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1CAN111501

November 4, 2015

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Second Set of Round 2 Responses to Request for Additional Information
Adoption of National Fire Protection Association Standard NFPA-805
Arkansas Nuclear One, Unit 1
Docket No. 50-313
License No. DPR-51

Dear Sir or Madam:

By email dated October 6, 2015 (Reference 9), the NRC requested additional information associated with the Entergy Operations, Inc. (Entergy) request to amend the Arkansas Nuclear One, Unit 1 (ANO-1) Technical Specifications (TS) and licensing bases to comply with the requirements in 10 CFR 50.48(a), 10 CFR 50.48(c), and the guidance in Regulatory Guide (RG) 1.205, "Risk-Informed Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants." The amendment request followed Nuclear Energy Institute (NEI) 04-02, "Guidance for Implementing a Risk-Informed, Performance-Based Fire Protection Program under 10 CFR 50.48(c)." This submittal described the methodology used to demonstrate compliance with, and transition to, National Fire Protection Association (NFPA) 805, and included regulatory evaluations, probabilistic risk assessment (PRA), change evaluations, proposed modifications for non-compliances, and supporting attachments.

The subject second set of 2nd Round Request for Additional Information responses are included in the attachment to this letter.

Changes or additional information, as detailed in this letter, with respect to the original Entergy request (Reference 1) have been reviewed and Entergy has determined that the changes do not invalidate the no significant hazards consideration included in the Reference 1 letter.

In accordance with 10 CFR 50.91(b)(1), a copy of this application is being provided to the designated Arkansas state official.

No new commitments have been identified in this letter.

If you have any questions or require additional information, please contact Stephenie Pyle at 479-858-4704.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on November 4, 2015.

Sincerely,

ORIGINAL SIGNED BY TERRY A. EVANS, ACTING SITE VICE PRESIDENT

TAE/dbb

Attachment: Round 2 Responses to Request for Additional Information – ANO-1 Transition to NFPA-805

REFERENCES:

1. Entergy letter dated January 29, 2014, *License Amendment Request to Adopt NFPA-805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)* (1CAN011401) (ML14029A438)
2. NRC letter dated May 5, 2015, *Arkansas Nuclear One, Unit 1 – Request for Additional Information Regarding License Amendment Request to Adopt National Fire Protection Association Standard 805* (TAC No. MF3419) (1CNA051501) (ML15091A431)
3. Entergy letter dated May 19, 2015, *Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN051501) (ML15139A196)
4. Entergy letter dated June 16, 2015, *60-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN061501) (ML15167A503)
5. Entergy letter dated July 21, 2015, *90-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN071501) (ML15203A205)
6. Entergy letter dated August 12, 2015, *120-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN081501) (ML15224A729)
7. NRC email dated September 8, 2015, *Arkansas Nuclear One, Unit 1 – 2nd Round Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA091501) (ML15251A220)
8. Entergy letter dated September 22, 2015, *Round 2 Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN091501) (ML15265A113)
9. NRC email dated October 6, 2015, *Arkansas Nuclear One, Unit 1 – 2nd Round Part 2 Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA101501) (ML15280A114)

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Attachment to

1CAN111501

Second Set of Round 2 Responses to Request for Additional Information
ANO-1 Transition to NFPA-805

SECOND SET OF ROUND 2 RESPONSES TO REQUEST FOR ADDITIONAL INFORMATION ANO-1 Transition to NFPA-805

By letter dated January 29, 2014 (ML14029A438), as supplemented by letters dated May 19, 2015 (ML15139A196), June 16, 2015 (ML15167A503), July 21, 2015 (ML15203A205), August 12, 2015 (ML15224A729), and September 22, 2015 (ML15265A113), Entergy Operations, Inc. (Entergy), submitted a license amendment request (LAR) to transition the Arkansas Nuclear One, Unit 1 (ANO-1), fire protection program to one based on the National Fire Protection Association Standard 805 (NFPA 805), "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants," 2001 Edition, as incorporated into Title 10 of the Code of Federal Regulations (10 CFR) Section 50.48(c).

In the course of its review, the NRC staff determined that additional information is required in order to complete its evaluation, as stated below. The following includes the subject questions associated with the request for information (RAI) and the relevant Entergy response to each.

Probabilistic Risk Assessment (PRA) RAI 03.b.01 – Integrated Analysis

The response to PRA RAI 03.b should provide a summary of how each issue identified in PRA RAI 03 was resolved for the integrated analysis. The Table in the response to RAI 03.b submitted on August, 12, 2015, includes a number of entries with statements such as “is being revised” and “will be consistent.” Additionally, based on PRA RAI responses received after PRA RAI 03 was issued on May 5, 2015, the NRC staff has identified two additional issues whose resolution should be confirmed in the Table.

Please up-date and resubmit the Table with the final action taken on each issue, and add the following two issues to the Table.

a) PRA RAI 01.e.d regarding spurious operation in other cable configurations.

   The response to PRA RAI 01.e.d submitted on July 21, 2015, explains that “other cable configurations” (as defined by Section 7.4 of NUREG/CR-7150) will be evaluated using guidance in NUREG/CR-7150 in the integrated analysis provided in response to PRA RAI 03. The list of issues in PRA RAI 03 did not include this issue because it was unknown at the time. Please add “PRA RAI 01.e.d regarding spurious operation in other cable configurations” to the summary table and confirm that “other cable configurations” have been evaluated using guidance in NUREG/CR-7150 in the integrated analysis provided in response to PRA RAI 03.

b) PRA RAI 02.b regarding completion of the large early release frequency (LERF) analysis.

   The response to PRA RAI 02.b identified two LERF analysis limitations associated with modeling of the atmospheric dump valves (ADVs) and the reactor coolant system electromagnetic relief valve (ERV) and explained these analysis limitations will be resolved in the integrated analysis provided in response to PRA RAI 03. The list of issues in PRA RAI 03 did not include this issue because it was unknown at the time. Please add “PRA RAI 02.b regarding completion of LERF analysis” to the summary table and confirm that modelling of the ADVs and ERV has been included in the integrated analysis provided in response to PRA RAI 03.

Response

The updated table from the PRA RAI 03.b response is provided below. The table includes a correction to the RAI numbers for four RAIs associated with PRA RAI 01 and also includes the planned disposition of PRA RAIs 03.b.01 and 18.01.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR (to be incorporated into the final PRA RAI 03 response which includes the final Fire PRA quantification results)	Disposition with respect to the self-approval model for post-transition changes
PRA RAI 01.a regarding spatial separation	Spatial separation is not credited. The zone of influence is allowed to cross non-barrier boundaries. No change to the Fire PRA (FPRA) model is required.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 01.b regarding fire barriers	There are no active fire protection systems supporting the Multi-Compartment Analysis (MCA) fire barriers that require an actuation system (i.e., barrier features which credit systems that require signals from cables or a detection system) as part of any physical analysis unit (PAU) boundary at ANO-1 (e.g., water curtains). The MCA is being revised to sum the generic barrier failure probabilities for each type of barrier present between PAUs.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 01.c regarding fire propagation from electrical cabinets	The panel factor approach was eliminated prior to submitting the LAR. Severe and non-severe panel fires have been defined based on the zone of influence up to and excluding the nearest target. The methodology used is based on data provided in NUREG/CR-6850, Appendices E and H, and the methodology defined in the Generic Fire Modeling Treatments (GMFT).	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 01.e regarding circuit failure likelihood analysis / PRA RAI 01.e.d regarding spurious operation in other cable configurations	Circuit failure likelihood values used will be consistent with the values specified in NUREG/CR-7150. The guidance from NUREG/CR-7150 regarding ‘other cable configurations’ recommends the use of the aggregate spurious operation conditional probabilities for in-panel wiring and trunk cables. For instrument circuits, no spurious operation conditional probability will be credited. The guidance on “other cable configurations” will be incorporated into the ANO-1 FPRA in support of the integrated risk assessment PRA RAI 03.	Same approach as that used for the final integrated analysis provided in support of the LAR.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR (to be incorporated into the final PRA RAI 03 response which includes the final Fire PRA quantification results)	Disposition with respect to the self-approval model for post-transition changes
PRA RAI 01.g regarding modeling new fire Human Error Events	The FPRA will incorporate the update to the Human Reliability Analysis (HRA) methodology that is consistent with developing detailed human error probabilities (HEPs) as outlined in NUREG-1921.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 01.h regarding state of knowledge correlation (SOKC)	A SOKC was applied to ignition frequencies, circuit failure probabilities, non-suppression probabilities, and HRA basic events. The SOKC will be addressed in the final FPRA documentation.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 02.a regarding impact of phenomenological conditions	The FPRA model will be revised to address the phenomenological issues as identified in response to PRA RAI 02.a.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 02.b regarding completion of LERF analysis	Spurious operation of the ADVs and ERV, which could impact Pressure-Induced Steam Generator Tube Rupture (SGTR) and Thermal-Induced SGTR, will be incorporated in the Integrated Analysis performed in response to PRA RAI 03.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 02.d regarding counting operational demands	The internal events model is not altered by the response to this RAI (see RAI response for basis). Therefore, the resolution of this RAI does not impact the PRA quantification.	Not applicable to the development of the post transition self-approval model, since this RAI did not impact the integrated analysis and the aggregated results provided in support of the LAR.
PRA RAI 02.e regarding counting failures	The internal events model is not altered by the response to this RAI (see RAI response for basis). Therefore, the resolution of this RAI does not impact the PRA quantification.	Not applicable to the development of the post transition self-approval model, since this RAI did not impact the integrated analysis and the aggregated results provided in support of the LAR.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR (to be incorporated into the final PRA RAI 03 response which includes the final Fire PRA quantification results)	Disposition with respect to the self-approval model for post-transition changes
PRA RAI 04 regarding reduced transient heat release rates (HRRs)	Reduced heat release rate values are used in distinct areas with restricted transient controls in the new fire protection program.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 05 regarding treatment of sensitive electronics	The impact of the results of walkdowns of sensitive electronics will be incorporated into the final FPRA quantification as necessary, consistent with the methodology outlined in FAQ 13-0004.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 07 regarding propagation of fire from > 440 V electrical cabinets	A review of the "well-sealed" panels that house circuits below 440 V is in progress. The "well-sealed" panels represent a small percentage of the total Bin 15 count and will be removed from the Bin 15 frequency allocation. Additionally, the FPRA will be revised to include fire propagation from sealed > 440 V panels, consistent with the guidance in FAQ 14-0009.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 08 regarding use of the transient frequency adjustment factors	Transient Frequency Adjustment Factor of 0.1 is being removed from the analysis and replaced with a frequency adjustment that is consistent with FAQ 12-0064.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 09 regarding fire propagation in the MCR	Fire propagation in the main Control Room (MCR) is being addressed consistent with the guidance of NUREG/CR-6850 Chapter 11 and Appendix S.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 11 regarding crediting MCR abandonment	The FPRA method for control room abandonment evaluation of the variant and compliant cases is addressed in the RAI response. No changes to this methodology are expected to be required, however, the values provided in the RAI response may change once revisions are incorporated and the final results are quantified.	Same approach as that used for the final integrated analysis provided in support of the LAR.

RAI No. / Description	Disposition with respect to the final integrated analysis and the aggregated results provided in support of the LAR (to be incorporated into the final PRA RAI 03 response which includes the final Fire PRA quantification results)	Disposition with respect to the self-approval model for post-transition changes
PRA RAI 12 regarding multiple versus single cables	The updated quantification will assume the heat release rates associated with multi-bundle configuration for all MCR panels.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 14	See PRA RAI 15.	See PRA RAI 15.
PRA RAI 15 [corrected RAI number for this subject, original list incorrectly identified RAI as PRA RAI 14] regarding large reduction credit for modifications	The response to this RAI will calculate the total risk increase associated with the unresolved variances from deterministic requirements (VFDRs) (i.e., VFDRs that are not associated with a plant modification and discuss the impact of important modeling assumptions contributing to the risk significant scenarios for fire areas in the compliant plant model).	Not applicable to the development of the post transition self-approval model, since this RAI did not impact the integrated analysis and the aggregated results provided in support of the LAR.
FM RAI 01.k regarding evaluation of MCR abandonment times	The abandonment frequency will be updated as necessary to reflect the response provided for Fire Modeling (FM) RAI 01.k.	Same approach as that used for the final integrated analysis provided in support of the LAR.
PRA RAI 18.01 – Minimum Joint HEP floor value	a) Each joint HEP value used in the FPRA below 1.0E-05 will include its own justification that demonstrates the inapplicability of the NUREG-1792 lower value guideline. b) An estimate of the number of these joint HEPs below 1.0E-05 and at least two different examples of the justification will be provided with the final PRA RAI 03 response.	Same approach as that used for the final integrated analysis provided in support of the LAR.

PRA RAI 11.01 – Main Control Room (MCR) Abandonment due to Loss of Control (LOC)

In the LAR supplement dated August 12, 2015, the response to PRA RAI 11 states, in part, that “[in] all non-loss of habitability cases, command and control for post fire shutdown is expected to remain in the MCR.” The response further clarifies that all fire scenarios which do not cause loss-of-habitability are modeled based on the equipment lost in each scenario. As clarified in Regulatory Guide 1.205, when command and control remains in the MCR, all operator actions to mitigate fire-induced failures outside of the MCR are recovery actions. Please confirm that actions to mitigate fire-induced failures outside of the MCR are recovery actions in the variant plant and are included in the additional risk of recovery action estimates.

Response

The actions to mitigate fire-induced failures outside of the MCR are considered recovery actions in the variant plant and are included in the additional risk of recovery action estimates regardless of the location of the fire (including control room and cable spreading room fire scenarios).

PRA RAI 18.01 – Minimum Joint HEPs

In the LAR supplement dated August 12, 2015, the response explains that the Fire PRA (FPRA) will be re-quantified using joint Human Error Probabilities (HEPs) greater than or equal to 1.0E-5, but that depending on the results, values less than 1E-05 may be introduced back into the FPRA model. The response explains, that in this case, the basis for these minimum joint HEPs, which are primarily related to separation in time, shall be justified and the results documented in the Fire Human Reliability Analysis notebook. If minimum joint HEPs less than 1E-05 are introduced back into the Fire PRA then per the request in PRA RAI 18:

a) Confirm that each joint HEP value used in the Fire PRA below 1.0E-05 includes its own justification that demonstrates the inapplicability of the NUREG-1792 lower value guideline.

b) Provide an estimate of the number of these joint HEPs below 1.0E-05 and at least two different examples of the justification.

Response

a) Each joint HEP value used in the FPRA below 1.0E-05 will include its own justification that demonstrates the inapplicability of the NUREG-1792 lower value guideline.

b) An estimate of the number of these joint HEPs below 1.0E-05 and at least two different examples of the justification will be provided with the final PRA RAI 03 response.

Safe Shutdown Analysis (SSA) RAI 11.01

In its response to SSA RAI 11.a in the LAR supplement dated August 12, 2015, the licensee stated that the modifications to address the circuit failure concerns in Information Notice (IN) 92-18, “Potential for Loss of Remote Shutdown Capability During a Control Room Fire,” for certain valves, were not credited in areas that use the deterministic approach of NFPA 805 Section 4.2.3. However, in LAR Attachment S, the licensee stated that these modifications will reduce risk because it will preclude the spurious operation; therefore, these modifications are credited to deterministically prevent any spurious operation in a performance-based analysis. The licensee further stated in its response to SSA RAI 11.b, that the installation of an inhibit circuit uses conductors and a control switch to intentionally short across the target coil when the device is in its de-energized state and will prevent intra-cable (internal) and inter-cable (external) hot shorts from energizing the target coil and causing the valve to spuriously actuate, and that this inhibit circuit could be bypassed by manual operation of the “break-before-make” control switch.

i) In SSA RAI 11.c, the NRC staff requested that the licensee discuss the effects of hot shorts (external and internal), open circuits, and shorts-to-ground on the circuits and include a discussion on the potential for “collateral damage” from open circuits in adjacent cables that have fusing greater than 10 amps based on the results of the DESIREE-Fire test documented in NUREG/CR-7100, “Direct Current Electrical Shorting in Response to Exposure Fire.” However, the response to SSA RAI 11.c did not provide all of the requested information. Rather, the licensee provided a qualitative analysis stating that the failure of the inhibit circuit to result in a spurious operation is unlikely to occur from an energized conductor (either intra-cable or inter-cable), without discussing the effects of circuit damage within the zone of influence due to significant arcing of adjacent cables that have fusing greater than 10 amps. Without the requested information, the NRC staff is not able to conclude if spurious operation is unlikely.

    Provide the information requested in SSA RAI 11.c (i.e., discuss the effects of hot shorts, open circuits and shorts-to-ground from adjacent circuits and the potential for “collateral damage” from arcing in adjacent cables with fusing greater than 10 amps), or provide further justification for concluding that failure of the inhibit switch circuit is unlikely, in light of the results of the DESIREE-Fire test. If a probabilistic approach (either qualitative or quantitative) is utilized, then provide the bases for acceptability of the approach when used in the performance-based analysis considering that the Fire PRA credits the modification to “preclude the spurious operation.”

ii) In SSA RAI 11.d, the NRC staff requested the licensee to describe how fire damage to the new shorting switch in the control room will not affect the desired nuclear safety function. In its response to SSA RAI 11.d, the licensee stated that the postulated damage to the shorting switch would not be sufficient to affect the nuclear safety function based on the fire testing performed and documented in Exelon Nuclear Evaluation EC-EV A1831999 01, “Evaluation of Shorting Switch Modification,” Rev. 0, dated December 2011, and that a peak temperature of 575˚F (300˚C) was maintained for 15 minutes. It does not appear to the NRC staff that with the peak temperature reached, the assumptions used to assess the shorting switch are consistent with those used to evaluate MCR fires (for either control room abandonment through loss of habitability or component damage) in accordance with NUREG\CR-6850, “EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities.” Discuss how the results of this Exelon fire test bound the fire modeling parameters defined in NUREG/CR-6850 (i.e., heat release rates, rate of fire growth, non-suppression probability, etc.), and discuss how the integrity of the shorting switch is affected if the fire modeling parameters defined in NUREG/CR-6850 are considered.

Response

The following information is supplemental to the previously submitted response to SSA RAI 11

i. The discussion of switchgear results in Section 6.4 of NUREG/CR-7100, *Direct Current Electrical Shorting in Response to Exposure Fire,* April 2012, shows a total of ten small scale tests (Penlight) and an additional twelve intermediate scale tests where fusing of 15 amps (A) and 35 A was used in simulated trip and close switchgear circuits. In two of these twenty-two tests, the conductors failed (melted) open and remained energized at 125 VDC. This represents a nominal 10% of the sample population where conductor melting occurred. Collateral damage limited to conductor insulation of a target cable that does not damage (melt open) the conductors would not result in the spurious operation of circuits that use inhibit circuits. If the path from the line side of the coil through the grounded neutral remains intact, the circuit cannot develop a sufficient coil pickup voltage to spuriously operate the component. Failure of other intact conductors (open, hot shorts, grounds) in the target cable will not result in spurious operation. The analysis for this circuit is consistent with the methodology of NEI 00-01, *Guidance for Post-Fire Safe Shutdown Circuit Analysis*. As stated in the original response to this RAI, there is no statement or conclusion made in NUREG/CR-7100 for either test, where conductors melted open, that the cable damage is collateral. This understanding is confirmed in the draft working copy for Appendix I (Shorting Switch) to NEI-00-01 (ML14141A480), which contains the following excerpt from Section 4.5.

> *"The DESIREE fire testing also identified that DC circuits fused at ≤10 A were isolated by the fuses prior to the open circuit failure of the conductor. Clarifying discussions were held with S. Nowlen from SANDIA Laboratories, that clarified that when open circuits occurred, they did not damage adjacent conductors, although in some cases they did result in insulation damage to adjacent conductors."*

In the absence of a documented test or industry Operating Experience that shows collateral damage beyond insulation damage in control circuits, the only analysis path available is qualitative, as supported by some empirical data. The following provides additional justification to Part c) of the original RAI response that supports the ANO position that this is a non-credible failure.

Postulating collateral damage where the conductors of the target cable are melted open requires the source DC cable to be arcing and adjacent to the target cable. The specific conductors that would need to be damaged, rendering the inhibit circuit non-functional while allowing the spurious actuation, will also need to be on the part of the target cable facing the arc source. If the arc source melts open intervening conductors needed to cause spurious actuation, the arc will only serve to make actuation more unlikely.

A review of cable routes, from exported Plant Data Management System (PDMS) data, for each valve was conducted to determine the total number of cables present at each route point and the number of all 125 VDC cables with fusing greater than 10 A. The non-DC cables will typically be multi-conductor jacketed control cables with at least one of the conductors being a 120 VAC source. The PDMS data was a snapshot of in-design data from a living database. All schemes associated with Switchgear and Load Centers were assumed to be DC with fusing greater than 10 A and all schemes associated with 480 VAC Motor Control Centers were assumed to be AC for simplification purposes. A review of design drawings was performed for remaining schemes to determine if the circuit was DC with fusing greater than 10 A. A comparison of the number of 125 VDC cables with greater than10 A fusing to the total number of cables in the raceway shows that for a typical tray, less than 20% of the subject DC cables are present. Conduits can range from 0% DC cables to greater than 50%. As indicated in the DESIREE fire testing, a DC cable is more likely to remain intact and not experience the aggressive arcing leading to melting of its conductors. If a nominal 10% of these DC cables are anticipated to fail in this manner, then the likelihood of a target cable being adjacent to a source cable is, based on random distribution of cables, greatly reduced (see the tables below for individual valves).

Large Early Release Frequency Reduction Valve Modifications

The valves that will be modified with an inhibit circuit for LERF reduction are redundant in-series valves with normally de-energized circuits. The AOVs fail closed in the desired position upon loss of air or loss of power, which is unaffected by the inhibit circuit. The in-series valve pairs, which are powered from opposite electrical trains and housed in different MCR cabinets, are shown in the table below. With the exception of cable RCB5243F for CV-5612, the cables associated with each valve pair are routed down into the Cable Spreading Room (CSR) below the MCR in separate enclosed raceways. Cable RCB5243F is routed overhead in the MCR until it exits the fire area and never enters the CSR. The conduits associated with LERF circuits contain a large percentage of DC cables, mostly 15 A for DC solenoids, with fusing greater than 10 A. If aggressively arcing DC cables were to cause collateral cable damage, it would need to occur in two separate raceways and fail specific conductors of the target cables protected by the inhibit switch. The conduits in the CSR are in close proximity to each other, but this location has full detection and automatic suppression.

In-Series Valve Pairs

Controls located on C-16		Controls located on C-18	
CV-1052	AOV	CV-1053	MOV
CV-4400	AOV	CV-4446	MOV
CV-5611	MOV	CV-5612	MOV
CV-7401	AOV	CV-7403	AOV
CV-7402	AOV	CV-7404	AOV

Core Damage Frequency (CDF) Valve Modifications

Each valve that will be modified with the inhibit circuit for CDF along with the associated cable and cable routing is described below. In each case, two faults would have to occur before spurious operation could occur.

CV-1221
Cables GCB6154E and GCB6154G (both cables are in the same raceway)
From: MCR panel C16
To: MCC B-61

If aggressively arcing DC cables were to cause collateral cable damage, the arcing would need to fail a specific conductor of cable GCB6154G with a subsequent fault that would energize target conductors on cable GCB6154E.

Cable	Conduit (C) Tray (T)	Raceway	Total Cables	Cables 125 VDC Fused > 10 A
GCB6154E GCB6154G	T	EC211	140	12
GCB6154E GCB6154G	T	EC210	131	12
GCB6154E GCB6154G	T	EC209	159	15
GCB6154E GCB6154G	T	EC208	144	16
GCB6154E GCB6154G	T	EC207	148	11
GCB6154E GCB6154G	C	EC2027	22	10
GCB6154E GCB6154G	C	EC2156	16	0
GCB6154E GCB6154G	C	EC2159	22	15

Sluice Gates SG-1
Cable RCB5253F1
From: MCR panel C26
To: MCC B-52

If an aggressively arcing DC cable were to cause collateral cable damage, the arcing would need to fail a specific conductor of cable RCB5253F1 with a subsequent fault that would energize target conductors that could cause spurious actuation.

Cable	Conduit (C) Tray (T)	Raceway	Total Cables	Cables 125 VDC Fused > 10 A
RCB5253F1	C	EC1483	4	0
RCB5253F1	C	EC1311	30	2
RCB5253F1	C	EC1300	17	1
RCB5253F1	C	EC1293	19	0
RCB5253F1	C	EC1321	19	0
RCB5253F1	C	EC1296	19	0
RCB5253F1	C	EC1315	17	0

Sluice Gates SG-3
Cable RCB5251C
From: MCR panel C26
To: MCC B-52

If an aggressively arcing DC cable were to cause collateral cable damage, the arcing would need to fail a specific conductor of cable RCB5251C with a subsequent fault that would energize target conductors that could cause spurious actuation.

Cable	Conduit (C) Tray (T)	Raceway	Total Cables	Cables 125 VDC Fused > 10 A
RCB5251C	C	EC1475	3	0
RCB5251C	C	EC109	115	5
RCB5251C	T	EC108	115	6
RCB5251C	T	EC107	118	3
RCB5251C	T	EC106	117	3
RCB5251C	T	EC105	126	12
RCB5251C	C	EC1018	9	0
RCB5251C	C	EC1485	3	0
RCB5251C	C	VJ033	7	0
RCB5251C	C	EC1486	7	0

Sluice Gates SG-2 and SG-4

The cables associated with Sluice Gates SG-2 and SG-4 are routed through conduits from MCR panel C26 to the applicable MCC. There are no 125 VDC circuits with fusing greater than 10 A present in these conduits.

CV-1405
Cables RCB51112C and RCB51112E (cables are routed in separate raceways)
From: MCR panel C18
To: MCC B-51

If an aggressively arcing DC cable were to cause collateral cable damage, the arcing would need to fail a specific conductor of cable RCB51112E with a subsequent fault that would energize target conductors on cable RCB51112C, routed in a separate raceway.

Cable	Conduit (C) Tray (T)	Raceway	Total Cables	Cables 125 VDC Fused > 10 A
RCB51112C	T	EC101	70	12
RCB51112C	T	EC102	75	15
RCB51112C	C	EC1255	13	0
RCB51112C	C	EC1213	14	0
RCB51112E	C	EC1408	1	0
RCB51112E	T	EC105	125	12
RCB51112E	C	EC1020	22	2
RCB51112E	C	VC133	27	3

CV-1406
Cables GCB6166C and GCB6166E (cables are routed in separate raceways)
From: MCR panel C16
To: MCC B-61

If an aggressively arcing DC cable were to cause collateral cable damage, the arcing would need to fail a specific conductor of cable GCB6166E with a subsequent fault that would energize target conductors on cable GCB6166C, routed in a separate raceway.

Cable	Conduit (C) Tray (T)	Raceway	Total Cables	Cables 125 VDC Fused > 10 A
GCB6166C	T	EC211	140	12
GCB6166C	T	EC210	131	12
GCB6166C	T	EC209	159	15
GCB6166C	T	EC208	144	16
GCB6166C	T	EC207	148	11
GCB6166C	C	EC2025	22	2
GCB6166C	C	EC2309	15	3
GCB6166E	C	EC2159	22	15
GCB6166E	C	EC2157	17	4
GCB6166E	C	EC2028	7	0
GCB6166E	C	EC2520	5	0

<u>Defense-in-Depth Non-Power Operations Valve Modification</u>

CV-1404
Cable B5651C
From: MCR panel C14
To: MCC B-56

This valve is modified with an inhibit circuit design to provide defense-in-depth (DID) for the drop line from the Reactor Coolant System to the Decay Heat Removal system. If an aggressively arcing DC cable were to cause collateral cable damage, the arcing would need to fail a specific conductor of cable B5651C with a subsequent fault that would energize target conductors that could cause spurious actuation.

Cable	Conduit (C) Tray (T)	Raceway	Total Cables	Cables 125 VDC Fused > 10 A
B5651C	T	EC204	110	20
B5651C	T	EC203	97	20
B5651C	T	EC223	117	22
B5651C	C	C4170	20	3

Cable	Conduit (C) Tray (T)	Raceway	Total Cables	Cables 125 VDC Fused > 10 A
B5651C	T	EC241	45	3
B5651C	T	DC018	99	6
B5651C	C	C4092	21	2
B5651C	T	DC098	105	7
B5651C	T	DC085	135	13
B5651C	T	DC086	133	11
B5651C	T	DC087	125	16
B5651C	T	DC088	108	15
B5651C	C	VC109	17	0

ii. Adequacy of the shorting switch to remain intact is evaluated for two conditions: fires external to the control panel and fire internal to the panel.

Fires that are external to the control panel would need to form a hot gas layer sufficient to damage the switch. The handswitch for CV-1221 is at 72" and bounds the location of the other handswitches that are mounted at lower heights (refer to table in this section). Fire modeling, using the same NUREG/CR-6850 compliant methodology used in CALC-ANO1-FP-09-00011 for the ANO-1 MCR abandonment times, was used to determine the time to reach a threshold damage temperature of 575 °F (300 °C) at a height of 6' (72"). This analysis is documented by CALC-ANO1-FP-15-00002, "ANO1 Control Room Hot Gas Layer for Hand Switch Damage Threshold," and shows transients and single bundle panels do not produce conditions that can damage the switches. The fire associated with multiple bundle panels can result in reaching the threshold damage temperature in some ventilation situations, but only at the highest HRR bins. This engineering report shows the frequency of fire scenarios external to the cabinet that can cause damage is less than 1.0E-6 per reactor year. MCR abandonment would have occurred prior to reaching this threshold. The recovery action for CV-1221 includes opening the associated MCC breaker B-6154. There is also an existing DID action to open the feeder breaker to Load Center B-6 that would de-energize all green train 480 VAC MCCs and the downstream MOVs. The remaining handswitches are lower than 72" and would have an appropriately lower risk of fire damage.

Fires internal to the control panel are not adequately addressed in NUREG/CR-6850, which states in Section 11.5.2.8, that modeling a fire inside a control panel is beyond the state of the art. A series of cabinet fire experiments reported in NUREG/CR-4527, *An Experimental Investigation of Internally Ignited Fires in Nuclear Power Plant Control Cabinets,* April 1987, is one of the references used to develop NUREG/CR-6850 and is appropriate when considering internal cabinet fires. The Exelon Nuclear Evaluation EC-EVAL A1831999 01, "Evaluation of Shorting Switch Modification," uses NUREG/CR-4527 to determine a HRR for realistic vertical panel fires. Appendix I, *Shorting Switch,* to NEI-00-01 recognizes the

Exelon evaluation, but this NEI document is a working draft not currently endorsed by the NRC. Since NEI 00-01, Appendix I, is in process and subject to change, and to be consistent with existing actions for the green train, an additional DID action to secure Load Center B-5, or its downstream breakers, is planned for MCR abandonment scenarios. This is accomplished to remove power to red train valves associated with CDF reduction. A revised Attachment G will be submitted with the response that summarizes RAI PRA 03 results.

In summary, the suitability for use of the shorting switch at ANO, using discussions from both the initial and this supplemental RAI response, is based on:

- The MCR is a continuously occupied space with access controlled by Operations.
- Postulated bounding fire scenarios external to the cabinets that reach switch damage threshold are of very low frequency.
- Information from NUREG/ CR-4527 was used by Exelon for testing and fire modeling of internal cabinet fires since NUREG/CR 6850 does not adequately address internal cabinet fires.
- Cables and internal cabinet wiring are thermoset and meet IEEE 383 requirements.
- The authors of scoping tests for NUREG/CR-4527 reached a conclusion that qualified cable fires in vertical cabinets do not spread throughout the cabinet and the thermal environment in the enclosure does not become severe enough to cause melting of components or result in flashover.
- Fire induced failure of the conductors that results in application of a suitable voltage to the target conductor causing spurious actuation is required in addition to shorting switch failure.
- DID features include redundancy for LERF valves and actions to secure the power source to valves credited for CDF reduction following MCR abandonment.

Valve	Type	MCR Panel	Switch Height	Power Removed by Recovery or DID?
*CV-1052	AOV	C-16	44”	No
*CV-1053	MOV	C-18	44”	Yes / B-5 (New)
*CV-4400	AOV	C-16	36”	No
*CV-4446	MOV	C-18	36”	Yes / B-5 (New)
*CV-5611	MOV	C-16	28”	Yes / B-6
*CV-5612	MOV	C-18	28”	Yes / B-5 (New)
*CV-7401	AOV	C-16	44”	No
*CV-7402	AOV	C-16	44”	No
*CV-7403	AOV	C-18	44”	No
*CV-7404	AOV	C-18	44”	No

Valve	Type	MCR Panel	Switch Height	Power Removed by Recovery or DID?
CV-1221	MOV	C-16	72”	Yes / B-6 and Breaker B-6154
CV-1405	MOV	C-18	22”	Yes / B-5 (New)
CV-1406	MOV	C-16	22”	Yes / B-6
SG-1	MOV	C-26	58”	Yes / B-5 (New)
SG-2	MOV	C-26	58”	Yes / B-6
SG-3	MOV	C-26	52”	Yes / B-5 (New)
SG-4	MOV	C-26	52”	Yes / B-6
**CV-1404	MOV	C-14	36”	No

*LERF Reduction

**NPO

REFERENCES

1. Entergy letter dated January 29, 2014, *License Amendment Request to Adopt NFPA-805 Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (2001 Edition)* (1CAN011401) (ML14029A438)

2. NRC letter dated May 5, 2015, *Arkansas Nuclear One, Unit 1 – Request for Additional Information Regarding License Amendment Request to Adopt National Fire Protection Association Standard 805* (TAC No. MF3419) (1CNA051501) (ML15091A431)

3. Entergy letter dated May 19, 2015, *Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN051501) (ML15139A196)

4. Entergy letter dated June 16, 2015, *60-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN061501) (ML15167A503)

5. Entergy letter dated July 21, 2015, *90-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN071501) (ML15203A205)

6. Entergy letter dated August 12, 2015, *120-Day Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN081501) (ML15224A729)

7. NRC email dated September 8, 2015, *Arkansas Nuclear One, Unit 1 – 2nd Round Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA091501) (ML15251A220)

8. Entergy letter dated September 22, 2015, *Round 2 Response to Request for Additional Information – Adoption of National Fire Protection Association Standard NFPA-805* (1CAN091501) (ML15265A113)

9. NRC email dated October 6, 2015, *Arkansas Nuclear One, Unit 1 – 2nd Round Part 2 Request for Additional Information - ANO-1 NFPA 805 LAR (TAC No. MF3419)* (1CNA101501) (ML15280A114)