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Serial: RNP-RA/15-0071

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

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261 / RENEWED LICENSE NO. DPR-23

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT REQUEST TO ADOPT NATIONAL FIRE PROTECTION ASSOCIATION STANDARD 805, "PERFORMANCE-BASED STANDARD FOR LIGHT WATER REACTOR ELECTRIC GENERATING PLANTS"

Dear Sir/Madam:

By letter dated September 16, 2013 (Reference 1) Duke Energy Progress, Inc. submitted a license amendment request to adopt a new risk-informed performance-based fire protection licensing basis for the H. B. Robinson Steam Electric Plant, Unit No. 2 (HBRSEP2). During the week of September 22, 2014, the NRC conducted an audit at HBRSEP2 to support development of questions regarding the license amendment request. On October 23, 2014 the NRC provided a set of requests for additional information (RAI) regarding the license amendment request (Reference 2). That letter divided the RAIs into 60-day, 90-day, and 120-day required responses. The Duke Energy Progress 60-Day, 90-Day, and 120-Day responses were conveyed to the NRC Document Control Desk via letters from R. Michael Glover on November 24, 2014 (Reference 3), December 22, 2014 (Reference 4), and January 22, 2015 (Reference 5), respectively. On April 23, 2015 a follow-up RAI regarding the Reference 4 submittal was conveyed to Duke Energy Progress, Inc. via electronic mail message (Reference 8). The Duke Energy Progress response to that request was provided by letter dated May 19, 2015 (Reference 9). The NRC requested a 3rd round of additional information regarding Fire Modeling, and a 2nd round of additional information related to probabilistic risk assessment (PRA) via electronic mail message (draft) dated June 17, 2015 (Reference 10), and letter (official) dated July 7, 2015 (Reference 11). The Duke Energy Progress response to that request is provided herein.

Please address any comments or questions regarding this matter to Mr. Richard Hightower, Manager – Nuclear Regulatory Affairs at (843) 857-1329.

There are no new regulatory commitments made in this letter.

I declare under penalty of perjury that the foregoing is true and correct. Executed on July 31, 2015.

Sincerely,

R. Michael Glover

R. Michael Glover
Site Vice President

RMG/jmw

Enclosure

cc: Mr. V. M. McCree, NRC, Region II
Ms. Martha C. Barillas, NRC Project Manager, NRR
Mr. Dennis Galvin, NRC Project Manager, NRR
NRC Resident Inspector, HBRSEP2
Ms. S. E. Jenkins, Manager, Infectious and Radioactive Waste Management Section (SC)

REFERENCES:

1. Letter from W. R. Gideon (Duke Energy Progress) to U. S. Nuclear Regulatory Commission (USNRC) (Serial: RNP-RA/13-0090), *License Amendment Request (LAR) to Adopt NFPA 805 Performance-Based Standard for Fire Protection for Light Water Reactor Generating Plants (2001 Edition),* dated September 16, 2013, ADAMS Accession No. ML13267A211
2. Letter from Martha Barillas (USNRC) to Site Vice President, H. B. Robinson Steam Electric Plant (Duke Energy Progress), *H. B. Robinson Steam Electric Plant, Unit 2 – Request for Additional Information on License Amendment Request to Adopt National Fire Protection Association Standard 805, Performance-Based Standard for Fire Protection (TAC No. MF2746),* dated October 23, 2014, ADAMS Accession No. ML14289A260
3. Letter from R. Michael Glover (Duke Energy Progress) to U. S. Nuclear Regulatory Commission (USNRC) (Serial: RNP-RA/14-0122), *Response (60-Day) to Request for Additional Information Associated with License Amendment Request to Adopt National Fire Protection Association (NFPA) Standard 805,* dated November 24, 2014
4. Letter from R. Michael Glover (Duke Energy Progress) to U. S. Nuclear Regulatory Commission (USNRC) (Serial: RNP-RA/14-0134), *Response (90-Day) to Request for Additional Information Associated with License Amendment Request to Adopt National Fire Protection Association (NFPA) Standard 805,* dated December 22, 2014
5. Letter from R. Michael Glover (Duke Energy Progress) to U. S. Nuclear Regulatory Commission (USNRC) (Serial: RNP-RA/15-0006), *Response (120-Day) to Request for Additional Information Associated with License Amendment Request to Adopt National Fire Protection Association (NFPA) Standard 805,* dated January 22, 2015
6. Letter from Martha Barillas (USNRC) to Site Vice President, H. B. Robinson Steam Electric Plant (Duke Energy Progress), *H. B. Robinson Steam Electric Plant, Unit 2 – Request for Additional Information on 60-Day Response to License Amendment Request to Adopt National Fire Protection Association Standard 805, Performance-Based Standard for Fire Protection (TAC No. MF2746),* dated March 26, 2015, ADAMS Accession No. ML15057A403
7. Letter from R. Michael Glover (Duke Energy Progress) to U. S. Nuclear Regulatory Commission (USNRC) (Serial: RNP-RA/15-0021), *Supplemental Response (120-Day) to Request for Additional Information Associated with License Amendment Request to Adopt National Fire Protection Association (NFPA) Standard 805,* dated April 1, 2015
8. Electronic Mail message from Martha Barillas (USNRC) to H. B. Robinson Steam Electric Plant, Unit 2 Regulatory Affairs staff members Richard Hightower/Scott Connelly (Duke Energy Progress) – Robinson NFPA 805 Follow-up 90-Day FM and RR RAI, dated April 23, 2015

9. Letter from R. Michael Glover (Duke Energy Progress) to U. S. Nuclear Regulatory Commission (USNRC) (Serial RNP-RA/15-0047), Response to Follow-Up Request for Additional Information (RAI) Associated with Response to 90-Day RAI Related to License Amendment Request to Adopt National Fire Protection (NFPA) Standard 805, dated May 19, 2015
10. Electronic Mail message from Dennis Galvin (USNRC) to H. B. Robinson Steam Electric Plant, Unit 2 Regulatory Affairs staff members Richard Hightower/Scott Connelly (Duke Energy Progress) – Robinson Draft NFPA 805 3rd Round RAIs – Fire Modeling and Draft 2nd Round RAIs – PRA(MF2746), dated June 17, 2015, ADAMS Accession No. ML15169A027
11. Letter from Martha Barillas (USNRC) to Site Vice President, H. B. Robinson Steam Electric Plant (Duke Energy Progress), *H. B. Robinson Steam Electric Plant, Unit 2 – Request for Additional Information Regarding License Amendment Request to Adopt National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants" (TAC No. MF2746),* dated March 26, 2015, ADAMS Accession No. ML15182A193

U. S. Nuclear Regulatory Commission
Enclosure to Serial: RNP-RA/15-0071
16 Pages (including this cover page)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING LICENSE AMENDMENT REQUEST TO ADOPT NATIONAL FIRE PROTECTION ASSOCIATION STANDARD 805, "PERFORMANCE-BASED STANDARD FOR LIGHT WATER REACTOR ELECTRIC GENERATING PLANTS"

REQUEST FOR ADDITIONAL INFORMATION

VOLUNTARY FIRE PROTECTION RISK INITIATIVE

DUKE ENERGY PROGRESS

H. B ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2

DOCKET NO. 50-261

Fire Modeling (FM) Request for Additional Information (RAI) FM RAI 01.b.01.01

In a letter dated April 1, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML 15099A454), the licensee responded to FM RAI 01.b.01. For the first part of the RAI response, the licensee referred to Figure 9-2 of NUREG/CR-7010, "Cable Heat Release, Ignition, and Spread in Tray Installations During Fire (CHRISTIFIRE)," as an example to show that as the progression of the fire extends outwards, "the burning region remains somewhat constant." In the second part of its response, the licensee further stated that the vertical zone of influence (ZOI) would be extended to the ceiling if there are multiple trays in the ZOI of the ignition source.

Figure 9.2 in NUREG/CR-7010 clearly shows that between the 15th and 30th minute periods, flames have spread laterally, while no sections of the trays have burnt out. According to the FLASH-CAT model described in Chapter 9 of NUREG/CR-7010, lateral flame spread begins as soon as a tray ignites and propagates at a rate of 0.9 millimeters per second for thermoplastic cable. Cables do not burn out until the combustible jacket and insulation have been consumed. In addition, from the response to the second part of FM RAI 01.b.01, it does not appear that the licensee accounted for the effect of the increased heat release rate (HRR) due to fire propagation in cable trays on the horizontal ZOI and the development of a damaging hot gas layer (HGL).

Reevaluate the target damage for all scenarios that involve secondary combustibles (i.e., cable trays). In this reevaluation, calculate fire propagation in stacks of cable trays taking horizontal flame spread into account, determine the expanded ZOI that corresponds to the combined HRR from the ignition source and the cable trays, and identify any targets that are in the expanded ZOI. If in the reevaluation the licensee does not use the model described in Section R.4 of NUREG/CR-6850, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities," or the FLASH-CAT model described in Chapter 9 of NUREG/CR-7010, explain in detail how the time to ignition of the lowest tray is determined and how subsequent fire propagation in cable trays is calculated. Determine the impact of the results of the reevaluation on the risk (CDF, ΔCDF, LERF, and ΔLERF). Alternatively, demonstrate that the approach currently used by the licensee to determine target damage in fire scenarios that involves cable trays as intervening combustibles is conservative and bounding.

Response:

As described in the response to the second round of this Request for Additional Information (i.e., RAI 01.b.01.01), the Robinson Nuclear Plant (RNP) Fire PRA includes cables in raceways as secondary combustibles as contributors to the heat release rate used for determining if and when a hot gas layer (HGL) scenario is postulated in each scenario progression. In response to this RAI, the Fire PRA has been reviewed to identify all the fire scenarios where no propagation to raceways occur or scenario that are not relevant to this evaluation (i.e., only fixed and transient ignition source fire scenarios capable of propagating a fire to raceways are within the scope of this evaluation). RNP is currently incorporating in the Fire PRA the following:

1. Fire propagation in the form of horizontal flame spread in the cable trays that can generate a HGL scenario faster, which may result in a higher non-suppression probability term for the HGL contribution, or

2. In scenarios where a HGL is not generated, evaluate if additional damage states following those failed in the ZOI with higher CCDPs are necessary.

The flame spread rate for thermoplastic cables listed in NUREG/CR-7010 will be used for determining the extent of fire propagation horizontally through a cable tray stack and the additional heat release rate contribution to each fire scenario. With this additional contribution, revised timing for the HGL scenario if applicable will be obtained and incorporated in the risk quantification. In addition, any targets associated with an expanded ZOI given the heat release rate contribution of cable fires will be included in the quantification process for the relevant scenarios. To do so, the size of the expanded ZOI will be determined so that the targets within the ZOI can be identified.

The evaluation described above will be part of the compliant and variant Fire PRA model. The risk results (i.e., CDF, ΔCDF, LERF, and ΔLERF) associated with the compliant and variant Fire PRA model will be reported as part of PRA RAI 03.

FM RAI 01.b.01.02

In its letter dated April 1, 2015, the licensee responded to FM RAI 01.b.01 and referred to the fire PRA quantification documentation for details on how the licensee calculated the HRR of cable trays.

During its review of pertinent sections of the fire PRA quantification documentation, the U.S. Nuclear Regulatory Commission (NRC) staff noted that the licensee determined the time to damaging HGL conditions for scenarios involving cable trays based on the cumulative combined HRR of the ignition source and the cable trays. The fire PRA quantification documentation does not describe this method in detail, but provides an example that seems to indicate that the licensee's approach allows the combined HRR to exceed the previously determined minimum HRR needed for damaging HGL conditions long before the cumulative HRR threshold for damaging HGL conditions is reached.

Provide a detailed description of the methodology that was used to determine the time to damaging HGL conditions for scenarios that do and do not involve secondary combustibles, and provide the technical justification for the underlying assumptions of the approach for both types of scenarios.

Response:

The Robinson Nuclear Plant (RNP) Fire PRA includes fire scenarios that have been determined to propagate to secondary combustibles. At the same time, there are also scenarios where no propagation is postulated as the fire scenario configuration is not amenable for such process. The distance between the ignition source and the closest intervening combustible as well as the appropriate fire condition within the zone of influence (ZOI) are used for determining if the fire propagates. In both cases (i.e., for scenarios where fire propagation is postulated as well as for those were no propagation is modeled), the time to a damaging hot gas layer (HGL) is calculated the same way. In general, both the heat release rate associated with the ignition source and that associated with the intervening combustibles are added as a function of time to obtain the heat release rate (HRR) profile that is used as input in the fire model. For cases where there are no intervening combustibles near the ignition source, the contribution to the HRR from intervening combustibles is set to zero and the heat release rate profile is based on the ignition source only.

Depending on the amount of combustibles (generally cable trays within the ZOI), the heat release rate profile is estimated uses guidance from NUREG/CR-6850, Appendix R. The fire propagation among a stack of vertical cables trays using the following timeline:

Table 1: Timeline for fire propagation in a cable tray stack

Timeline	Description
T1	Time to reach HRR capable of damaging first tray
T2	Time to ignite the first target (tray) based on NED-M/MECH-1009
T3	Time to ignite second tray = T2 + 4min
T4	Time to ignite third tray = T3 + 3min
T5	Time to ignite forth tray = T4 + 2min
T6	Time to ignite fifth tray = T5 + 1min
TX	Time to ignite remaining trays = previous tray + 1min

The following properties are assigned to the horizontal cable fire growth for RNP based on NUREG/CR-6850 and NUREG/CR-7010:

Table 2: Cable tray flammability and configuration properties

Cable Tray Width	0.61 m	Typical tray width
HRR per unit area	250 kW/m^2	NUREG/CR-7010, for thermoplastic cables
Cable Tray Length	1 m	Initial cable tray length
Cable Tray Spacing	0.16 m	Typical tray spacing

Using the values listed above, the heat release rate for the cable trays is calculated as the surface area of the tray multiplied by the heat release rate per unit area. The angle of 35° described in Appendix R.4.2 of NUREG/CR-6850 is used for determining the length of the cable trays in the stack above the ignition source. This in turn is used to estimate the appropriate burning surface for each tray. The following contribution per cable tray added to the fire scenario. It should be noted that the heat release rate values listed below may increase as a result of the addition of horizontal flame spread in response to FM RAI 01.b.01.03.

Table 3: Cable tray flammability and configuration properties

Tray Count	Cable Tray Length	Cable Tray Contribution
1^{st} Tray	1 m	153 kW
2^{nd} Tray	1.4 m	339 kW
3^{rd} Tray	2.2 m	560 kW
4^{th} Tray	3.3 m	815 kW
5^{th} Tray	4.4 m	1104 kW
6^{th} Tray	9.4 m	2343 kW

The time to HGL is determined when the cumulative energy released over time exceeds the energy needed for a HGL scenario for the corresponding fire compartment. Specifically,

- The total heat release rate is based on adding the source fire HRR and each tray HRR for each time interval. The HRR assigned to the ignition source is based on the guidance in Appendix G of NUREG/CR-6850 in terms of peak HRR and t2 growth profile. If the fire grows large enough to support a HGL, the time to HGL can be estimated. The total energy generated by the combined scenario HRR profile (i.e., ignition source plus intervening combustibles) is calculated as a function of time by performing a numerical integration of the heat release rate profile over a period of sixty minutes.

- The constant HRR needed for 30 minutes to develop a HGL scenario is calculated using either the MQH or Beyler room temperature models (see NUREG 1805). The total energy needed for developing a HGL scenario is then calculated multiplying the resulting heat release rate, which is assumed constant for a duration of thirty minutes MQH or Beyler room temperature model calculation, by 30 minutes.

In summary, the total energy released by the fire is compared to the total energy needed to raise the temperature in the room to the damage threshold (i.e., the HGL scenario). The time HGL is the point in time where the total energy released by the fire exceeds the energy needed for the HGL scenario.

FM RAI 01.b.01.03

In its letter dated April 1, 2015, the licensee responded to FM RAI 01.b.01 and referred to the fire PRA quantification documentation for details on how the licensee calculated the time to ignition of the lowest tray in a stack of cable trays.

The response refers to Section 5.6.2 of fire PRA calculation RNP-F/PSA-0094 (fire PRA quantification), which in turn refers to another document for a description of the method that was used to determine the time to ignition of the lowest tray in a stack. This method relies on Heskestad's correlation to calculate the plume temperature at the tray as a function of time based on the HRR of a cabinet during the t2 growth phase. However, the report also indicates that in addition, a damage accrual method was used to determine the damage delay based on Tables H-5 and H-6 in NUREG/CR-6850, Appendix H. There is no detailed description of the method, and it appears that the damage accrual method used does not account for the effect of the preheat that would occur during the initial period when the plume temperature is below the damage threshold.

In addition, Section 5.6.2 of the fire PRA quantification seems to imply that a cable is assumed to ignite when it has reached the damage threshold. Since Section H.1.5.2 in NUREG/CR-6850, Appendix H, does not discuss the application of Tables H-5 and H-6 to determine ignition delay, the use of the damage accrual method to estimate the time to ignition requires technical justification.

Finally, the licensee's response to FM RAI 01.a in a letter dated December 22, 2014 (ADAMS Accession No. ML 15005A073), states that all fire modeling tools and methods used in the development of the license amendment request (LAR) were discussed in LAR Attachment J. However, a discussion of the damage accrual method that was used is not included and should be, particularly because it is used to determine ignition delay.

Provide a detailed description of the damage accrual method used and the technical basis and verification and validation to justify its use to determine ignition and damage delays. In the description, discuss how the method accounts for the effect of the preheat that would occur during the initial period when the plume temperature is below the ignition/damage threshold. If the method does not address preheat, either revise the analysis to address this phenomenon, or provide technical justification that the method used is conservative.

Response:

The time to damage and ignition of the lowest tray in a cable tray stack is determined using the Heskestad's plume temperature correlation to calculate the plume temperature at the tray as a function of time based on the heat release rate (HRR) of a cabinet during the t2 growth phase preceding a steady burning phase. The time to damage and ignition is then obtained with the delay based on the information available in Table H-6 in NUREG/CR-6850, Appendix H. The following clarifications on this approach are provided:

1. It is assumed that ignition and damage occurs at the same time. This is based on electrical shorts and sparks generated when cables are damaged due to fire generating the pilot flame necessary to ignite the cables.
2. The damage times listed in Table H-6 of NUREG/CR-6850, Appendix H are used as recommended in the guidance. With respect to this clarification, a detailed description of the accrual method for determining time to damage/ignition of the lowest tray in a stack is provided next. To facilitate the description, Table H-6 of NUREG/CR-6850, Appendix H has been reproduced in this response and is included as Table 4. An example is also provided as part of the description.

The approach for determining the time to damage/ignition of the lowest tray in a stack in the RNP Fire PRA consists of three steps. These steps are completed for each applicable fire scenario. The steps are:

1. Step 1: Scan each row in Table 4 below in which the maximum incident temperature affecting the target exceeds the lower bound of the range listed in the first column. For example, if the maximum fire generated temperature at the location of the target is 250 °C, the first four rows will be scanned as the temperature affecting the cable tray will never exceed 250 °C.
2. Step 2: For each scanned row, the time for exceeding the maximum exposure temperature for that row and the time to failure listed in the second column of Table 4 gets recorded (i.e., Min($t_{max\text{-}i}$, Time to failure$_i$)). This MIN function ensures that damage/ignition has occurred in this period of incident heating. If the incident temperature does not exceed the maximum value, time to damage listed in the second column of Table 4 gets recorded. Continuing with the example introduced in Step 1, in which the incident temperature is 250 °C:
    a. The time at which the incident temperature exceeds 220 °C is recorded. Notice that in this case, the incident temperature exceeds the maximum value in the range. For the purpose of this example, assume the time at which the incident temperature exceeds the maximum temperature in the range is 5 min. The Min function is Min(5, 30) = 5 min, which suggests that the cable has not been immersed in a temperature in the range of 205 < T < 220 °C long enough (at least 30 minutes for this temperature range) to be damaged or ignited.

b. The time at which the incident temperature exceeds 230 °C is recorded. Notice that in this case, the incident temperature exceeds the maximum value in the range. For the purpose of this example, assume the time at which the incident temperature exceeds the maximum temperature is 7 min. The Min function is Min(7, 25) = 7 min, which suggests that the cable has not been immersed in a temperature in the range of 220 < T < 230 °C long enough (at least 25 minutes for this temperature range) to be damaged or ignited.

c. The time at which the incident temperature exceeds 245 °C is recorded. Notice that in this case, the incident temperature exceeds the maximum value in the range. For the purpose of this example, assume the time at which the incident temperature exceeds maximum temperature is 8 min. The Min function is Min(8, 20) = 8 min, which suggests that the cable has not been immersed in a temperature in the range of 230 < T < 245 °C long enough (at least 20 minutes for this temperature range) to be damaged or ignited.

d. Since the incident temperature of 250 °C is within 245 < T < 260, a value of 15 minutes is recorded, which means that at least 15 minutes is needed for this temperature range for the cables to be damaged.

3. Step 3: Notice that Step 2 determines if the cable affected by the fire generated conditions can fail if exposed for a period of time to a specific range of temperature (i.e., each row in Table 4 is individually inspected). Step 3 is intended to evaluate these individual times and select the time to damage/ignition characterizing the target. This is accomplished by selecting the maximum value from the set of results produced in Step 2. In this example, the resulting time to damage/ignition is 15 minutes (i.e., 15 minutes is the maximum value between 5, 7, 8 and 15 minutes identified in Step 2). This result suggests that the cable was subjected to exposures under the 245 °C range for a relatively short period of time. Notice that the time it took the plume temperature to reach the target damage temperature of 205 °C is conservatively ignored when the value of 15 minutes is selected. Under the approach, the credited damage/ignition time is measured starting when the incident temperature reaches the lower temperature in the range listed in the first column of Table 4. That is, the Time to failure listed in Table 4 is not added to the time at which the incident temperature reaches the target damage temperature.

Table 4: Thermoplastic target damage times from Table H-6 in NUREG/CR-6850

Exposure Temperature (°C)	Time to Failure (Min)
205 < T < 220	30
220 < T < 230	25
230 < T < 245	20
245 < T < 260	15
260 < T < 275	10
275 < T < 290	8
290 < T < 300	7
300 < T < 315	6
315 < T < 330	5
330 < T < 345	4
345 < T < 355	3
355 < T < 370	2
T> 370	1

The determination of time to damage/ignition described earlier in Step 3 conservatively accounts for any heat transfer that may occur between the environment and the cable before the incident temperature reaches the thermoplastic damage threshold of 205 °C. This is because the incident temperature is treated as constant at the time it reaches a value that is within one of the ranges listed in Table 4, which is then assumed to happen at time equals zero. In the example above, the time to damage/ignition is 15 minutes because the temperature of 250 °C is between the range of 245 < T < 260 °C regardless if it took 8 minutes to reach that level. In other words, the analysis assumed a constant heating of 250 °C, starting at time zero, which is a more severe exposure than the one experience by the cable before the lower bound of the range was exceeded. To further illustrate this argument, consider the following conceptual examples:

- Assume that in the above example, the exposure temperature remained between 230 < T < 245 °C for a relatively long time, exceeding 245 °C at time 30 minutes instead of 8 minutes. The Min function in Step 2c above would have been Min(30, 20) = 20 min. The Min function in Step 2d would have been Min(31, 15) = 15 min. With these values, Step 3 would have produced Max(5, 7, 20, 15) = 20 min. This result suggests that the target was immersed in constant temperature between 230 < T < 245 °C for 20 minutes generating damage and ignition. This is a more severe exposure than what is actually experienced in the first 20 minutes of the fire event, which included a temperature exposure increasing from ambient conditions.

- Consider instead the case of a cable exposed for a relatively long time (e.g., 45 min) to a temperature just below the damage threshold of 205 °C. At this point, the cable is not expected to fail as it has not reached the damage threshold. Now assume that 45 min into fire event, the temperature increases within the range of 205 < T < 220 °C. The algorithm described above would have selected a time of 30 min, which is shorter than the preheating period. This means that if the cable is exposed to a temperature within the range of 205 < T < 220 °C, the cable will fail in no more than 30 minutes (according to Table H-6).

In summary, Table H-6 of NUREG/CR-6850, Appendix H is used for determining damage times. In order to appropriately use it, an algorithm has been developed to ensure that the "pre-heating" of the cable as the fire grows is conservatively accounted for in the analysis. The resulting method follows the guidance in Appendix H of NUREG/CR-6850 as it assumes a constant heating of the cables. This approach was documented in NED-M/MECH-1009 and submitted will be submitted in an updated Attachment J of the NFPA 805 LAR. Attachment J will be updated reflect the latest report revision (i.e., Rev 1) and submitted with the other updated LAR attachments.

Probabilistic Risk Assessment (PRA) RAI 01.k.01

PRA RAI 01.k requested additional information on how scenarios involving abandonment of the main control room (MCR) due to loss of habitability are evaluated. PRA RAI 23.a requested additional information on any special calculations used to evaluate the change-in-risk from MCR abandonment. (In its letter dated December 22, 2014, the licensee responded to PRA RAI 01.f and stated that only the MCR abandonment scenarios in the PRA are loss of habitability scenarios, so it is assumed that the responses to PRA RAI 01.k and PRA RAI 23.a (both provided in a letter dated January 22, 2015 (ADAMS Accession No. ML15036A059) refer only to loss of habitability).

The response to PRA RAI 01.k.ii states:

> The CCDP/CLERP [conditional core damage probability/conditional large early release probability] values were only calculated based on the worst-case scenario; these different scenarios are bounded by the current modeling results. The worst-case scenario is determined by failure of any operator actions as discussed in the previous section.

The response to PRA RAI 23.a states:

> For the compliant case, critical actions that occur outside of a PCS [primary control station] in the updated MCR abandonment procedure will be set to always succeed as these would be considered recovery actions. However, the planned changes to the MCR abandonment procedure will not include critical actions that occur outside of a PCS. Therefore, it is currently assumed that MCR abandonment will not differ between the compliant and [post-transition] variant models for calculating reported change-in-risk.

The NRC staff requests the following information to determine whether accounting for the range of probabilities for properly shutting down the plant following loss of MCR habitability could change the acceptable change-in-risk estimates to unacceptable estimates.

a) Identify the fire frequency, CCDP, and CLERP assigned to the abandonment scenarios for the compliant and the variant plant.

b) Explain all differences between the compliant and the variant plant PRA models for the abandonment scenarios.

c) A simple claim of "worst case scenario" is insufficient when the meaning of worst case can vary as it does with change-in-risk calculations. For each of the three fire severity bins identified in PRA RAI 01.k.ii (ADAMS Accession No. ML14289A260), summarize how the change-in-risk calculation is performed and justify that the change-in-risk estimates from the loss of habitability abandonment scenarios is well characterized or conservative.

d) Confirm that "will not differ" means that the post-transition plant and the compliant MCR abandonment PRA model are identical (both quantitative values and logic models) and model only the human actions to operate the single train, or explain any differences. Clarify how post-transition plant changes that affect non-modelled details, such as the equipment available and alternative operator actions, will be included in the post-transition change-in-risk evaluations.

e) If the post-transition plant and the compliant MCR abandonment PRA model are the same, all variances from the deterministic requirements (VFDRs) in Fire Area 18 must have been removed during transition. Otherwise the two models would differ because of retained VFDRs in one but not the other. Please confirm that all VFDRs in the fire area will be removed or clarify why the two models (i.e., the post-transition and the compliant) are the same.

Response:

a) The fire frequency, CCDP and CLERP used for the control room abandonment scenarios is listed below.

Model	Abandonment Frequency (per/reactor critical year)	CCDP	CLERP
Variant	1.26E-5	2.80E-1	2.80E-2
Compliant	1.26E-5	1.63E-1	1.63E-2

b) There is only one abandonment scenario and that is for loss of control room habitability. In that one case, only the equipment credited in the control room abandonment procedure is used for the scenario. As has been stated in the response to PRA RAI 01.k, the difference between the CCDP and CLERP values for the compliant and variant cases is the assumption that actions taken at a location other than a Primary Control Station are assumed to always be successful in the compliant case, whereas in the variant case the actions are maintained at their nominal fire Human Error Probability. The actions are listed in the previous response to PRA RAI 01.k.i.

c) For Fire Area A18, the change-in-risk calculations for Attachment W of the LAR include risk contributions for both loss of control and loss of control room habitability. The three fire severity bins identified in PRA RAI 01.k.ii describe a progression of increasing functional failures and spurious operations toward a loss of control. There is no VFDR contribution to the change-in-risk calculation in Attachment W of the LAR for any of these scenarios, because the only VFDRs associated with fires in the control room are actions (identified as Type 2 VFDRs in Attachment C of the LAR) which are taken at a remote shutdown location that does not meet the definition of a primary control station, and control room abandonment is not credited for these fires. In Attachment W of the LAR, the change-in-risk calculations for these non-abandonment scenarios do contribute to the additional risk of recovery actions for actions performed outside the control room based on using the nominal HEPs in the variant model and assuming these actions are always successful in the compliant model.

The risk associated with control room abandonment for loss of habitability is determined separately and in addition to scenarios involving a progression toward a loss of control. This treatment conservatively applies the full ignition frequencies to both loss of habitability and loss of control scenarios, without using a split-fraction to apportion the frequencies between the two possible outcomes. The change-in-risk calculation for control room abandonment is based on using nominal HEPs for Type 2 VFDRs in the variant model and assuming these actions are always successful in the compliant model. This is considered a worst case scenario because the most limiting operator actions are assumed to be required.

d) The control room abandonment treatment for the compliant case and post-transition (variant) case use the same operator actions and logic to determine the probability of successful control room abandonment. The only difference is that actions taken at a location other than a Primary Control Station are assumed to always be successful in the compliant case. No additional consideration of the available equipment and alternative operator actions is taken since the control room abandonment procedure is prescriptive and only provides actions for the protected equipment.

e) As identified in Attachment C of the LAR for Control Room Abandonment Recovery Actions, actions taken at a remote shutdown location that does not meet the definition of a primary control station are considered Type 2 VFDRs. These actions will be retained in the post-transition model at their nominal HEP. As previously stated, this differs from the compliant MCR abandonment model in which these actions are assumed to be always successful.

PRA RAI 05.c.01

In a letter dated March 16, 2015 (ADAMS Accession No. ML15079A025), the licensee responded to PRA RAI 05.c and indicated that for well-sealed and robustly secured cabinets that are not motor control centers (MCCs) but do house circuits greater than 440V, propagation of fire outside the ignition source will be evaluated using the guidance in Frequently Asked Question (FAQ) 14-0009, dated April 29, 2015. However, as stated in the final revision to the FAQ, "[t]he scope of this FAQ is limited to well-sealed, robustly-secured MCCs operating at 440V or greater, and does not apply to other electrical cabinets..." Confirm whether fire propagation outside of well-sealed and robustly secured cabinets that are not MCCs but do house circuits greater than 440V is evaluated consistent with guidance in NUREG/CR-6850. If it is not, to resolve this issue provide updated risk results as part of the aggregate change-in-risk analysis requested in PRA RAI 03, evaluating propagation for these cabinets consistent with NRC-accepted guidance.

Response:

The treatment of fire propagation outside well-sealed and robustly secured cabinets that are not MCCs but that do house circuits greater than 440V is consistent with NUREG/CR-6850, as clarified in FAQ 08-0042. For Bin 15 fires, the RNP FPRA postulates no fire propagation beyond the targets that terminate in the cabinet. This is consistent with FAQ 08-0042 which states that electrical cabinets matching the description of well-sealed and robustly secured should be screened from fire propagation potential. In excluding non-MCCs from consideration for arcing faults, FAQ 14-0009 re-affirmed the guidance in FAQ 08-0042 in stating, "It should be noted that there is no lack of consensus with the guidance provided in NFPA 805 FAQ 08-0042 for no fire propagation from 'well sealed' electrical cabinets that are not MCCs. For Bin 16 (High Energy Arcing Fault) fires, the RNP FPRA does not consider whether these cabinets are "well-sealed" and postulates target damage and fire propagation external to the cabinet, also consistent with the guidance in NUREG/CR-6850.

PRA RAI 06.01

In a letter dated January 22, 2015, the licensee responded to PRA RAI 06 and indicated that the FAQ 13-004 guidance will be applied in the fire probabilistic risk analysis (FPRA) used for the integrated analysis provided in response to PRA RAI 03. PRA RAI 06 also requested explanation on how several specific configurations that fall outside the guidance will be treated. The response failed to provide the information about the specific configurations. Discuss how configurations outside the guidance in FAQ 13-0004 are addressed (i.e., sensitive electronics external to cabinets, within adjacent cabinets, mounted on the surface of cabinets, or in the presence of louver or vents).

Response:

In general, the lower damage thresholds (i.e., 3kW/m^2 and 65°C) specified in Section H.2 of NUREG/CR-6850 were used for configurations outside the guidance in FAQ 13-0004 (e.g., cabinet surface mounting, in the presence of cabinet louvers or vents, or external to a cabinet). On a case-by-case exception, higher damage temperatures were used where supported by a documented technical basis (e.g., vendor qualification reports on accelerated aging). Where Sensitive Electronics were located within an adjacent cabinet separated from the ignition source by a single wall, no damage delay time was used. Where Sensitive Electronics were located within an adjacent cabinet separated from the ignition source by a double wall and an air gap, the time to target cabinet Sensitive Electronics damage was delayed by 10 minutes, unless the Sensitive Electronic was "qualified" above 82°C and assumed to be undamaged.

PRA RAI 12.01

In a letter dated January 22, 2015 (ADAMS Accession No. ML15036A059), the licensee responded to PRA RAI 12 and stated that, following a high energy arching fault (HEAF), exposed combustibles within the initial HEAF zone of influence (ZOI) are ignited consistent with guidance in FAQ 07-0035 but that continued propagation beyond the initial ZOI is not assumed to occur for the ensuing fire. The response states that the basis for this assumption is FAQ 13-0005, which states that a relatively small quantity of molten slag resulting from cutting or welding is insufficient to establish sustained combustion. Cable fires due to welding and cutting are not comparable to HEAF events, which, as indicated by event descriptions in FAQ 07-0035, are capable of producing large amounts of slag. To resolve this issue modify the methodology to be consistent with the accepted guidance by applying continued fire propagation in accordance with FAQ 07-0035 guidance in the PRA model and in the results provided in the response to PRA RAI 03.

Response:

For the results that will be reported in the response to PRA RAI 03, the molten slag is assumed to ignite exposed combustibles at a point and assumed to propagate per the guidance of FAQ 07-0035.

PRA RAI 15.01.01

In a letter dated March 16, 2015 (ADAMS Accession No. ML15079A025), the licensee responded to PRA RAI 15.01 and explained "[c]able protection against overload and short circuit is a consideration in the general design criteria for protective device selection, however is limited in application," and that the Fire PRA does not model secondary fires resulting from lack of adequate circuit protection. The phrase "however is limited in application" seems to imply that there may not be adequate circuit protection in some cases and that secondary fires could occur. If breaker coordination will not be implemented through modifications described in Attachment S of the LAR, provide further information about how lack of coordination is reflected in the Fire PRA.

a. Please clarify what "limited in application" means and whether this means that some secondary fires cannot be precluded. If the secondary cable fires cannot be precluded based on the general design criteria, why can they be precluded. If they cannot be precluded, resolve this issue by including the secondary fires in the transition and post-transition FPRA, and in the results reported in the response to PRA RAI 03.

b. The response to PRA RAI 15.01 explains that, "[i]n some cases breaker coordination was achieved by crediting cable length for the load." The guidance in NUREG/CR-6850, Section 3.5.4.2, Step 4.1 item 3 states: "coordination should not be predicated on limiting fault current based on cable length." Clarify whether the guidance in NUREG/CR-6850 is being met. If the guidance is not met, resolve this issue by adding the affected breakers to the uncoordinated breaker population in the transition and post-transition FPRA, and in the results reported in the response to PRA RAI 03.

Response:

a. As used in the response to PRA RAI 15.01, the phrase "limited in application" meant that during original plant design, safety related circuits were analyzed for both protective device coordination and cable protection as opposed to other primarily non-safety related circuits. For some safety related circuits, the protective device was set or sized to allow a higher current draw and prevent nuisance tripping. The cable protection may be challenged in these cases to favor the device achieving its safety function. Non-safety related circuits protective device schemes were designed with job aids or design standards. For these circuits no documented protective device study exists, particularly for 480V MCCs or power supplies less than 480V. This general design criteria was primarily a consideration for protective device selection for more important cables, particularly those associated with equipment used for safe shutdown or modeled in the FPRA. In addition, subsequent to issuance of 10CFR50 Appendix R, an analysis was made for component/cable separation and common power supplies for safe shutdown components. To confirm the effectiveness of applying these criteria, a review was conducted for SSA and FPRA equipment and other equipment important to plant operations. The impact of secondary fires due to cables associated with SSA and FPRA equipment is included in the response to PRA RAI 03.

Secondary fires have not been postulated for cables, generally carrying lower voltages, associated with equipment (e.g., lighting panels) that are not identified as important for plant safety and operation. The design of such equipment includes consideration for fire-induced failures not impacting equipment important to safety. But, the associated design documentation has not been developed to the same standards, making specific analysis more difficult. Instead, bounding engineering analyses provide confidence that such secondary fires would be unlikely. To estimate the risk from secondary fires in cables not directly modeled in the FPRA, the results of a separate sensitivity analysis will be provided with the response to PRA RAI 03.

b. In cases where the cable length is credited for maintaining breaker coordination, fires that can impact that cable length are assumed to fail the supplying bus. Since fire impacts are mapped to trays and conduits containing the cable, and not to individual cable lengths, there is additional length of cable to provide margin for coordination. The failure of the affected breakers is included in the compliant and variant FPRA, with the results that will be reported in the response to PRA RAI 03.

PRA RAI 16.01

In a letter dated January 22, 2015, the licensee responded to PRA RAI 16, and regarding area wide incipient detection, described the system that will be installed and credited three items in the fire PRA: 1) prompt detection credit, 2) 5-minute credit for detecting a fire during its incipient stage, and 3) use of the MCR suppression curve.

a) Justify applying the 5-minute credit for i) the open relay racks and ii) for the other cabinets, or remove the credit from some or all of the ignition sources in the transition and post-transition FPRA and in the results reported in the response to PRA RAI 03.

b) Use of the MCR non-suppression curve was argued as justified, "because the detection of a fire during the incipient stage by an area-wide incipient detection system is expected to prompt an operator response to act as a continuous fire watch in fire compartment 190 until the incipient alarm is resolved." A continuous fire watch in a compartment does not appear to be equivalent to the staffing and attentiveness in the MCR. The general electric cabinet non-suppression curve may be the most applicable. To resolve this issue, justify and use an alternative non-suppression curve in the transition and post-transition FPRA and in the results reported in the response to PRA RAI 03.

c) Appendix P of NUREG/CR-6850 provides a method for calculating the non-suppression probability, which depends on time for manual suppression. With respect to its use for area wide incipient detection, please address the following:

   i. Discuss how much reduction in the non-suppression probability is associated with crediting area wide incipient detection and the basis for the reduction.
   ii. The time to manual suppression in Appendix P is dependent on the time to target damage, the time for fire brigade response, and the time to detection. Discuss

differences in the assumptions for these terms depending on success or failure of incipient detection.

iii. Discuss the range of non-suppression probabilities for fire scenarios crediting areawide incipient detection (when detection is successful and not successful).

d) Discuss how the areawide and in-cabinet incipient detection compare in terms of reducing the risk for credited sequences (i.e., the reduction factor from crediting incipient detection).

Response:

a) The 5 minute delay was not applied for the area-wide application of incipient detection. For the results reported in the response to PRA RAI 03, the new guidance from Draft NUREG-2180 will be used for area-wide incipient detection. The equivalent branch of the new guidance involving $\pi 3$ would have a zero minute delay for all sources in the area with a suppression curve with a lambda = 0.194 for the Field Operator Response curve. The field operator responding to the alarm is trained equivalently to the fire watch for hot work. (Note NUREG-2180 Example Case 4)

b) For the results that will be reported in the response to PRA RAI 03, the Draft NUREG-2180 guidance for the non-suppression branches that are successful to the point of the Field Operator and Technician Response will be used for a lambda = 0.194. Note that the success of the Field Operator and Technician response to prevent the fire from limiting damage to only the component is not credited.

c)

i. There is not a single value for the reduction in probability as the time to damage depends on the distance to targets outside of the cabinet. The largest reduction in non-suppression probability is due to the use of the Operator Response curve (lambda = 0.194) for the cases where there is an incipient stage, available incipient detector, incipient effectiveness and successful control room response to dispatch the technician and operator that limits the damage to only the source cabinet.

ii. Following the example outlined in Draft NUREG-2180, the non-suppression probabilities in the branches with an incipient stage and an available incipient detection system are determined using a brigade response time of 0 minutes and detection time of 0 minutes. For cases with only the conventional detection system, the fire brigade non-suppression probabilities are decreased by the 10 minute brigade response time and 1 minute detection time. The impact of the brigade response time is limited as there is automatic detection and suppression (Halon) in the area where the area-wide incipient detector is credited.

iii. With the values provided in the Draft NUREG-2180 document, there is nominally worse predicted fire damage conditions with incipient detection than for the case of crediting only automatic detection and suppression in the RNP Cable Spreading Room (Fire Compartment 190). Correcting the decision tree $1 - \pi 3$ branch to credit the availability of automatic suppression and detection that is not dependent on the incipient detection system results in a roughly 50% improvement in the probability of non-suppression over the automatic detection and suppression alone. The application of the Draft NUREG-2180 with the change described results in an approximately 97.5% success rate for Area-wide Incipient and Halon versus approximately 95% for automatic suppression with Halon alone.

d) The largest potential impact between the in-cabinet and area-wide application is the allowed credit for preventing damage within the cabinet for the in-cabinet applications, although this reduction factor is set to 1 (no credit) in the simplified event tree in FAQ 08-0046.

PRA RAI 16.02

The response to PRA RAI 16 states that FAQ 08-0046 is not used to credit incipient detection in main control board scenarios (MCB), but then describes an overview of an evaluation that includes the same factors in the same sequence as those described in FAQ 08-0046. The factors in FAQ 08-0046 only apply to in cabinet detection for non-continuously occupied areas and cannot be used for the MCB. To resolve this issue modify the methodology to be consistent with the accepted guidance by removing the credit for incipient detection for reducing the frequency of MCB fires from the transition and post-transition FPRA and in the results reported in the response to PRA RAI 03.

Response:

The credit for incipient detection in the main control boards will be removed from the compliant and variant models and in the results reported in the response to PRA RAI 03; and, being uncredited, the upgrade of the existing incipient detection system in the main control boards will be removed from the Plant Modifications Committed Table (Item 3, Table S-2 of the LAR).

PRA RAI 30.01

With regard to the planned new reactor coolant pump seals, the NRC is accepting models of shutdown seal (SDS) failure based on the best available information at the time of transition, when accompanied by assurance that accepted models will be used when available. Please include a Table S-3 implementation item (e.g., implementation item 11) that ensures Robinson will use NRC-accepted SDS failure models as they become available and to confirm, as a minimum, that the transition change-in-risk estimates will not exceed the Regulatory Guide 1.205, Revision 1, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," acceptance guidelines. The implementation item should also clarify that self-approved changes that rely on the SDS failure model will not be undertaken before acceptable models have been developed. In addition, please clarify how transition to NFPA 805 could be achieved with if an acceptable RCP seal model is delayed for an extended time.

Response:

The following implementation item will be added to Table S-3, to be submitted later:

> Prior to the use of the FPRA to support self-approval of Fire Protection Program changes that rely on the RCP shutdown seal (SDS) failure model, update the FPRA to incorporate the NRC-accepted SDS failure models and confirm that the transition change-in-risk estimates do not to exceed the RG 1.205 acceptance guidelines.

If an acceptable RCP seal model is delayed for an extended time, acceptable transition to NFPA 805 is provided by retention of the compensatory measures which were established prior to the RCP seal replacement until the transition change-in-risk estimates have been confirmed not to exceed RG 1.205 acceptance guidelines.