section III.G.2 requirements is not required.

OMA #9 is no longer required in Fire Areas/Zones AB-FZ-4, CB-FA-2a, and CB-FA-2b, since it was discovered that adequate seal return isolation capability exists in these fire areas/zones. In each of these fire areas/zones, MU-V-26 is available to isolate seal return from the control room. The power and control cables for MU-V-26 are not located in Fire Areas/Zones AB-FZ-4, CB-FA-2a, and CB-FA-2b, and control room capability to close MU-V-26 and isolate seal return is not affected in these fire zones. Therefore, the OMA to close downstream manual valve MU-V-189 is not required for these fire areas/zones.

OMA #2 does not require a new exemption, since the requested revision to the approved exemption was only required for scenarios caused by fire related failures of ESAS, which is an "Important to Safe Shutdown" system, as described above. The requested exemption revision was limited to a change in the allowable performance time. The existing exemption allows operator action to locally re-establish makeup flow through MU-V-16B within two hours (Reference 6). This exemption remains valid for the Fire Zone AB-FZ-6 fire where circuit failures only occur on required for safe shutdown components (i.e., no loss of RCP seal cooling occurs). The requested revision requires makeup be restored within one hour if fire causes inadvertent ESAS which results in a loss of RCP seal cooling. Since ESAS is an important to safe shutdown system, OMAs are allowed to mitigate the fire-induced failures. As described in Reference 1, this OMA can be performed reliably in less than one hour. However, per the regulatory guidance in References 2, 3, and 5, OMA for the events which require the revised performance criteria (one hour time limit) do not require exemption from Appendix R, Section III.G.2 requirements.

OMA #4 is also an example of an SSC "Important to Safe Shutdown." This OMA involves closing NR-V-4A or NR-V-4B in response to flow diversion from the Nuclear River Water system. This OMA is only required to support re-establishing RCS letdown. Based on application of the criteria established in NEI 00-01, Appendix H (Reference 3), which is endorsed by Regulatory Guide 1.189, Rev. 2, the letdown function is not required for the safe shutdown success path. The existing safe shutdown analysis recognized that loss of letdown for four hours did not challenge the ability to maintain hot shutdown conditions. Therefore, this OMA is characterized as "Important to Safe Shutdown," and while shown to be feasible and reliable, it does not require exemption from Appendix R, Section III.G.2 requirements.

OMA #7 is considered a recovery action per close-out of FAQ 06-0012 (Reference 4), since it is a normally operated switch at a local control station and separation of redundant trains has been provided. This OMA involves selecting MU-P-1B from the 1E 4160V switchgear if a loss of offsite power (LOOP) occurs. MU-P-1B is the credited success path SSC for makeup in all the fire zones listed for this OMA in Table 1 above. This switch is located on the MU-P-1B breaker compartment and is part of normal operator response to a loss of makeup condition. There is no control room control for selecting MU-P-1B. There is only start/stop control, which is utilized to start MU-P-1B after it is selected locally. In the closeout to FAQ 06-0012, the NRC supports this as an acceptable recovery action in bullet #3, which states "manual operation of normally operated manual switches and valves where separation/protection is provided from redundant safe-shutdown trains in accordance with 10 CFR 50, Appendix R, Section III.G.1 or III.G.2." Circuit analysis confirms that the circuitry for the local switch and all other circuits required for MU-P-1B are not affected for any of the fire zones listed in Table 1. This OMA has been shown to be feasible and reliable. Based on the regulatory guidance, it does not require exemption from Appendix R, Section III.G.2 requirements.

Based on the withdrawal of these OMAs, the fire areas/zones of origin that require an OMA in this exemption request have been reduced to Fire Zone AB-FZ-6 (OMA #8 from Table 1 of Reference 1).

References:

1. Letter from P. B. Cowan, Exelon Generation Company, LLC, to U.S. Nuclear Regulatory Commission, “Request for Exemption from 10 CFR 50, Appendix R, Section III.G, ‘Fire Protection of Safe Shutdown Capability’,” dated March 3, 2009.

2. Regulatory Guide 1.189, Revision 2, “Fire Protection for Nuclear Power Plants,” dated October 2009.

3. NEI 00-01, “Guidance for Post-Fire Safe-Shutdown Circuit Analysis,” Revision 2, Nuclear Energy Institute, Washington, DC, May 2009.

4. Memorandum from Alexander Klein, U.S. Nuclear Regulatory Commission, “Close-out of National Fire Protection Association Standard 805 Frequently Asked Question 06-0012, On Determining Manual Actions That Require A Change Evaluation During Transition,” dated January 24, 2008.

5. SECY-08-0093, “Resolution of Issues Related to Fire-Induced Circuit Failures,” dated June 30, 2008.

6. Letter from John F. Stoltz, U.S. Nuclear Regulatory Commission, to Henry D. Hukill, GPU Nuclear Corporation, “Fire Protection for TMI-1,” dated December 30, 1986.