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eDF

February 28, 2014

U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTENTION: Document Control Desk

SUBJECT: **R.E. Ginna Nuclear Power Plant**
Renewed Facility Operating License No. DPR-18
Docket No. 50-244

Response to Request for Additional Information RE: License Amendment to transition to NFPA 805

REFERENCES: (a) Letter from Mr. Joseph E. Pacher (Ginna LLC) to Document Control Desk (NRC) dated March 28, 2013, Subject: License Amendment Request Pursuant to 10 CFR 50.90: Adoption of NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants (ML13093A064)

By Reference (a), R.E. Ginna Nuclear Plant, LLC (REG) submitted a request for the adoption of NFPA 805, Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants. On October 9, 2013, the NRC requested additional information regarding this submittal. Attached please find the third in the set of three responses to the staff's questions. There are no regulatory commitments identified in this letter.

Should you have any questions regarding this submittal, please contact Thomas Harding at 585-771-5219.

I declare under penalty of perjury that the foregoing is true and correct. Executed on February 28, 2014.

Sincerely,

JP/KC
Attachment: (1) 120-Day Responses to Request for Additional Information for NFPA 805 (54 pages)

A006
NRR

cc: NRC Regional Administrator, Region I
NRC Project Manager, Ginna
NRC Resident Inspector, Ginna
A.L. Peterson, NYSERDA

Attachment (1)

120-Day Responses to Request for Additional Information for NFPA 805

120-Day Responses to Request for Additional Information for NFPA 805

FM RAI 01

Section 4.5.1.2, "Fire PRA" of the Transition Report states that fire modeling was performed as part of the FPRA development (NFPA 805 Section 4.2.4.2). Reference is made to Attachment J, "Fire Modeling V&V," for a discussion of the acceptability of the fire models that were used.

Regarding the acceptability of the PRA approach, methods, and data:

1. During the audit, the technical approach for detailed fire modeling of fire compartments in support of the FPRA for the R.E. Ginna Nuclear Power Plant NFPA 805 Transition Project was discussed. The NRC staff identified the following questions related to this general discussion:

    a. It was discussed that mechanical ventilation was not considered in any of the Consolidated Model of Fire and Smoke Transport (CFAST) fire modeling. Provide justification that the assumptions made concerning ventilation are conservative.

    Response:
    NUREG 1824 demonstrates the verification and validation of mechanical ventilation in CFAST simulations. The fire is considered over or under ventilated based on the ratio of the energy release rate of the fire to the energy release rate that can be supported by the mass flow rate of oxygen into the compartment. Mechanical ventilation would affect the fire conditions in the room by introducing fresh air (oxygen) into the room. None of the CFAST simulations indicated oxygen depletion; therefore the available oxygen in the volume of the compartment is enough to sustain combustion throughout the simulation time. Where the natural ventilation of the room does not fall within the validation range, a sensitivity case is run to allow enough oxygen into the compartment to meet the natural ventilation equivalence ratio. This will be documented in G1-FSS-F006, (Verification and Validation of Fire Models Supporting the FIRE PRA Notebook Fire Scenario Selection and Analysis Detailed Fire Modeling at R.E. Ginna).

    As an example, section 7.5 of G1-FSS-F006 will document a sensitivity analysis to analyze ventilation effects on a small fire compartment (Battery Room A BR1A). Modeling BR1A as a closed room (which is the configuration in the Fire PRA), the enclosure reaches a hot gas layer temperature of 205 C at 9.8 minutes. Running a simulation that leaves an opening to the room simulates introducing fresh air into the compartment. This run results in a time to hot gas layer of 10.1 minutes. Extrapolating these results to larger rooms, the sensitivity analysis suggests that modeling the compartments without ventilation will not significantly modify the time to hot gas layer results. .

    b. CFAST has been used for calculating hot gas layer characteristics in several compartments, as detailed in audit discussions. Describe whether the presence of enclosed obstructions was considered in the effective volume estimation. If not, explain why the presence of obstructions that reduce the net effective volume will not affect the results of the CFAST analyses.

    Response:

Enclosed obstructions were not considered in determining the effective volumes for the fire zones in the Ginna Fire PRA. This approach is consistent with the examples described in Appendices A and B of NUREG-1934, where the CFAST analysis is performed without subtracting the volume of the equipment. Furthermore, the zone modeling analysis in CFAST has the inherent conservatism of not considering the heat losses to equipment in the room (i.e., the analysis only considers heat losses to the boundaries). Since this approach to modeling could be considered a source of uncertainty, in keeping with the requirements of ASME/ANS RA-Sa-2009 a sensitivity analysis was conducted to determine the effect of enclosed obstructions and will be documented in the detailed fire modeling notebook, G1-FSS-F001. In order to bound the effect, a fire compartment with a small volume is chosen for the sensitivity. Volume reductions will have a larger effect on small fire compartments given the hot gases will develop in less time in smaller volumes. Battery Room A (BR1A) is chosen for the sensitivity given the small area and relatively quick time to hot gas layer development. BR1A results in a hot gas layer time of 9.8 from an electrical cabinet fire minutes as documented in Appendix M of G1-FSS-F001, Rev 1. Reducing the volume of the room by 10%, CFAST results show a time to hot gas layer of 9.5 minutes. Given that a small area results in a minimal difference in times to hot gas layer development, enclosed obstructions are not considered to have a major impact on the Ginna fire PRA. For large areas, a sensitivity analysis was also conducted to verify the volume reduction will not have an effect on the results. Fire compartment IBN-1 was selected as a representative fire compartment for the sensitivity because of its large size. Reducing the compartment volume by 20%, results in a maximum hot gas layer of 100°C, well below the thermoplastic damage criteria of 205°C.

c. Where Detection Actuation (DETACT) was used to determine sprinkler activation, provide justification for the response time index (RTI) value chosen for these analyses and describe how that value compares with the RTI of the actual sprinklers in the fire zone.

Response:
Automatic suppression was credited in a number of fire compartments, as noted in Table 1 of G1-FSS-F001, Rev1. Automatic suppression is credited after a number of targets are failed. This strategy was selected to ensure that suppression is not credited immediately after ignition, given the uncertainty associated with the calculations of time to detection. Instead, cable targets in the scenario are used as surrogates for activation of automatic suppression. It is assumed that if a fire can generate conditions to damage a cable, those conditions should be able to trigger the automatic suppression system. Therefore, a set of targets near the suppression system are failed before the automatic suppression is credited. In the compartments where sprinklers are credited, the suppression systems are "in tray" configurations, with the sprinkler heads located between the cable trays. For fire scenarios in these compartments, the ignition source, closest cable tray and conduits are failed before suppression is credited. The modeling approach assumes a fire in the first tray will

activate the sprinkler head between the first and second tray.

d. With respect to the treatment of transient fires and transient fires due to hotwork, it was stated that, "in cases where cable trays or other FPRA targets are near the floor, a representative relatively low fire intensity of 15 kW is assumed as the critical fire size to damage targets in close proximity to the postulated fire." Provide additional justification for this fire size and clarification for why this is applicable for fires close to the floor.

Response:
The statement "in cases where cable trays or other FPRA targets are near the floor, a representative relatively low fire intensity of 15 kW is assumed as the critical fire size to damage targets in close proximity to the postulated fire", which is quoted from the Fire PRA Notebook G1-FSS-F001, Revision 1 is in error and will be corrected. The Ginna Fire PRA does not use a fire size of 15kW for a transient fire. The fire modeling calculations in the Fire PRA are not based on the assumption of a 15 kW fire for targets near the floor. Revision 2 of G1-FSS-F001 will provide clarifications regarding the treatment of transient fires and transient fires due to hot work, by updating Item 2 at the bottom of Appendix D, Section D.5 in Revision 2 with the following:

> "In cases where cable trays or other FPRA targets are nearby, the critical fire size is determined using algebraic hand calculations, based on the distance to the targets and the fire condition. If a target is located above the fire, the Heskestad flame height correlation or the Heskestad centerline plume temperature is used to calculate the critical heat release rate (HRR) at target damage. If a target is located horizontally adjacent to the fire, then the point source model for flame radiation is used to calculate the critical HRR at target damage. The severity factor associated with the calculated critical HRR is determined, using the heat release rate probability distribution for transient fires listed in Appendix G of NUREG/CR-6850."

e. The applicability of CFAST was discussed and it was stated that, "for some fire zones at R.E. Ginna, the sheer size of the fire zone and openings to other zones preclude the formation of a hot gas layer for numerous relatively small ignition sources where the fire would remain localized. As such, the analysts identified those zones which could be qualitatively screened from the CFAST analysis." Provide additional information about the criteria used to qualitatively screen a fire zone and provide a list of those fire zones which were screened from the hot gas layer CFAST analysis.

Response:
Only outside compartments were screened from the CFAST analysis. A list of compartments qualitatively screened from CFAST analysis is below.

Compartment	Compartment Description	Screening Criteria
PA-NE	OUTSIDE CONDENSATE STORAGE TANK AREA	This area is an outside area. This area is screened from CFAST analysis given lack of definite volume and confined area for hot gases to accumulate. The limited ignition sources in the area screen from damage to any adjacent areas and therefore this compartment is screened from multi-compartment consideration.
TY-E	TRANSFORMER YARD	The transformer yard is south of the control building and is an outside area. This area is screened from consideration in the CFAST analysis given lack of definite volume and confined area for hot gases to accumulate. This area is assumed to damage adjacent control building compartments in the multi-compartment analysis.
TY-W	TRANSFORMER YARD	The transformer yard is south of the control building and is an outside area. This area is screened from consideration in the CFAST analysis given lack of definite volume and confined area for hot gases to accumulate. This area is assumed to damage adjacent control building compartments in the multi-compartment analysis.

f. Several assumptions related to fire modeling hand calculations were discussed and lead to the following questions.

i. A fire dimension of 2 ft. has been assumed for all postulated fires. Explain why this generic assumption is valid for all ignition sources across the plant.

Response:
The selection of a default diameter in the fire modeling calculations has little effect in the Fire PRA. In a number of scenarios, the zone of influence corresponds to the transient zones, which are larger than calculated zones of influence, and the fire diameter is not a factor when the full failure of the transient zone is assumed. The fire diameter will affect the time to target damage as calculated using the Heskestad's Plume Correlation in selected scenarios. The plume correlation is used to determine the time to damage of the nearest target to the ignition source. The 2 ft diameter is representative of a number of ignition sources at RE Ginna and it often provides a conservative estimate of the diameter as ignition sources such as vertical sections in buses and pumps have diameters larger than 2 ft. Since this approach to modeling could be considered a source of uncertainty, in keeping with the requirements of ASME/ANS RA-Sa-2009 a sensitivity analysis was conducted to assess the effect of this fire diameter in the RE Ginna Fire PRA. It should be noted that a smaller fire diameter will result in lower critical heat

release rate for a certain target distance as the fire is concentrated in a smaller area (i.e., plume temperatures tend to be higher resulting in shorter times to target damage). The sensitivity analysis was completed assuming a shorter time to damage than calculated using the critical heat release rate. For all scenarios with a time to damage greater than 1 minute were assigned a time to damage of 1 minute for the closest target damaged. Table H-6 from NUREG/CR-6850 lists the failure time-temperature relationship for thermoplastic cables. For exposure temperatures above 370 °C, the time to failure is 1 minute. The results, listed in the table below, indicate an overall increase in CDF and LERF of less than 1.2%. It should be noted that the sensitivity analysis is very conservative as it assumes that all the time for first target damage in all the fire scenarios is 1 minute, and so will bound the effect of the fire diameter. Based on the results of the sensitivity analysis, the use of a fire diameter of 2ft is clearly not a significant source of uncertainty. This sensitivity will be documented in the detailed fire modeling notebook G1-FSS-F001, Rev 2.

	CDF	LERF
Baseline Model	2.96E-05	4.80E-07
Sensitivity Case	2.98E-05	4.86E-07
% Increase	0.6%	1.2%

ii. Section R.4.2.1 of NUREG/CR-6850 prescribes taking the characteristic length of the fire as equal to the cabinet's length (or vertical section as appropriate) for the purpose of calculation fire propagation through cable trays. Justify the use of a characteristic length of 2 ft. as this may not satisfy the NUREG/CR-6850 criterion.

Response:
There is only one compartment, the Relay Room (RR-C1) that results in a hot gas layer as a result of a cabinet fire propagating to overhead cable trays. The characteristic length of the fire is considered as the length of the cabinet and is used as an input to the flame spread calculations. The cabinet scenarios resulting in a hot gas layer in the Relay Room are 2' in length. Therefore using 2ft as the cabinet length is appropriate for this application.

g. Sprinkler activation in the Air Handling Room and ABM-C1 was discussed. It was stated that since sprinklers are located within the cable trays, it is reasonable and conservative to assume that, with the exception of the first cable tray above the ignition source, the remaining trays are protected by the activation of the sprinklers.

The activation of an automatic Halon system in the Relay Room (RR-C1) was discussed. It was stated that the same rationale is used to assume that only the first tray above the ignition source is damaged and the remainder of the trays are protected, due to activation of the Halon system.

Provide justification for this assumption that the same rationale for the sprinkler system can be applied to the Halon system.

Response:
The general approach for crediting automatic detection and suppression in the Fire PRA is:

- Automatic detection is credited in every fire zone where the system is available. This approach is consistent with crediting manual suppression using the manual suppression failure probability curves in Chapter 14 of Supplement 1 to NUREG/CR-6850, as the system will provide indication to start the fire response.
- Automatic suppression is credited only when necessary based on the risk contribution (i.e., CDF and LERF contribution) for the individual scenario.

The activation models have been applied conservatively. Automatic detection and suppression capabilities are not credited to protect the initial target set in fire scenarios. These systems are credited only after the initial target set is damaged by fire. From a fire modeling perspective, this approach assumes that the ignition source and the first target set (i.e., cable trays) are on fire before the system starts. For the automatic sprinkler systems this is a conservative approach as the sprinklers are located within the cable trays. Therefore, assuming that some cable trays are on fire before the sprinklers start is bounding as the damage and ignition of cables occurs at higher damage thresholds compared to the activation temperature of the sprinklers.

A similar approach is applied to the Halon system credit in the Relay Room (Fire Zone RR-C1). The ignition source (relay panels in most cases) and the cable tray(s) immediately above the ignition source are failed without suppression credit. Credit is then assigned to subsequent scenarios (which include additional targets) to which the fire propagates from the initial target set. Given that the system is activated by a smoke detection signal, this is a conservative practice because a relatively large fire (ignition source and cable trays) is postulated before the Halon system is credited in applicable scenarios.

In summary, the scenario configuration has been considered to ensure that relatively severe fire conditions in close proximity to the activation device and initial target set damage are postulated before the automatic suppression is credited. That is, the specific timing results from the activation models are not explicitly used. They are only used as indications that the system can activate before the ignition source and the initial target set are assumed damaged, so that they can be credited for subsequent fire scenarios.

h. Damage to cable trays in fire zone TB-1 was discussed. It was stated that the model input parameters and result for the point source model calculation utilizes a radiative fraction of 0.3. However, it was previously stated that for all the calculations the radiation fraction is assumed to be between 30-40%, where the 40% radiative fraction will be assumed for point source radiation model. Confirm which value for the radiative fraction was used in the analyses. Also, explain what value was used throughout the analysis of the other fire zones and the basis for the value used.

Response:
Section G.2 in Appendix H of G1-FSS-F001, Revision 2, will be revised to state the following:

> "The radiation fraction is assumed to be 30% of the heat release rate. The value is used as follows: (1) for the point source flame radiation model, a value of 30%, and (2) for plume temperature calculations, where the convective fraction (i.e., 1− radiation fraction) dominates the temperature calculations, a value of 30% is selected."

Further discussion of the radiative fraction that is used in the algebraic equations will be provided in G1-FSS-F006.

i. The detailed fire modeling that was conducted in fire compartment BR1A was discussed. The following fires were postulated for this analysis: a cabinet fire, located in the center of the room, with no secondary combustibles, a battery charger fire, also located in the center of the room, with two overhead cable trays modeled as secondary combustibles and a transient fire, also located in the center of the room, also with two overhead cables trays. Explain why two of the fires postulated in the center of the room have secondary combustibles overhead and the cabinet fire (with the largest heat release rate) does not. This type of discrepancy is also noted in fire compartment BR1B and RR-C1. Provide a similar explanation for any fire area with this discrepancy.

Response:
All fires considered in the CFAST analysis are placed in the center of the room in the CFAST simulation. The fire configuration (ignition source and any secondary combustibles) is determined by plant drawings and field walkdowns. If the location of the ignition source is determined to be in wall or corner, the heat release rate distribution is adjusted to account for wall and corner effects as described in Fire Modeling RAI 01 part 2. All cases are run in CFAST to determine the limiting case in the fire compartment that will result in a hot gas layer. This information is then transferred to the PRA to include only the fire scenarios large enough to result in a hot gas layer are considered in the full compartment burn frequency. Therefore the model represents the actual configuration of the fire scenario with the location factor accounted for in the heat release rate distribution.

j. Describe how the fire modeling analysis accounts for the potential increase in heat release rate caused by the spread of a fire from the ignition source to secondary combustibles.

Response:
The detailed fire scenario analysis in the Ginna Fire PRA provides extensive treatment of secondary/intervening combustibles.

The increase in heat release rate (HRR) due to fire propagation from the ignition source to other combustibles is accounted for as follows (reference Appendices I through AS in the Detailed Fire Modeling Fire PRA notebook, G1-FSS-F001):

1. The scenario progression starts with a fire postulated in the ignition source.

2. Fire propagates to the cable trays in the zone of influence. The heat release rate contribution from these cable trays is included in the fire modeling analysis. A flame spread calculation is used for determining the heat release rate of cable trays involved in the fire scenario. Walkdowns were conducted for determining a bounding combination of ignition source and number of cable trays to be used as inputs to the fire models.

3. The fire in the ignition source and the cable trays is used as input for determining the hot gas layer temperature and the time at which the fire zone will reach the damage threshold of the targets in the fire zone. The zone model CFAST was used for calculating hot gas layer temperatures and the time to reach the damage criteria for cables considering the fire zone characteristics and the bounding combination of ignition source and cable trays.

   Probabilistic Risk Assessment RAI 30 provides additional information on propagation of damage over multiple transient areas.

2. Of particular concern are fires in the proximity of a wall or a corner. The entrainment of air into the flame of these types of fires is restricted compared to fires of the same size in the open. The reduced air entrainment results in higher plume and upper gas layer temperatures.

   a. What are the criteria (i.e., distance from a wall or corner) that were used during the walk-downs to determine whether wall or corner effects have to be accounted for in the fire modeling analyses and provide a basis for the acceptability of the criteria?

   Response:

Fixed ignition sources that were located in contact with walls or corners were applied the wall and corner effects in the fire modeling calculations. No specific guidance is provided in NUREG/CR-6850 or subsequent FAQ's on a specific distance from wall or corners to be used. Therefore, it is assumed that separation from wall and corners would allow some air entrainment into the flames and lower portions of the fire plume (i.e., lower portions of the fire plume near the flames) for the fire to exhibit characteristics associated with fires away from wall or corners. A review of the fire protection engineering literature provides no further clarification on the criteria to use to determine wall or corner configurations. A review of documented flame height and fire plume studies suggests that fires flush with surfaces will generate longer flame heights, particularly if the flames can attach to the surface (see Mowrer, F.W. and Williamson, R.B., "Estimating Room Temperatures from Fires along Walls and in Corners," Fire Technology, Vol. 23, No.2, 1987; McCaffrey, SFPE Handbook of Fire Protection Engineering 2nd Edition, SFPE, Bethesda, MD, 1995; and Drysdale, D., An Introduction to Fire Dynamics, Wiley-Interscience, New York, 1992). However, the studies do not suggest a specific distance from the surfaces at which these effects are no longer present. On the contrary, some studies suggest that fires separated short distance from surfaces would present characteristics similar to fires in the open (see Mowrer, F.W. and Williamson, R.B., "Estimating Room Temperatures from Fires along Walls and in Corners," Fire Technology, Vol. 23, No.2, 1987).

b. Explain how wall and corner effects are accounted for in the flame height, plume temperature and ceiling jet temperature calculations.

Response:
The wall and corner effects are accounted for as follows:

- For the flame height correlation: The flame height correlation is not used for determining relevant risk quantification inputs in the RE Ginna Fire PRA. That is, for ignition source-target configurations where the targets are immediately above the ignition source, the plume temperature correlation is used for determining severity factors and time to target damage as described in the next bullet. This is the case because the use of the plume temperature results in lower critical heat release rates, which produces higher severity factors (i.e., a lower heat release rate is necessary to generate a damaging plume temperature at a specific height than to produce a flame height reaching that height). Consequently, the time to target damage, which is equivalent to the time the heat release rate grows to the critical value is shorter when the plume temperature correlation is utilized instead of the flame height correlation.
- For the plume temperature correlation: For ignition sources that were flagged as wall or corner configuration, the Heskestad's plume correlation was solved using the location factors of 2 and 4 for wall and corner configurations respectively as multipliers to the heat release rate. The Heskestad's plume temperature correlation is used for determining the critical heat release rate as an input to the severity factor calculations and to determine time to target damage for raceways or conduits immediately above the ignition source.
- For the ceiling jet correlation: The ceiling jet correlation was not used in the RE Ginna Fire PRA.

c. Explain how wall and corner effects are accounted for in the CFAST hot gas layer calculations.

Response:
Wall and corner effects were not accounted for in CFAST as it is only used for calculating hot gas layer temperatures. The heat release rate used for determining hot gas layer temperatures is bounding as it is based on the worst combination of cable trays and cabinets in the fire zone. The intent is to use bounding heat release rate values to obtain hot gas layer conditions that would bound the different fire scenarios that would develop in the fire zone.

Since this approach to modeling could be considered a source of uncertainty, in keeping with the requirements of ASME/ANS RA-Sa-2009, a sensitivity analysis accounting for wall and corner effects was completed for fire compartments that did not result in a hot gas layer in the original analysis. The "image" method was applied to fire scenarios considered in the CFAST analysis. The 'image' method postulates that fires in wall and corner configurations may be modeled using an equivalent open fire that is two (wall configuration) or four (corner configuration) times larger in both heat release rate and plan area (NIST-GCR-90-580). The results indicate a hot gas layer will not form accounting for the wall and corner effects. This sensitivity will be documented in G1-FSS-F001, Rev 2.

3. During the audit, the technical approach for determining the time to abandon the Main Control Room (MCR) for several fire scenarios was discussed. The NRC staff identified the following questions related to this discussion:

   a. It was stated that, "Although the scenarios presented in this calculation were chosen as a representative set, the results of this calculation cannot be assumed to be bounding results. Additional calculations may be required to assess the impact of fire scenarios not specifically identified in this calculation." During the audit walkdown of the MCR, an office directly across from the rear of the main control board (MCB) was observed with a typical workstation and potential transient combustibles (trash can). Explain how a fire in this part of the MCR would affect the calculated abandonment times and provide reasonable assurance that the scenarios considered in the analysis are bounding.

   Response:
   The Shift Supervisors Office is located in the northwest corner of the control room envelope directly across from the rear of the main control board. The space contains combustible fuel loads typical of office occupancies, including a workstation, a desk, a chair, a bookshelf, a trash container, as well as binders, books, and paper. The door from this space to the general control room area was assumed to be closed for the fire scenarios considered in the control room abandonment calculation (1FJJ28008.000-02, Rev. 002) to provide a conservative bound on the available space for smoke products to accumulate for fire scenarios postulated in the general control room area.

   The type of fire that would result in the Shift Supervisors Office, if ignition were to occur, would be one that involves Class A combustible material. A Class A combustible material fire is typically characterized in the FPRA using the NUREG/CR-6850, Appendix E, Case 8 (transient) heat release rate conditional probability distribution. However, based on the type and arrangement of combustible fuels in the Shift Supervisors Office, a fire that is more challenging in terms of the peak heat release rate is possible given that the NUREG/CR-6850, Appendix E, Case 8 ignition source was based primarily on trash container fire tests and fire tests that involved loose and bagged Class A combustible material. Full scale test data on workstation fuel packages having a similar type and arrangement of combustible to that found in the Shift Supervisors Office is provided in Section 3.1 of the SFPE Handbook (Babrauskas, V., "Heat Release Rates," Section 3–1, SFPE Handbook of Fire Protection Engineering, 4th Edition, SFPE, Bethesda, MD, 2008). The heat release rate profile reported for these fuel packages reaches 300 kW in 120 second, 500 kW in 250 seconds, and 1,800 kW in 400 seconds (See Figure 3-1.59 and Table 3-1.18 for Codes B, C, and D which have three side acoustic panels). These are approximate values by inspection of the plot in Figure 3-1.59. This is a more severe heat release rate growth profile than what is postulated for the transient and for the electrical panel fire ignition sources considered in the control room abandonment calculation, and therefore could lead to shorter abandonment times. A lower bound estimate for the abandonment time for a workstation fire may be determined using the data provided in the control room abandonment calculation for the transient and electrical panel ignition sources. Table 6-2 of the control room abandonment calculation shows that the 98th percentile NUREG/CR-6850 transient ignition source fire scenarios do not result in control room abandonment in less than twenty-minutes. Because the transient fuel packages contain an eleven minute period of steady burning, it may be inferred that abandonment would not be predicted for a workstation fire regardless of its location before it reaches 317 kW, provided it reaches 317 kW in less than eleven minutes.

In order to provide assurance that the scenarios considered in the analysis are bounding, a comparison of the CDF for a workstation fire scenario in the Shift Supervisors Office is provided. From inspections of Tables 6-5 through 6-10 in the Main Control Room Abandonment Study 1FJJ28008.000-02, Rev. 002, the heat release rate necessary for control room abandonment is between approximately 300 kW (for the case of no HVAC functioning) to approximately 400 kW (for the case of normal HVAC or smoke purge mode functioning). Comparing these values with the profile for workstations fires from Section 3.1 of the 4th Edition of the SFPE Handbook of Fire Protection Engineering, a heat release rate in the range of 300 to 400 kW could occur in the order of approximately 2 to 4 minutes. Given that a value of approximately 400 kW is necessary for most of the ventilation schemes, a value of 3 minutes is selected for abandonment. Using a time of 3 minutes, and a value of 0.33 for λ, an abandonment probability can be calculated using the probability of non suppression calculation, $\Pr(ab) = e^{-\lambda t}$, recommended in Appendix P of NRUEG/CR-6850. The abandonment probability is calculated to be 0.37. In addition to the probability of abandonment, the scenario frequency for the transient fire is calculated. The scenario frequency is determined by the ignition source frequency of transient fires apportioned for the Ginna main control room, 3.76E-04 as documented in Appendix C of the ignition frequency notebook, G1-IGN-F001, Rev 1. The frequency will be apportioned for the available floor area of the Shift Supervisors Office as discussed below. The area ratio occupied by the workstation in the Shift Supervisors Office is determined from the area available for transient ignition sources and the area occupied by the workstation fuel package. The area available for transient ignition sources includes the floor area of the control room minus the area occupied by closed spaces and fixed objects, such as the control boards and electrical panels. Based on Drawing D-105-011, the total floor area of the control room envelope is 1,983 ft². Table 1 summarizes the portions of the control room envelope floor area that are occupied by closed spaces or fixed combustibles as determined from D-105-011. The total floor area available for a transient ignition source is the total floor area minus the sum or the areas shown in Table 1 and is equal to 1,302.7 ft².

Closed Space or Fixed Object	Area (ft²)	Notes
Kitchen, Restroom, Stairs, Air-Conditioning Duct	228	Closed spaces in southwest corner of the control room envelope
Control Board	282	Closed electrical panel

Digital Impact Monitoring System	6.3	Closed electrical panel
Reactor Trip System (west panels)	19.3	Closed electrical panels
Reactor Trip System (east panels)	19.3	Closed electrical panels
RSC Panels	9.9	Closed electrical panels
PLP Panels	9.9	Closed electrical panels
Auxiliary Benchboard	13.9	Closed electrical panel
Radiation Monitors	18.2	Closed electrical panels
Incore Racks	18.2	Closed electrical panels
Instumentation Racks	18.2	Closed electrical panels
Plans Cabinet	8.5	Closed electrical panel
CNWT Relay	5.3	Closed electrical panel
Bookshelf (Shift Supervisors Office)	23.3	Fixed object
Total Area	680.3	

The total area occupied by the workstation fuel package is 30.8 ft^2 per drawing D-105-011. This area includes the desk, the area behind the desk to the north wall, and a 1 ft perimeter around the desk and chair area. The resulting area ratio of the workstation fuel package is 30.8/1302.7, or 0.024.

Applying a floor area ratio of 0.024 to the ignition source frequency (3.76E-04), a value of 9.02E-06 is calculated for the fire ignition frequency of a transient workstation fire. To calculate the total contribution of the workstation fire, the total scenario frequency, including the probability of abandonment, is multiplied by the CCDP. The highest CCDP quantified for the main control room is 1.3E-02. This is chosen to represent the worst case target set damaged in the main control room. The CDF for the workstation fire is 4.3E-08 (i.e., 4.3E-08 = 9.02E-06 x 0.37 x 1.3E-02).

The total CDF contribution of the Main Control Room is 4.6E-06 and the overall CDF of the plant is 2.96E-05. The workstation fire would represent approximately 0.1% of the total plant CDF and less than 1% of the risk in the main control room. Therefore, the workstation fire, would result in a very low risk contribution when compared with all the other fixed and transient scenarios quantified in the Main Control Room.

b. It was stated that, "The electrical panels, including the main control boards, may contain [IEEE-383] qualified (thermoset) cables, non-IEEE-383 qualified cables (thermoplastic), or both."

The above statement implies that IEEE-383 qualified cables are assumed to be equivalent in terms of damage thresholds to "thermoset" cables as defined in Table 8-2 of NUREG/CR 6850. In addition, non-IEEE-383 qualified cables are assumed to be equivalent to "thermoplastic" cables as defined in Table 8-2 of NUREG/CR 6850.

These assumptions may or may not be correct. An IEEE-383 qualified cable may or may not meet the criteria for a "thermoset cable" as defined in NUREG/CR-6850. It is also possible that a non-IEEE-383 qualified cable actually meets the NUREG/CR-6850 criteria for a "thermoset" cable.

Describe the flame spread characteristics used in the fire modeling analysis for the cables in the main control boards and provide a basis for the assumptions above.

Response:
The control room abandonment calculation (Report 1FJJ28008.000-02, Rev. 002) does not consider cable damage or postulate fire spread in cable trays or cables other than that addressed by the heat release rate profiles provided in Appendix E of NUREG/CR-6850 for electrical panels. The IEEE qualification status is used to select the heat release rate profiles for the electrical panels, which is consistent with the classification of the electrical panel fires described in Appendix E of NUREG/CR-6850.

c. It was stated that transient fires are assumed to reach the peak heat release rate (HRR) in two minutes. However, the transient fire ramp function reaches the peak HRR in 552 s. Explain this discrepancy.

Response:
The incorrect heat release rate ramp was used in the control room abandonment calculation (Report 1FJJ28008.000-02, Rev. 002) for the transient ignition source fires. It should have been 120 seconds to reach the peak heat release rate instead of 552 seconds. This is not considered to be a significant issue in this case for several reasons. First, the transient fire scenarios are only evaluated as preliminary fire scenarios in order to determine a conservative single ignition source fire scenario for analysis as a baseline case. The initial preliminary scenario analysis postulates five types of ignition sources, including two transient fuel packages and three electrical panels located in various areas of the control room. The 98th percentile heat release rate is assumed for all preliminary fire scenarios. It is shown in Table 6-2 of Report 1FJJ28008.000-02, Rev. 002 that none of the postulated transient ignition sources lead to control room abandonment over a twenty minute interval, and that the most adverse electrical panel fire scenario leads to abandonment in 754 – 805 seconds depending on the ventilation configuration. The original conclusion was based on transient fuel package fire scenarios that had an incorrect ramp to the peak heat release rate (552 seconds vs. 120 seconds). However, it can be asserted, using the original results, that if the ramp to the peak heat release rate was 120 seconds, control room abandonment would not be predicted in less than 768 seconds for the most severe case. This is based on the observation that the original scenarios had a 648 second steady burning stage plus a growth stage, which if reduced to 120 seconds is equal to 768 seconds. Because this is longer than the most adverse electrical panel fire scenarios listed in Table 6-2, the original conclusion would remain unchanged if the transient had a shorter ramp time. A further observation that supports this finding is that control room abandonment is not predicted for any baseline fire scenario if the heat release rate is less than about 527 kW as

determined from Tables 6-5 and 6-8 in Report 1FJJ28008.000-02, Rev. 002. The 98th percentile heat release rate for the transient is 317 kW, which suggests that even with a 120 second ramp to the peak heat release rate, the control room abandonment times would be greater than the bounding electrical panel fire scenario.

d. It was stated that "The panels at R.E. Ginna are closed ..." However, it was noted during the walkdown that the interior of the MCB is a large open space. Provide technical justification for the assumption that the MCB panels are closed, and for not using the HRR distribution for Case 5 in Table E-1 of NUREG/CR-6850, Vol. 2.

Response:
The Main Control Board (MCB) panels are treated as closed electrical panels containing multiple cable bundles (NUREG/CR-6850, Appendix E, Case 4) in the control room abandonment calculation (1FJJ28008.000-02, Rev. 002). The selection of this ignition source to represent the MCB panels rather than an open panel configuration (NUREG/CR-6850, Appendix E, Case 5) was a conservative alternative to modeling the fire conditions within the MCB interior and the corresponding vent flows. Although the fuel configuration inside the MCB could be characterized as an open panel configuration, the configuration would be applicable to the MCB sub-volume and not the control room proper. The effect of an open panel fire within the MCB on the control room environment would depend on the conditions within the panel (temperature and equivalence ratio) and the vent flows from the MCB panel to the control room. Because of the relatively small volume within the MCB panels, an open panel heat release rate would quickly reach ventilation limited conditions and the internal equivalence ratio would approach and exceed unity. Based on the available validation studies for FDS and the guidance provided in NUREG-1934, this type of scenario would be challenging for the FDS combustion model and may exceed its capabilities in the FDS version used (Version 5.5.3). As an alternative to modeling the internal MCB conditions, a closed panel, multiple cable bundle ignition source (NUREG/CR-6850, Appendix E, Case 4) was modeled in the open configuration (i.e., outside the panel). This is considered conservative because no credit is taken for the energy released within the MCB that remains in the MCB, or for the limited mass flow rate from the MCB panels to the general control room area through vents. Essentially, is it asserted that the effects of a MCB fire in the control room are more severe when the fire is treated as a closed panel source fire burning in the control room rather than an open panel source fire burning inside a sub-enclosure within the main control room. There is physical merit for this approach when the fire is viewed from the main control room because the MCB panels are closed and have limited ventilation flow paths to the general control room area.

The Kawagoe vent flow equation may be used in combination with the actual vent dimensions in the MCB panels to provide a quantitative insight into the assertion that the closed panel treatment is more severe than the open panel burning within a sub-enclosure. The Kawagoe equation may be used to provide an estimate of the largest fire size that may be supported by available natural vents and is given as follows (Section 3–6, *SFPE Handbook of Fire Protection Engineering*):

$$\dot{Q} = 1500A\sqrt{H} \qquad (1)$$

where $\dot{Q}$ is the maximum fire size in an enclosure that may be supported by a natural vent, A is the vent area, and H is the vent height. The fire size predicted by Equation (1) will have a nominal equivalence ratio of unity. The MCB panels in the Ginna main control room collectively have three square vents on their top surface; two vents are 0.3 × 0.3 m and one vent is 0.45 × 0.45 m (Section 2–5, *SFPE Handbook of Fire Protection Engineering*). Buoyant vertical flows through horizontal vents are complex and in general bidirectional (Section 2–3, *SFPE Handbook of Fire Protection Engineering*). However, horizontal flow through vertical vents located at the top of the panels is expected to provide an indication of the flow rate through the vertical vents. In this case, the maximum fire size supported by all three vents as determined using Equation (1) is 636 kW, assuming each of the three vents is 0.45 × 0.45 m. This energy release rate corresponds to NUREG/CR-6850, Appendix E, Case 5 heat release rate Bin 5 and indicates that external burning would not occur for fires that correspond to this heat release rate bin and to lower heat release rate bins. This represents approximately 94.3 percent of the severity factor for open panel fire scenarios. This should be contrasted with closed panel fire scenarios which per Tables 6-6, 6-8, and 6-10 result in abandonment for heat release rate Bins 4 and above, representing 30.4 percent of the overall severity factor. In addition, because the maximum equivalence ratio within an enclosure is on the order of three per Section 2–5, *SFPE Handbook of Fire Protection Engineering*, the maximum fire size expected within the MCBs is about 1,908 kW, and the maximum external heat release rate (at the vents) would be about 1,272 kW, regardless of internal panel-to-panel propagation. The maximum fire size associated with the propagating multiple cable bundle electrical panel fire is 2,448 kW, which bounds the maximum heat release rate that would be released at the MCB vents if it were evaluated as an open panel ignition source (NUREG/CR-6850, Appendix E, Case 5). As such, it is concluded that treating the MCBs as closed electrical panels that burn outside the sub-enclosure bounds the actual open panel configuration within the MCB sub-enclosure.

e. It was discussed that a cabinet fire is assumed to propagate to adjacent cabinets in 10 minutes. In the MCR walk-down during the onsite audit staff noted that there are no internal walls between different sections of the MCB. Based on the observed field conditions, the assumptions concerning fire propagation between cabinets in the analyses do not appear to be valid. Justify the assumptions concerning fire propagation in the MCB. Provide justification for deviating from the standard method provided in Appendix L of NUREG/CR-6850. Perform a sensitivity analysis to assess the effect of more rapid propagation between sections of the Main Control Board. Quantify the impact on core damage frequency (CDF), ΔCDF, large early release frequency (LERF) and ΔLERF.

Response:
The main control board model in the Ginna fire PRA assumes fire propagation time between boards of 10 minutes. This is part of a comprehensive event tree model including sequences for small fires that are promptly suppressed, and fires that do not propagate outside of the panel of fire origin. The justification for the assumed values for characterizing the different sequences is based on a comparison with values obtained from the approach described in Appendix L of NUREG/CR-6850: The following table lists the three panel propagation impacts considered in the Ginna MCB propagation analysis. The table also compares the analysis with results that would be obtained using the guidance in Appendix L of NUREG/CR-6850. The likelihood values listed in the table for the Ginna MCB analysis refers to the probability of damaging the assigned targets given a fire starting in a panel.

Damage Scope	Ginna FPRA Likelihood	NUREG/CR-6850 Appendix L Likelihood
Very Localized	0.632	8.5E-3
Full Panel is Lost	0.331	5.0E-3
Full Panel and Adjacent Panels are Lost	0.0369	3.5E-3

A very localized impact is considered to be, for example, a tight grouping of hand switches. This is conservatively developed based on the worst case grouping on switches/indication on the panel. This is assumed to be a fire duration 3 minutes or less using the control room non-suppression probability with no severity factor applied. The NUREG/CR-6850 Appendix L method includes a severity factor integrated with the non suppression probability as a function of distance. For the case of no propagation, outside the point of ignition (i.e., a zero distance), a value of 8.5E-3 is used as the conditional likelihood of that damage outcome given a main control board fire. For a full panel being lost in the Ginna FPRA. A value of 0.33 is used as the conditional likelihood of a full panel being lost. This value is the non suppression probability at a time of 10 minutes. In contrast, this likelihood would be about 5.0E-3 using NUREG/CR 6850 Appendix L at a distance of 0.5 m. If 10 minutes is exceeded in the Ginna FPRA, then all adjacent panels are damaged as well at a 3.69% likelihood). Using Appendix L, the likelihood of two or three panels being lost would be about 3.5E-3 given a distance of 1 m. Notice that severity factors are not included for the switch/instrument damage evaluation. Even the smallest Ginna damage likelihood exceeds the largest value from NUREG/CR-6850 Figure L-1.

The only time severity factors are consider in the Ginna main control room analysis is for control room abandonment. This is solely used for hot gas layer development which forces abandonment.

The NUREG/ CR 6850 Appendix L approach is developed for a typical main control board which does not include walls that separate the instrumentation and controls within the board. Yet, the likelihood of damage progress beyond 0.1 m per NUREG/CR 6850 Appendix L Table is about 8E-3. This is far lower than the smallest Ginna conditional likelihood given a control board fire the damage will propagate to two or more panels (i.e. 3.69%). As a bounding approach is already applied, no additional sensitivity evaluations are required.

f. Several figures were discussed, which show the variation of the fire diameter with the peak heat release rate for transient and panel fires, respectively. Each figure shows two curves, one curve corresponding to the low limit (0.4) and one curve corresponding to the high limit (2.4) of the NUREG-1824 Froude number validation range. Explain how these curves were used in determining the fire diameter for the different bins of transient and panel fires. Also, explain how the fire area(s) were determined for the MCB fires that involve multiple panels.

Response:
Figures 5-5 and 5-9 in the control room abandonment calculation (Report 1FJJ28008.000-02, Rev. 002) show the fire diameter range for each transient and multiple cable bundle electrical panel source fire heat release rate bin such that the resulting fire Froude Number falls within the NUREG-1824, Volume 1 validation range (i.e., between 0.4 and 2.4). Fires with low fire Froude Numbers (0.4) are denoted as weak plume scenarios because the fire plan area is larger than the high fire Froude Number fire scenarios and the resulting fire plume entrains a greater amount of surrounding air resulting in a lower plume temperature and buoyancy at a fixed height. Fires with high fire Froude Numbers (2.4) are denoted as strong plumes for the opposite reason. This information is used to select the appropriate fire diameter for each ignition source modeled in FDS. The first step was to determine whether a strong or a weak plume is bounding. The initial baseline hypothesis was that a weak plume would be bounding because the plume mass flows would be greater. Section 6.2.2 provides confirmation of this hypothesis by comparing the results of simulations performed with a weak plume and a strong plume. Subsequent baseline simulations were evaluated using the weak plume, defined as the plume generated by a fire having a fire Froude Number equal to 0.4. The fire diameter for each bin for a given ignition source is different because the fire Froude Number is held constant. The diameter for each heat release rate bin is determined using Equation 5–2 in Report 1FJJ28008.000-02, Rev. 002). Figures 5-5 and 5-9 were not directly used in this process; rather the figures are provided for a visual depiction of the variation in the fire diameters to improve the clarity of the discussion. The fire area for multiple electrical panel fires was determined in the same way as single electrical panel fires. Subsequently ignited panels are treated as separate fire objects with their own burning area.

g. It was stated that the abandonment probability for transient fire scenarios is determined on the basis of the results of the fire dynamic simulator (FDS) abandonment time calculations for panel HRR bins 1-5. Provide technical justification for this approach as a transient fire grows at a faster rate (2 min to reach peak HRR versus 12 min for panel files) and may therefore result in a shorter abandonment time compared to a panel fire with the same peak HRR.

Response:
Part C of this RAI response indicates the FDS simulations for transient fires did not result in abandonment conditions. The worst case fire scenarios (electrical cabinet fires) are considered for the probability of abandonment calculations. To conservatively estimate the transient fire contribution to the abandonment

calculations, bins 1-5 of the bounding case is chosen to represent the transient fire 98th percentile HRR of 317 kW. This is conservative given the FDS simulations did not identify any transient fire resulting in abandonment conditions.

PRA RAI 03

On July 26, 2013, Westinghouse Electric Company issued a 10 CFR Part 21 report on the inconsistency between the intended design functionality of the SHIELD passive thermal shutdown seal (SDS) and that which was observed during post-service testing. The likelihood and magnitude of inventory loss from these types of seals was based on Revision 1 to Pressurized Water Reactor Owners Group Topical Report WCAP-17100-P/NP, "PRA Model for the Westinghouse Shut Down Seal."

Recently, Indiana Michigan Power Company (I&M) notified the NRC about recent operating experience with the new RCP seals, which indicates that the likelihood and magnitude of inventory loss may be greater than that assumed from these types of seals.

a) What impact does this recent operating experience with the new RCP seals associated with Part 21 notification have on the CDF, LERF, delta-CDF and delta-LERF? Explain the basis for any revised assumptions.

b) If the impact causes the acceptance guidelines of RG 1.174 to be exceeded, how do you plan to address this operating experience?

c) Discuss whether any currently proposed license conditions are affected by these changes.

Response:

The current Ginna Fire PRA model includes credit for the upgraded Westinghouse shutdown seal that is outlined in Revision 1 to Pressurized Water Reactor Owners Group Topical Report WCAP-17100-P/NP, "PRA Model for the Westinghouse Shut Down Seal." Ginna is aware of the operating experience issues with the shutdown seals and how the experience does not match the initially assumed design analysis for the magnitude of inventory loss which is credited in the current model. The modeling in the PRA, which reflects the original PRA modeling guidance for the shutdown seal, will remain in place and Ginna will commit to achieving the performance represented by that modeling. Ginna plans to install the seals that Westinghouse provides when the design issues identified in the Part 21 notification are resolved, however, alternative options are also being explored. Ginna will monitor Westinghouse's efforts to resolve these design issues and will confirm that the updated seal design meets the performance factors provided in their original guidance that was included in Revision 1 to Pressurized Water Reactor Owners Group Topical Report WCAP-17100-P/NP, "PRA Model for the Westinghouse Shut Down Seal." Ginna will confirm that the contribution of RCP seal LOCA to CDF, LERF, delta-CDF, and delta-LERF in the post-transition plant is equal to or less than what is represented in the current baseline FPRA model or an alternative will be implemented which achieves comparable results.

PRA RAI 15

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a fire PRA and endorses, with exceptions and clarifications, NEI 04-02, revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805.

Transient fires should at a minimum be placed in locations within the plant PAUs where CCDPs are highest for that PAU, i.e., at "pinch points." Pinch points include locations of redundant trains or the vicinity of other potentially risk-relevant equipment, including the associated cabling. Transient fires should be placed at all appropriate locations in a PAU where they can threaten pinch points. Hot work should be assumed to occur in locations where hot work is a possibility, even if improbable (but not impossible), keeping in mind the same philosophy. Describe how transient and hot work fires are distributed within the PAUs at your plant. In particular, identify the criteria for your plant which determine where an ignition source is placed within the PAUs. Also, if you have areas where no transient or hot work fires are located since those areas are considered inaccessible, define the criteria used to define "inaccessible." Note that an inaccessible area is not the same as a location where fire is simply unlikely, even if highly improbable.

If you have used an influence factor outside of those identified in Table 6-3 of NUREG/CR-6850, provide a sensitivity analysis using the corresponding factors from Table 6-3 in NUREG/CR-6850. Discuss the use of the area weighting factor in evaluating the importance of transients in the PAUs.

Response:
Transient fires and transient hot work fires scenarios are developed in all compartments using the influence factors identified in Table 6-3 of NUREG/CR-6850. Where no detailed fire modeling is performed, the total transient fire frequency is included in the total fire compartment frequency and all fire PRA targets in the compartment are damaged. Appendix B of the ignition frequency notebook, G1-IGN-F001, documents the transient fire frequency contribution for each fire compartment. Detailed transient fire scenarios are modeled in all fire compartments considered for detailed fire modeling following the guidance in Task 11 NUREG/CR-6850. Transient fires are postulated in smaller areas designated as transient zones to span the total floor area in each fire compartment (i.e., there are no open floor areas where transient fire scenarios are excluded). At Ginna, these transient zones are defined by column lines. Section 6.1.2 of the detailed fire modeling notebook, G1-FSS-F001, documents transient zone definitions.

Each transient zone is indicated by the invisible transient zone boundaries that follow the north to south and east to west column lines. The transient zone name is composed as follows; e.g. 12-A-03, where 12 indicates turbine building level 2, and "A" and "03" are the corresponding column lines.

A transient fire and transient hot work fire are postulated for each transient area. A transient fire and transient hot work fire is assumed to occur anywhere within the transient zone and all identified targets are mapped to them. There are two main inputs for modeling transient fires: target mapping and apportioning the frequency.

The transient ignition frequency includes influence factors for fire compartment characteristics as well as an area (geometry) weighting factor for each transient zone. The influence factors identified in Table 6-3 of NUREG/CR-6850 for maintenance, occupancy, and storage are used for apportioning transient fire frequencies. Influence factors outside of this guidance are not used in the Ginna fire PRA. Section 2.7.2 and Appendix B of the ignition frequency notebook, G1-IGN-F001, documents the approach and assignment of influence factors for each fire compartment.

Section 2.7.2 of the ignition frequency notebook, G1-IGN-F001, documents the geometric factor (i.e., floor area ratio) applied for transient fire scenarios. The transient zone floor area is divided by the total compartment floor area to obtain this factor. The entire transient zone floor area is considered as the transient fire is postulated anywhere in the transient zone. The factor is multiplied by the transient source frequency.

Target mapping includes cable tray and conduits. All the Fire PRA targets were mapped to transient zones regardless of their location relative to the fire within the transient zone. For cable trays, plant layout drawing review and walkdowns are performed to identify any cable trays that are within the transient zone boundary or near (within 4 feet to account for the radiant damage of a transient fire) the transient zone boundary and are included in the target set. The transient area is larger than the zone of influence for a 317kW fire (recommended 98^{th} percentile HRR for transient fires). This approach ensures that "pinch points" for transient fires are not missed, as the transient zones cover the entire floor area of the corresponding fire zone and all the Fire PRA targets within the transient zone are mapped.

When mapping conduits to transient scenarios, the cable routing through the plant needs to be developed. The routing of fire PRA conduits is available in the cable routing database (TRAK 2000). The smallest division for routing conduits is by column lines. Given the transient zones have been selected in the same manner, conduits by transient zone are known. A transient fire is postulated to occur anywhere in the transient zone therefore, all conduits in the transient area are damaged in the transient fire.

To account for conduits in adjacent transient zones, a matrix is developed similar to a multi-compartment matrix denoting all adjacent transient zones. The conduits in the adjacent transient zones are then mapped to each transient zone fire. Consider the following example:

12-A-03	12-A-04	12-A-05
12-B-03	12-B-04	12-B-05

A sample of 6 transient rooms is shown. The opposite side of the wall to the north of 12-A-04 is outside. The transient zone under consideration is the shaded transient zone 12-A-04. The adjacent transient zones are 12-A-05, 12-B-05, 12-B-04, 12-B-03, and 12-A-03. To account for conduits in the adjacent zones, the transient fire for 12-A-04 would include all of the conduits from the 5 adjacent transient zones. Where the results of this quantification indicate significant risk increase, field walkdowns are conducted for exact conduit location. The conduit is then failed in fire scenarios where the conduit is in the zone of influence for a transient fire. For example, if the conduit runs 20 feet above the floor and there are no intervening combustibles between the transient source and the conduit, the conduit can be screened from the transient fire scenario.

One area considered in the Ginna fire PRA that is excluded from transient fire analysis is the transformer yard manhole west (MH-1W). This area is located underground below the transformer yard (located outside, south of the control building). The only access to the manhole is through the transformer yard. The transformer yard is locked during normal operations. A key is required to enter the transformer yard area as well as the specific transformer location (where the manhole is located). The manhole also requires a confined space permit to enter the area. Given the numerous permissions required to enter the area, the compartment is considered inaccessible during normal operations and is screened from transient analysis.

PRA RAI 19

RG 1.174, Revision 2, identifies that key sources of model uncertainty should be identified and sensitivity analysis performed or reasons given as to why they are not appropriate for the application. In the ASME/ANS PRA standard a source of model uncertainty is labeled as "key" when it could impact the PRA results that are being used in a decision, and consequently, may influence the decision being made.

Discuss the FPRA key sources of uncertainty and assumptions, including any related to planned modifications, and discuss the results and significance of sensitivity analyses for them.

Response:

The uncertainty and sensitivity analysis for the Ginna FPRA is documented in G1-UNC-F001, "Fire PRA Notebook Uncertainty and Sensitivity Analysis (UNC)". A summary of the results and approach used for the analyses is summarized in the following paragraphs.

The uncertainty and sensitivity analysis ensures that key uncertainties, that is, those uncertainties that can affect the use of a FPRA's results in a risk-informed decision-making process, are appropriately identified and characterized with their impacts on the results understood. Numerous inputs that make up CDF and LERF estimates are uncertain (e.g., fire frequencies, extent of fire growth, equipment failure probabilities, operator action probabilities, etc.). The various fire-induced accident sequences and their frequencies modeled in the Fire PRA include aleatory uncertainties associated with the occurrence of a fire and possible plant and operator responses. Each input of the model (i.e., initiating event frequency, equipment failure probabilities, and human error probabilities) also includes epistemic uncertainties with regard to the frequencies and probabilities described by distributions. Sampling techniques (e.g., Monte Carlo, Latin hypercube) are typically used to propagate the epistemic uncertainties to generate a probability distribution for each accident sequence frequency and from that, CDF and LERF uncertainty distributions.

Each task of the Fire PRA was reviewed explicitly for parameters that introduce uncertainty to the model. The tasks that are reviewed and interface with this analysis include (NUREG/CR-6850 Task number in parentheses):

- Plant Boundary Definition and Partitioning (Task 1)
- Fire PRA Component Selection (Task 2)
- Fire PRA Cable Selection (Task 3)
- Qualitative Screening (Task 4)
- Fire-Induced Risk Model (Task 5)
- Fire Ignition Frequency (Task 6)
- Quantitative Screening (Task 7)
- Scoping Fire Modeling (Task 8)
- Detailed Circuit Failure Analysis (Task 9)
- Circuit Failure Mode Likelihood Analysis (Task 10)

- Detailed Fire Modeling (Task 11)
- Post-Fire Human Reliability Analysis (Task 12)
- Seismic-Fire Interactions (Task 13)
- Fire Risk Quantification (Task 14)

Details of the review of each task can be found in G1-UNC-F001, but the Summary of the review can be found in Table 1.

Table 1. Summary of Uncertainty from NUREG/CR-6850 Fire PRA Tasks

Task	Task Description/Uncertainty Parameter	Uncertainty Type	Approach to Address
1	Plant Boundary Definition and Partitioning	Qualitative	See 3.1.1 of G1-UNC-F001
2	Fire PRA Component Selection	Qualitative	See 3.1.2 of G1-UNC-F001
3	Fire PRA Cable Selection	Qualitative	See 3.1.3 of G1-UNC-F001
4	Qualitative Screening	Qualitative	See 3.1.3 of G1-UNC-F001
5	Fire-Induced Risk Model		
	Plant Modifications	Quantitative	Sensitivity
	Methodology Change for Common Cause Failure Probability Calculations	Quantitative	Sensitivity
6	Fire Ignition Frequency	Quantitative	Parametric Distribution
	Credit for Automatic Suppression	Sensitivity	See 3.1.6 of G1-UNC-F001
	Alpha Factors of 1.0 or Less	Sensitivity	See 3.1.6 of G1-UNC-F001
7	Quantitative Screening	Qualitative	See 3.1.7 of G1-UNC-F001
8	Scoping Fire Modeling	Qualitative	See 3.1.8 of G1-UNC-F001
9	Detailed Circuit Failure Analysis	Qualitative	See 3.1.9 of G1-UNC-F001
10	Circuit Failure Mode Likelihood Analysis	Quantitative	Parametric Distribution
	Methodology Change for CF Probability Calculations	Quantitative	Sensitivity
11	Detailed Fire Modeling		
	Non-Suppression Probabilities	Quantitative	Sensitivity

Table 1. Summary of Uncertainty from NUREG/CR-6850 Fire PRA Tasks

Task	Task Description/Uncertainty Parameter	Uncertainty Type	Approach to Address
12	Post-Fire Human Reliability Analysis		
	Human Error Probabilities	Quantitative	Parametric Distribution
	Treatment of HFE Dependencies	Quantitative	Parametric Distribution
	Control Room Evacuation	Quantitative	Parametric Distribution
	Methodology Change for HEP Calculations	Quantitative	Sensitivity
13	Seismic-Fire Interactions	Qualitative	See 3.1.13 of G1-UNC-F001
14	Fire Risk Quantification	See uncertainties in Task 5	

The following paragraphs summarize the uncertainty and sensitivity analyses that were performed for the Ginna FPRA model. These are documented in detail in G1-UNC-F001.

Monte Carlo sampling was performed to propagate parametric uncertainty through the Ginna FPRA model. The results of the analysis are found in Figures 1 and 2 and are summarized in Table 2. The analysis was performed on the following parameters:

- Fire ignition frequencies
- Human error probabilities,
- Existing internal events component random failure probabilities and unavailabilities, and
- Circuit failure probabilities.

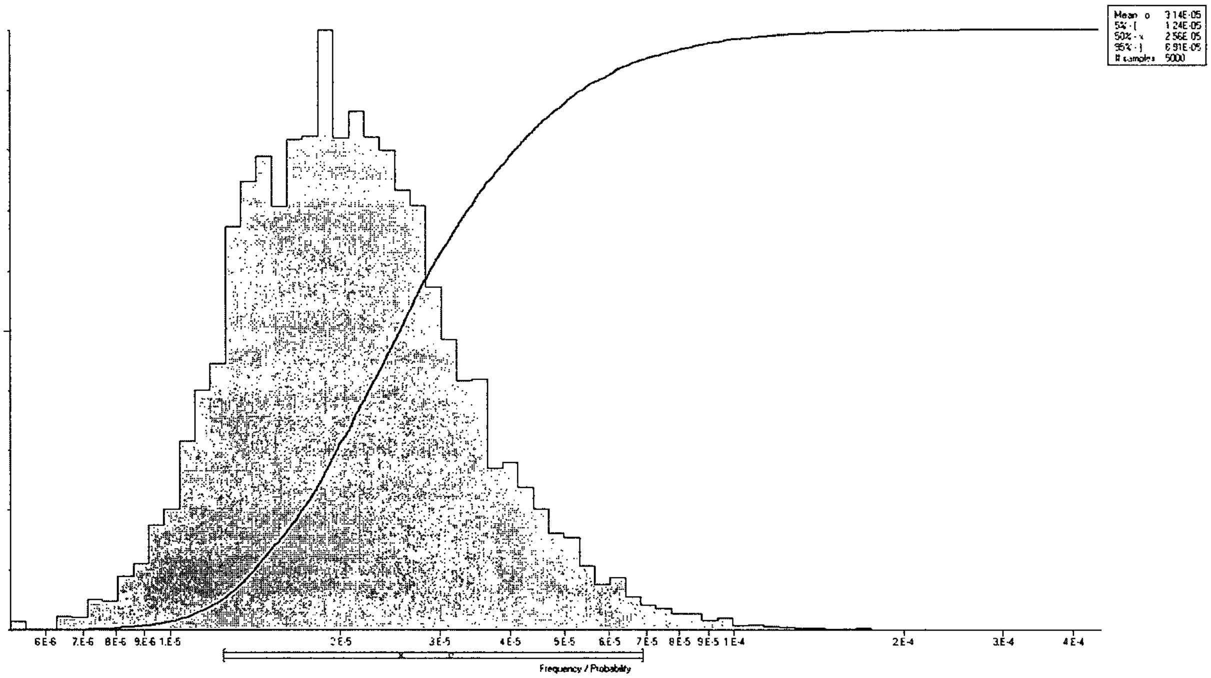

Figure 1. R.E. Ginna Fire CDF Distribution

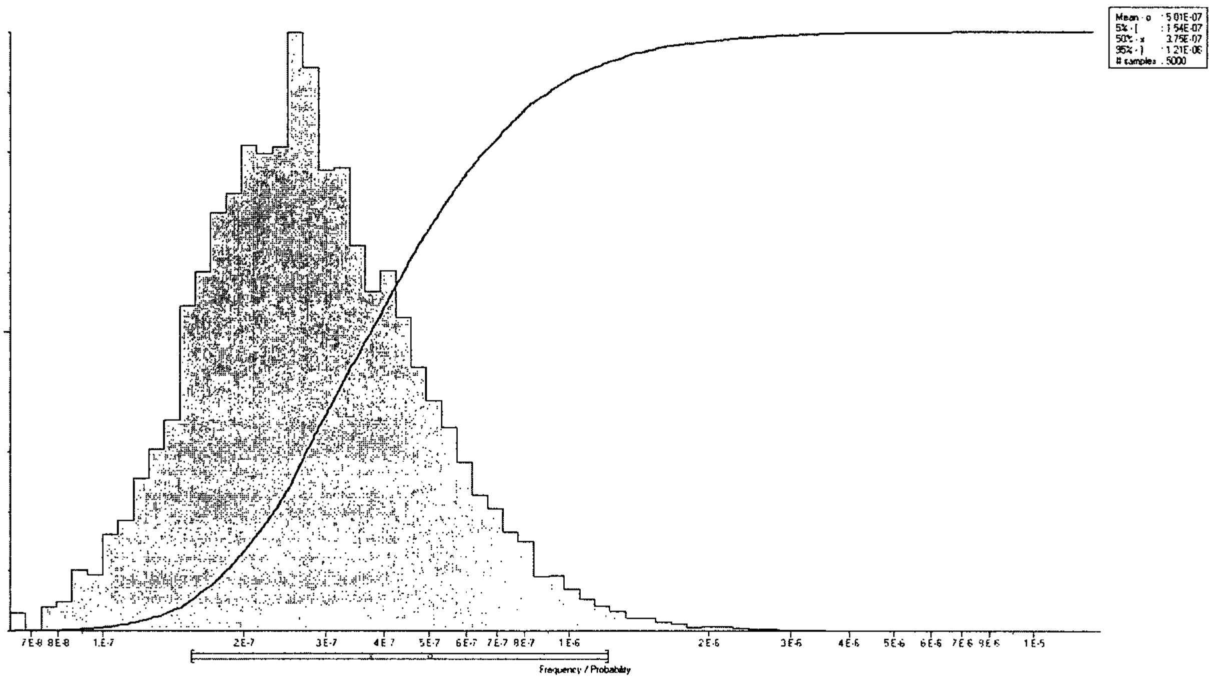

Figure 2. R. E. Ginna Fire LERF Distribution

Table 2. Uncertainty Results Summary

Uncertainty Parameter	CDF (/rx-yr)	LERF (/rx-yr)
Point Estimate	2.96E-05	4.80E-07
Mean	3.14E-05	5.01E-07
5th Percentile	1.24E-05	1.54E-07
50th Percentile	2.56E-05	3.75E-07
95th Percentile	6.91E-05	1.21E-06
Sample Size	5000	5000

The sensitivity analysis at Ginna includes an analysis of how the credited plant modifications collectively affect the overall CDF and LERF. The plant modifications were assigned a conservative failure probability to represent the impact of the modification. Sensitivity cases were run to determine the impact of the CDF and LERF. Each assigned modification probability was evaluated using the calculated 95th percentile and a value of 0, similar to the methodology change analysis that is done for PRA parameters such as HRA probabilities or common cause failures (CCFs).

Sensitivity analyses were run to address the potential for a methodology change for the calculation of HEPs, CF probabilities, and common cause failure probabilities. Each set of probabilities was evaluated independently using the calculated 95th percentile and a value of 0 for each probability for each affected event.

Automatic suppression is credited in several areas of the plant. Crediting automatic suppression has a direct impact on the ignition frequencies for the scenarios in these areas. A sensitivity study was completed to determine the impact of crediting automatic suppression on the overall CDF and LERF. Credit was removed and new ignition frequencies were used to update the CDF and LERF.

As outlined in PRA RAI 38, a sensitivity analysis was also run to address the potential for the use of Alpha 1 factors for equipment that is an ignition source. The sensitivity calculates the delta in the CDF and LERF when the 6850 Means are used for these equipment ignition sources. In addition to the changes to the CDF and LERF, the changes to the ΔCDF and ΔLERF associated with fire risk evaluations were also analyzed.

The results of all of the sensitivity analyses are listed in Table 3.

Table 3. Summary of Sensitivity Studies

Sensitivity Run	CDF (/rx-y)	ΔCDF (from Baseline) (/rx-yr)	LERF (/rx-yr)	ΔLERF (from Baseline) (/rx-yr)
Baseline Risk	**2.96E-05**	–	**4.80E-07**	–
Modification Credit Set to 95th	7.73E-05	4.77E-05	2.49E-06	2.01E-06
Modification Credit Set to 0	2.19E-05	-7.75E-06	1.89E-07	-2.91E-07
HEP Set to 95th	8.02E-05	5.06E-05	1.06E-06	5.82E-07
HEP Set to 0	1.13E-05	-1.83E-05	2.67E-07	-2.13E-07
CCF Set to 95th	3.06E-05	9.43E-07	4.84E-07	4.45E-09
CCF Set to 0	2.92E-05	-3.84E-07	4.78E-07	-2.03E-09
CF Probabilities Set to 95th	3.08E-05	1.17E-06	8.86E-07	4.06E-07
CF Probabilities Set to 0	2.66E-05	-2.98E-06	2.22E-07	-2.58E-07
Ignition Frequencies without Credit for Automatic Suppression	3.67E-05	7.08E-06	8.85E-07	4.05E-07
Ignition Frequencies Updated to use 6850 Means for Equipment with Alpha 1.0	5.05E-05	2.09E-05	7.47E-07	2.67E-07
Baseline Delta Risk	**9.36E-06**	–	**6.29E-08**	–
Ignition Frequencies Updated to use 6850 Means for Equipment with Alpha 1.0	2.24E-05	1.30E-05	2.63E-07	2.00E-07

PRA RAI 22

Section 2.2 (h) of NFPA 805 states that general approach of the standard shall involve performing the plant change evaluation that demonstrates that changes in risk, defense-in-depth, and safety margins are acceptable. Section 2.4.4.2 of NFPA 805 states that the plant change evaluation shall ensure that the philosophy of defense-in-depth is maintained, relative to fire protection and nuclear safety. If any one of these is unacceptable, additional fire protection features or other alternatives shall be implemented. Section 2.4.4.3 states that the plant change evaluation shall ensure that sufficient safety margins are maintained. The DID echelons, as defined in NEI 04-02, and the general strategy of looking for substantial imbalance in the echelons is described at a high level in Section 4.5.2.2 of the LAR. Attachment W to the LAR provides additional information on evaluation of DID and safety margin. Address the following questions related to DID and SM.

a) Describe the methodology that was used to evaluate defense-in-depth and that was used to evaluate safety margins. The description should include what was evaluated, how the evaluations were performed, and what, if any, actions or changes to the plant or procedures were taken to maintain the philosophy of defense-in-depth or sufficient safety margins.

b) In the LAR Table C-1, reactor containment building fire area, the DID discussion notes that a CCDP of 1.0 exists. Please explain why no defense in depth is considered necessary for the relevant fire scenarios.

c) LAR Attachment W, Table W-3, shows that ISLOCA is a dominant contributor to LERF. In addition, for two potential ISLOCA pathways (MOV-313 and MOV 371) reliance on preventing fire-induced ISLOCA appears to be placed on a single status light indication for an MOV. Please discuss your defense-in-depth evaluation of ISLOCA. Discuss any DID taken or proposed with respect to ISLOCA, or if none, how this conclusion satisfies your DID approach.

Response:

Response to Item a):

Method of Evaluation of Defense-in-Depth (DID)

Section 1.2 of NFPA 805 defines DID as:

1. Preventing fires from starting

2. Rapidly detecting fires and controlling and extinguishing promptly those fires that do occur, thereby limiting fire damage

3. Providing an adequate level of fire protection for structures, systems, and components important to safety, so that a fire that is not promptly extinguished will not prevent essential plant safety functions from being performed.

In general, DID is considered satisfied if the proposed change does not result in a substantial imbalance among these elements (or echelons). The review of DID is qualitative and addresses each of the elements with respect to the proposed change. It involves a review of plant documents such as the fire protection program, pre-fire plans, and administrative procedures such as FPS-16 (bulk storage of combustible materials and transient fire loads), and A-905 (hot work permit).

In the context of the NFPA 805 transition, the DID evaluation accounts for the fact that the fundamental elements of the fire protection program and the design requirements for fire protection systems and features have been addressed in a manner consistent with the requirements of Chapter 3 of NFPA 805. Accordingly, the DID evaluation focuses on potential enhancements that may be required to maintain the balance of DID echelons. Insights gained from the Fire PRA are used in the evaluation of each echelon. Examples of types of insights are:

- Fire scenario frequencies, which, because they embed ignition source frequencies and non-suppression probabilities, provide indications on the adequacy of both Echelon 1 and Echelon 2.
- The Fire PRA Ignition Frequency Notebook (G1-IGN-F001), is used to identify potential challenges to Echelon 1. Fire events at the plant that show an unusual pattern (i.e., higher frequency of occurrence than the generic frequency from other plants) may reveal vulnerabilities in Echelon 1. At Ginna, no such unusual patterns were noted in the G1-IGN-F001 Notebook, thereby indicating that the fire event frequency at the plant is not significantly different from the general population of plants.
- The maintenance, occupancy, and storage influencing factors used in each compartment to evaluate transient and hotwork fire frequencies provide DID insights. In the Fire PRA, ranking numerical values are assigned to these factors based on Table 6-3 of NUREG/CR-6850. These values are considered in the DID evaluation to identify areas of the plant that have a higher susceptibility to fire events, and as such might challenge Echelon 1.
- Fire Scenario Selection Notebooks (G1-FSS-F001 through G1-FSS-F004) document the fire detection and suppression systems credited in the Fire PRA, as well as fire protection features such as electrical raceway fire barrier system (ERFBS). Thus, they are used to evaluate Echelon 2. In addition, the Fire PRA analyzes the potential for fire scenarios that can lead to widespread damage, such as hot gas layer and structural steel fire scenarios. Multi-compartment fire scenarios are also reviewed to identify potential vulnerabilities in fire barriers and the resulting level of protection to SSCs important to safety. As such, they are used to evaluate the adequacy of Echelon 3.
- Conditional Core Damage Probability (CCDP) and Conditional Large Early Release Probability (CLERP) values, which help evaluate Echelon 3. A relatively high CCDP or

CLERP value in a fire scenario of the fire area may point to a vulnerability in Echelon 3 that, for example, a DID action may mitigate.

The Fire Risk Evaluations (FREs) found that an adequate balance between DID echelons was preserved, without further enhancements required. No DID modifications and no DID actions are required.

Method of Evaluation of Safety Margin

In accordance with Section 5.3.5.3 of NEI 04-02, the adequacy of Safety Margin is assessed by the consideration of categories of analyses utilized by the FRE. Safety margins are considered to be maintained if:

- Codes and standards or their alternatives accepted for use by the NRC are met and
- Safety analysis acceptance criteria in the licensing basis (e.g., FSAR, supporting analyses) are met, or provide sufficient margin to account for analysis and data uncertainty.

The maintenance of adequate safety margin is described below for each of the specific analysis types used in support of the fire risk assessment.

Fire Modeling

Fire modeling studies performed in support of the FRE are part of the Fire PRA. Fire modeling was utilized to characterize selected scenarios included in the fire risk profile of the plant. No performance based fire modeling analysis is credited to disposition Variance From the Deterministic Requirements (VFDRs) under section 4.2.4.1 of NFPA 805. The fire modeling studies conducted in support of the Fire PRA are documented in the FSS notebooks. These notebooks were submitted for Peer Review and updated with the resolution of Facts and Observations.

The development and quantification of fire scenarios in support of the Fire PRA follow the guidance available in NUREG/CR-6850. Consistent with the Fire PRA process, not all the fire zones require a detailed fire modeling analysis, as some of them are analyzed conservatively due to their relatively lower risk contributions. Fire zones are evaluated on a case by case basis during the Fire PRA development process for determining the level of detailed fire modeling analysis necessary. The highest level of fire modeling analysis is applied to selected zones on an "as needed basis" when screening techniques can mask true risk contributors and practical insights. Zones requiring less detailed analysis are modeled in the Fire PRA conservatively (e.g., failing all targets in the fire zone for every fire scenario, failing targets at time of ignition, etc.). In either case, safety margin is maintained by the level of conservatism included in the modeling approach. The fire modeling analysis can be classified in three groups:

- Fire zones treated as "full zone damage". These zones have been screened from detailed analysis as they are included in the fire risk profile of the plant assuming all the Fire PRA targets are failed at the time of ignition with the total frequency of fixed and transient ignition sources. In practice, they are represented as one fire scenario in a single fire zone and the corresponding multi compartment scenarios.

- Fire zones that have been subdivided into fire scenarios for crediting severity factors and specific location characteristics within the fire zone. In this group of scenarios, times to damage are assumed to occur at the time of ignition of specific ignition sources. There is no credit for detection or suppression features in scenarios pertaining to these fire zones.
- Fire zones receiving detailed fire modeling analysis in which severity factors, detection and suppression features are credited for the individual fire scenarios. For these scenarios, determination of target damage is necessary.

For this last group, the quantification process requires analytical fire modeling for determining time to target damage, time to detection and suppression, and time for the different fire zones to reach hot gas layer conditions. The following modeling approaches, applied to fire zones requiring detailed analysis, ensure that safety margins are maintained:

- Time to target damage calculations are conservative and provide safety margin because cables are considered damaged when exposed to environmental temperatures equal or exceeding the corresponding damage criteria. That is, heat transfer calculations throughout the thickness of the targets to determine internal target temperatures are not credited in the analysis. Targets (e.g. cables) are assumed damaged as soon as the fire generated environmental temperatures reach the damage criteria.
- Time to detection and suppression calculations are conservative because suppression is not considered effective in the Fire PRA for the first set of targets immediately in contact with the ignition source. For example, in case of a fire started in a cabinet located near cable trays, no credit is taken for automatic suppression (for example, Halon) protecting the ignition source (i.e., the electrical cabinet) or any raceways/cabling in direct contact with the cabinet. Automatic suppression is credited to prevent impacts beyond the initial target set.
- Time to generating hot gas layer conditions in the fire zone. The expression "hot gas layer conditions" refers to a postulated fire increasing the temperature in a fire zone to the target damage criteria. The fire sizes selected for these calculations bound the worst case fire scenario in the fire zone. That is, the combination of the ignition source and intervening combustibles deemed to generate the highest heat release rate are selected for determining the time to hot gas layer conditions. This approach generally results in shorter times to hot gas layer conditions, which maintains safety margin in the analysis.

The fire modeling is conducted utilizing fire modeling codes and guidance documents developed by the commercial nuclear industry and NRC staff. Specifically, the fire modeling tools used for the analysis includes the zone model Consolidated Model of Fire Growth and Smoke Transport (CFAST), and engineering calculations routinely used and available in NUREG-1805 and/or Five-REV1 library (EPRI 1002981) (e.g. point source flame radiation, plume temperature, etc.).

Plant System Performance

The safety margins inherent in the analyses for the plant design basis events are captured in the internal event PRA notebooks, for example the PRA Success Criteria Notebook (SC Notebook). Section 5.0 of the SC notebook provides insights about sources of uncertainty in these success criteria. In summary, they are deemed to be realistic or to embed conservatism. Furthermore, the SC notebook was developed in accordance with the ASME/ANS RA-Sa-2009 Standard and Regulatory Guide 1.200. The standard calls for the success criteria to be defined on bases consistent with the features, procedures, and operating philosophy of the plant (SC-A6 Category II requirement), to use realistic evaluations (SC-B1 Category II requirement), as well as computer codes that, when used within known limits of applicability, provide results representative of the plant (SC-B4 Category II requirement). The Fire PRA was developed using the internal event PRA as a starting point. A peer review of the internal events PRA was performed and did not leave open findings relevant to the Fire PRA modeling. Thus, it is concluded that the safety margin inherent to analyses of the plant design basis events and captured in the internal events PRA is preserved.

The Fire PRA was developed based on the internal event PRA, to which fire-specific modifications were made to model the plant response to a fire, in accordance with the ASME/ANS RA-Sa-2009 Standard, which requires identifying new or modified success criteria to support the Fire PRA (Requirements PRM-B7 and PRM-B8). No new or modified success criteria were needed to support the Fire PRA, confirming that the safety margin of the PRA model was preserved.

From a quantification perspective, the FRANX software was used to assign initiating events and their fire-induced frequencies to fire scenarios and to model fire-induced equipment failures and human failure events. An initiating event from the internal events PRA model was assigned to each scenario to be quantified, ensuring the appropriate accident sequences were triggered given the postulated fire. The initiating event selected for all fire scenarios was TIRXTRIP (reactor trip). In the structure of the Fire PRA model, all potential initiating events which can cause the initiating event condition, either by themselves or in combination with equipment failures, are input into the logical representation of the sequence. Since FRANX applies fire impacts to equipment, the fire-induced component failures combined with the use of the TIRXTRIP initiator addressed all fire-induced initiators.

The fire-induced equipment failures were quantified by setting the associated basic events to failure (TRUE), as determined by the equipment and cables affected in the fire scenarios. Circuit failure probabilities for spurious events from the Circuit Failure Analysis (CF) tasks were incorporated as relevant. The circuit failure mode probabilities were assigned following state of the art industry practices and guidance, which are based on conservative assumptions. Finally, operator actions in the internal events PRA were reviewed in view of fire scenarios, and instruments that were found to be required to support the human reliability assessment were added to the model; in addition, the HEP values were re-evaluated to account for the effect of fires, and, as relevant, additional fire-specific human failure events were added to the model.

The FREs found that an adequate safety margin was maintained, without further enhancements required.

Response to Item b)

A re-evaluation of the Fire PRA multi-compartment fire scenarios was performed to remove excessive conservatisms. The re-evaluation showed that no hot gas layer could develop in the containment (e.g. compartment RC-2). Thus, the associated multi-compartment fire scenario was eliminated from further consideration. There are no fire scenarios remaining with a conditional core damage probability of 1. This more realistic result confirms that the defense-in-depth in the fire area is adequate.

Response to Item c)

The updated model results which are documented in the response to PRA RAI 44 were reviewed and ISLOCA scenarios are no longer a contributor to LERF. There is no need for DID consideration for the ISLOCA or reliance on MOV-313 or MOV-371 since this sequence is no longer a contributor to LERF.

PRA RAI 27

It was recently stated at the industry fire forum that the Phenomena Identification and Ranking Table Panel being conducted for the circuit failure tests from the DESIREE-FIRE and CAROL-FIRE tests may be eliminating the credit for Control Power Transformers (CPTs) (about a factor 2 reduction) currently allowed by Tables 10-1 and 10-3 of NUREG/CR-6850, Vol. 2, as being invalid when estimating circuit failure probabilities. Confirm that no CPT credit reduction is included in the Fire PRA model.

Response:

Per the memorandum "INTERIM TECHNICAL GUIDANCE ON FIRE-INDUCED CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS" dated June 14, 2013, the hot short-induced spurious operation likelihood reduction factor of "two" that is given when a CPT is the power source for a circuit was not taken in the updated fire PRA model for Ginna. The summary results provided in PRA RAI 44 reflect the analysis with no factor of "two" credit taken in the development of hot short probabilities for CPT-powered circuits.

PRA RAI 28

Provide a discussion on the treatment of sensitive electronics as described in NUREG/CR-6850 for the Fire PRA, including those within cabinets and outside of cabinets, within and without the main control room, and for multi-compartment screening based on the hot gas layer temperature in the exposing fire compartment. Include a description of how identification of components defined as sensitive was performed. If the impact of fire on sensitive electronics that could have an impact on fire risk was not performed, provide the contribution of these scenarios to CDF, delta-CDF, LERF, and delta-LERF using recommended criteria from NUREG/CR-6850 Appendix S for sensitive electronics.

Response:

The closure memo on FAQ 13-004 (sensitive electronics) was issued on 3 December 2013. NRC took no exception to the FAQ, which contained the following guidance:

he following is provided as additional guidance for identifying the scope of plant equipment to be treated using the lower damage threshold specified in Section H.2 of NUREG/CR-6850.

- Electro-mechanical devices are not considered sensitive electronics.
- Integrated circuits employing any of the variants of pin-grid arrays should be treated as sensitive electronics unless they satisfy the item below.
- Sensitive electronic components that are mounted inside a control panel (cabinet) such that the cabinet walls, top, front and back doors shield the component from the radiant energy of an exposure fire may be considered qualified up to the heat flux damage threshold for thermoset cables, provided that:
    - The component is not mounted on the surface of the cabinet (front or back wall/door) where it would be directly exposed to the convective and/or radiant energy of an exposure fire.
    - The presence of louvers or other typical ventilation means do not invalidate the guidance provided for here.

All of the electrical equipment (over 3900 components) in the Ginna PRA model were reviewed based this FAQ guidance. All but 292 of these components are not considered sensitive electronics per the guidance. The 292 remaining components contain circuit cards with pins or have a digital display. The vast majority of these 292 components (all but 33) are contained in an enclosed cabinet that meet the criteria for the use of the heat flux damage threshold for thermoset cables per the third bullet of the guidance. The remaining 33 components either have an external digital display or are open to hot gas layer intrusion. Of these 33 components, as expected, 29 are indicators in the main control room. Since the conditions required to fail these indications would lead to a control room abandonment, they are not credited in those scenarios and so their failure does not affect the HRA. The failure of these indicators does not affect any control circuitry, and so there is no impact on any other aspect for the PRA. In addition to the MCR indications, the remaining 4 components are emergency lights which have circuit boards and are well ventilated. The failure of emergency lights is not considered to fail operator actions as each operator has access to a flashlight, but the loss of emergency lighting can degrade operator performance. A hot gas layer would also generate smoke. Smoke in a fire area is already considered to either degrade or fail actions in the area. Therefore, the impact of a fire that affects the emergency lights is already accounted for by the travel path exclusion used in the FPRA. There are no other circuit impacts of these failures beyond the direct effects on the emergency lights and control room indications. Therefore, there is no need to modify the model to account for the impact on sensitive electronics or to perform any risk or delta-risk quantification.

PRA RAI 29

During the audit, it was observed that several bus ducts run through the relay room. Provide a discussion of the analysis which describes the frequency and zone of influence (ZOI) associated with bus duct fires in the relay room and compare to FAQ-07-0035 in NUREG/CR-6850 Supplement 1. Indicate if the ZOI from the FAQ extends beyond the single transient zone.

Response:

There are 4160V buses (Bus 11A, 11B, 12A, and 12B) located north of the Relay Room in the Turbine Building. The bus ducts from the buses enter the Relay Room north wall and exit the south wall to the transformer yard connecting to transformers 11 and 12. The equipment IDs for these bus ducts are 4KVBD11A-RR, 4KVBD11B-RR, BB-PPSA-12A-RR, and BB-PPSB-12B-RR. Because of their relative length, the bus ducts are assumed to be segmented for Fire PRA purposes.

For assigning targets, the approach follows the FAQ-07-0035 guidance that indicates a zone of influence, originating at a point in the center and bottom of the bus duct, in a cone shape encompassing targets inside a right circular cone with a 15° angle from the vertical axis. Plant arrangement drawing 33013-2136 identifies the bottom of the highest elevated bus duct to be 13' 8" (13' 8" = 284' 8" – 271'). Conservatively using this height for all bus ducts, the radius from the center point is 3' 6"'. Plant arrangement drawing 33013-2123 identifies the entrance location of the bus ducts into the relay room. Electrical drawing D201-0015 identifies the location of the path of the bus ducts from the transformers, through the Relay Room, and to the buses in the Turbine Building. The bus ducts run through transient areas G2-F-11 and G2-F1-11. Overlaying the bus duct path from D201-0015 onto the cable tray drawing D214-0033 allows identification of impacted targets. A review of these layout drawings shows the bus ducts furthest east are located more than 4' (almost 5') from the transient border. This distance is greater than the radius of 3' 6" calculated earlier. Using the guidance from FAQ-07-0035, the ZOI for all four bus ducts will conservatively include all conduit targets in G2-F-11 and G2-F1-11. The bus duct failure is also considered to impact the trays and equipment that are located within a 3' 6" radius from the center of the ducts above or below the Bus Duct. The only exception to this is, as per the FAQ, that any trays more than 1' 6" above the cross sectional center of the bus duct are considered outside the ZOI.

Approach 2 from FAQ-07-0035 was used for counting bus ducts. The ratio of the length of the bus duct for which targets are identified in the zone of influence (ZOI approach described above) over the total length of the bus ducts in the plant is used. The approach will be documented in the next update of the ignition frequency notebook.

PRA RAI 30

Discuss the transient zone approach for fire damage. Discuss if scenarios across transient zones were identified and evaluated in the PRA. Discuss the mechanism for propagation across transient zone boundaries. List the scenarios that cross the boundary that were included in the PRA, identifying the originating and final transient zones. Provide the contribution of these scenarios to CDF, delta-CDF, LERF, and delta-LERF.

Response:

Transient zones are developed to consider the contribution of transient fires in all floor areas in fire compartments that have been selected for detailed fire modeling analysis. The transient fires are modeled in the Fire PRA as follows:

1) Each transient zone is assumed to be a transient ignition source.

2) The fire propagates to cable trays in the zone of influence. Cable trays are identified by plant drawing review and confirmed by field walkdowns. Where the ignition source (fixed or transient) zone of influence includes the transient zone boundaries, targets in the adjacent transient zone within the ignition source zone of influence are mapped to the ignition source.

3) Where the total heat release rate contribution from the postulated scenario will cause a hot gas layer capable of thermoplastic damage, a full compartment burnout is considered.

To account for propagation across transient zone boundaries:

1) As stated in item 2 above, where the ignition source is located on the transient zone boundary, targets within the zone of influence are included in the damage state. Since the zone of influence crosses the transient zone boundary, targets outside of the initial transient zone are included in the target set.

2) For all fire scenarios that damage cable trays, an additional damage state (i.e., a scenario progression in time) for horizontal propagation is considered. Horizontal propagation is only considered for a length of 1 hour (10.75' spread using a flame spread rate of 0.9 mm/s). Where this horizontal propagation extends to the next transient zone, the targets associated with this adjacent transient zone are included in the damage state.

3) To account for conduits in adjacent transient zones, a matrix is developed similar to a multi-compartment matrix denoting all adjacent transient zones. The conduits in the adjacent transient zones are then mapped to each transient zone fire. Consider the following example:

12-A-03	12-A-04	12-A-05
12-B-03	12-B-04	12-B-05

A sample of 6 transient rooms is shown. The opposite side of the wall to the north of 12-A-04 is outside. The transient zone under consideration is transient zone 12-A-04 in green. The adjacent transient zones are 12-A-05, 12-B-05, 12-B-04, 12-B-03, and 12-A-03. To account for conduits in the adjacent zones, the transient fire for 12-A-04 would include all of the conduits from the 5 adjacent transient zones. Where the results of this quantification indicate significant risk increase, field walkdowns are conducted for exact conduit location. The conduit is then failed in fire scenarios where the conduit is in the zone of influence for a transient fire. For example, if the conduit runs 20 ft above the floor and there are no intervening combustibles between the transient source and the conduit, the conduit can be screened from the transient fire scenario.

CDF, delta-CDF, LERF, and delta-LERF contribution for these scenarios will be provided in the response to PRA RAI 44. PRA RAI 44 includes the results given the combined effect of all of the changes.

PRA RAI 36

During the audit it was noted that the HEPs in cutsets were not truncated at a floor due to independence considerations. However, extremely low HEPs are difficult to justify and a floor is reasonable. NUREG-1792 notes that the total combined probabilities of all the human failure events in the same accident sequence/cutset should not be less than a justified value, and suggests an HEP floor of 1E-5. Therefore, perform a sensitivity study using this probability as a floor. Provide the LAR Table W-4 CDF, LERF, delta-CDF, and delta-LERF results.

Response:
The requested sensitivity study has been performed. The sensitivity study changed the value of any HEP (either single or joint) in the saved cutsets that was less than 1.0E-05 to a value of 1E-5. This was done only on the transition model cutsets and not on the compliant plant model cutsets. This is conservative, as any increases to the risk of the compliant plant would reduce the calculated delta risks, but are ignored in this method. The results of the analysis are shown in the attached table. The column labeled 'HRA Floor Increase' shows the absolute increase in the CDF/LERF, both by fire area and for the entire plant, if an HEP floor value of 1.0E-05 is used. The column labeled 'Percentage Change in Delta Risk' shows the absolute increase in the CDF/LERF as a percentage of the Delta CDF between the 'Transition' plant and the 'Compliant' plant, again by fire area and for the entire plant. This provides the largest percentage risk increase, and is therefore conservative. The table below lists as 'negligible' any fire area CDF/LERF increase, or Percentage Increase, where the percentage change is less than 0.01%.

The results of this sensitivity study show that the overall increase in CDF and LERF are minimal, on both a total plant and a fire area basis, if a 1.0E-05 floor is applied to HEP combinations. Similarly, the percentage increase in Delta CDF and Delta LERF are also minimal for the total plant and each fire area. Therefore, there is no significant impact on the fire risks by including an HEP floor of 1E-5.

This sensitivity result is expected as there are no single HEP values (including the common cognitive HEPs) in any cutset that have a value of less than 1E-5. Since common cognitive actions by their nature fail whole groups of single HEPs, this acts to ensure the equivalent of a HEP floor effect is modeled. Additionally, as the common cognition actions fail all the associated actions, only the dependency of the common cognitive actions need be examined. There are just two joint HEP combinations less than 1E-5 that involve only common cognitive HEPs (with values of 2.87E-6 and 7.29E-6). These are primarily used in the internal events analysis when control room HVAC is lost. These combinations do not appear in the fire cutsets. Thus it is only cases where the common cognitive actions are successful, such that multiple HEP combinations are required, and which have joint failure likelihoods for those combinations of less than 1E-5, where CDF/LERF will increase as a result of using a floor value of 1.0E-05.

	HRA Floor Increase		Percentage Change in Delta Risk	
Fire Area	**CDF**	**LERF**	**CDF**	**LERF**
ABBM	1.4E-09	Negligible	0.03%	Negligible
ABI	1.6E-08	2.1E-11	0.80%	0.22%
BOP	1.2E-08	2.1E-12	1.82%	0.08%
BR1A	5.4E-10	Negligible	0.11%	Negligible
BR1B	1.6E-10	Negligible	0.07%	Negligible
CC	Negligible	Negligible	Negligible	Negligible
CHG	7.8E-11	Negligible	1.22%	Negligible
CT	Negligible	Negligible	Negligible	Negligible
EDG1A	6.0E-12	2.0E-14	0.05%	0.03%
EDG1B	Negligible	Negligible	Negligible	Negligible
INTAKE	Negligible	Negligible	Negligible	Negligible
OFFSITE	Negligible	Negligible	Negligible	Negligible
PA	Negligible	Negligible	Negligible	Negligible
RC	2.4E-09	8.7E-15	5.88%	0.02%
SAF	1.8E-13	Negligible	0.02%	Negligible
SH	9.1E-09	Negligible	1.08%	Negligible
STA13ACH	Negligible	Negligible	Negligible	Negligible
YARD	Negligible	Negligible	Negligible	Negligible
Grand Totals	4.2E-08	2.3E-11	0.25%	0.01%

PRA RAI 38

Section 10 of NUREG/CR-6850 Supplement 1 states that a sensitivity analysis should be performed when using the fire ignition frequencies in the Supplement instead of the fire ignition frequencies provided in Table 6-1 of NUREG/CR-6850. If the frequencies from FAQ 08-0048 were used, was the required sensitivity analysis performed? If not, provide the sensitivity analysis of the impact on using the Supplement 1 frequencies instead of the Table 6-1 frequencies on CDF, LERF, delta-CDF, and delta-LERF for all of those bins that are characterized by an alpha that is less than or equal to one. Perform this sensitivity analysis using the baseline established by PRA RAI 45 for CDF, LERF, delta-CDF, delta-LERF. Provide the results, and if risk acceptance criteria are exceeded, consider fire protection, or related measures that can be taken to provide additional defense-in-depth.

Response:

The sensitivity analysis of the impact on using the Supplement 1 frequencies instead of the Table 6-1 frequencies on CDF and LERF was quantified in the original LAR supporting documentation (FPRA Sensitivity and Uncertainty Notebook) for the overall variant (i.e., baseline) plant CDF and LERF only. The PRA baseline model has been updated as a result of the RAI process, and a new baseline established per RAI 44. The ignition frequency sensitivity analysis has also been updated using this new baseline and includes both the sensitivity for the overall CDF and LERF as well as the sensitivity analysis for the delta-CDF and delta-LERF. The sensitivity analyses are included in the summary of the sensitivity results and are documented in PRA RAI 19 along with the other sensitivity analyses performed. Please refer to the response to PRA RAI 19.

PRA RAI 40

The peer review notes that the PRA assumes staggered testing for all components subject to CCF. However, main steam isolation valves (MSIVs) are apparently not tested on a staggered basis. Please confirm that you have addressed this observation for the MSIVs. If not, please discuss your plans, and whether or not this change is part of Implementation Item 9 in the LAR, Attachment S.

Response:

All of the equipment in the common cause groups used in the Fire PRA were reviewed to determine if they are tested on a staggered or non-staggered basis. This review identified several common groups that are not tested on a staggered basis. These items had their common cause factors increased by a factor of two in the model. This review included the MSIVs and the factor of two was applied to their common cause group. This approach is also used conservatively to account for cases where components are staggered but not by a full half-interval.

PRA RAI 41

The INTAKE structure was qualitative screened on low probability and assuming only cable self-ignition. If the INTAKE structure does not meet the qualitative screening criteria, it should be included in the Fire PRA since screening based on low probability alone is not one of the criteria. In addition, it appears that only self-ignited cable fires were postulated for the cables above water, while SR IGN-A9 requires the postulation of transient combustibles for physical analysis units, so that this may also need to be considered for the Fire PRA.

Response:
The INTAKE structure will no longer be screened and the full range of transient packages will be assumed possible. The updated results which are provided as part of PRA RAI 44 reflect the modeling of the INTAKE structure with these transient packages added.

PRA RAI 42

NUREG/CR-6850 describes a qualitative screening as the first screening step for multi-compartments. Please describe the screening approach used for the multi-compartment analysis, all the screening criteria used, and how the approach and criteria is consistent with NUREG/CR-6850. If there are differences, provide an explanation. The screening analysis used a fire scenario frequency of 1.0E-8, however, to ensure an adequate level of screening for multi-compartment analysis, use a screening frequency of 1.0E-9. Provide the results of re-evaluation for CDF, delta-CDF, LERF and delta-LERF.

Response:

The multi-compartment screening analysis follows the recommended screening criteria in task 11.5.4 of NUREG/CR-6850. The following screening criteria are applied for the Ginna fire PRA multi-compartment screening:

1) If the exposed or exposing compartment is qualitatively screened, then the multi-compartment combination is also screened from quantification. There are minimal combinations that screen based on this criteria. The entire combination is removed from the quantitative quantification process.
2) If there are no fire PRA targets in the exposed fire zone, the multi-compartment combination is screened. No targets (cables, raceways, conduits, or equipment credited in the fire PRA) in the exposed fire zone indicates that a fire propagating from the exposing to the exposed fire zoned does not impact targets already accounted for in the exposing fire zone.
3) If there are no new targets in the exposed fire zone, the multi-compartment combination is screened from quantification. No new targets identifies that the impacted basic events are identical or bounding by the exposing fire zone. Consequently, a fire propagating from the exposing to the exposed fire zone does not impact any new targets. The targets are already accounted for in the exposing fire zone alone.
4) Multi compartment combinations where the hot gas layer in the exposing fire zone does not reach damaging levels (i.e. approximately 200 °C) are expected not to propagate damaging temperatures to the exposed fire zone. These combinations are completely screened from the FPRA quantification process.

As noted in the RAI, multi-compartment combinations were previously screened using a quantitative screening criterion, a fire scenario frequency less than 1E-08. This screening criterion is no longer used in the multi-compartment screening analysis that will be documented in Fire Scenario Selection Notebook G1-FSS-F003; therefore, all multi-compartment scenarios that are not screened using the qualitative criteria are retained in the baseline model. The contribution of the multi-compartment scenarios will be included in the revised model provided in the response to PRA RAI 44. PRA RAI 44 includes transition plant CDF and LERF as well as delta CDF and LERF risk metrics.

PRA RAI 44

Section 2.4.3.3 of NFPA 805 states that the PRA approach, methods, and data shall be acceptable to the NRC. RG 1.205 identifies NUREG/CR-6850 as documenting a methodology for conducting a fire PRA and endorses, with exceptions and clarifications, NEI 04-02, revision 2, as providing methods acceptable to the staff for adopting a fire protection program consistent with NFPA-805. The Fire PRA model should reflect the post-transition modifications and the as-built plant, and incorporate acceptable methods. To address these considerations, make the following changes to the Fire PRA model to redefine the baseline of your Fire PRA using acceptable methods.

- changes from RAI 3 involving the planned reactor coolant pump seals;
- changes from RAI 26 a) involving current transformers;
- changes from RAI 29 involving sensitive electronics;
- changes from RAI 31 involving transient zone fire modeling;
- changes from RAI 37 involving the cutset HEP floor;
- changes from RAI 43 involving multicompartment analysis screening frequency.

Provide the LAR Table W-4 CDF, LERF, delta-CDF, and delta-LERF results.

Response:

The fire PRA model has been quantified to reflect our latest state of knowledge. This includes the changes due to the RAIs listed above, as well as other changes that were identified during the process (either internally or through other RAIs). Note that in the RAI, reference is made to RAI 31 as involving transient zone fire modeling, RAI 37 as involving the cutset HEP floor and RAI 43 as involving multicompartment analysis screening frequency. This is believed to be a typographical error since none of those RAIs refer to those issues. In each case, the correct RAI reference is numerically one less (i.e. RAI 30, 36 and 42). Issues related to the subjects requested in the PRA RAI 44 question are addressed in the chart below under the corrected RAI numbers. The chart below lists the changes and the overall effect on risk. An updated Table W-4 is also provided that reflects the current fire model.

Impact	Related RAI	Description	Impact on Delta Risk
RCP Shutdown Seals	PRA RAI 03	No Modeling Change. Removal of the seal credit causes unacceptable risk increases. The Westinghouse RCP seal model must be maintained or an equivalent alternative will be installed.	N/A
Transient Conduit Addition	PRA RAI 15 PRA RAI 30	Added conduits in adjacent transient zones. If the calculated risk increased significantly, then the conduits of concern were walked down to determine the actual location, such that the actual impact could be modeled.	Increase
HEMYC Modeling	PRA RAI 16	Reduced the HEMYC credit to 25 minutes beyond the development of a hot gas layer versus the 45 minutes originally credited in the LAR.	Negligible Increase

Impact	Related RAI	Description	Impact on Delta Risk
Suppression Impacts	PRA RAI 18	Added equipment failures due to automatic suppression system activation.	Increase
MCAs CCDPs and CLERPs	PRA RAI 22	Refined the multi-compartment analysis (MCA) to eliminate conservatisms related to compartments with a CCDP of 1.0	Minor Reduction
Current Transformers	PRA RAI 25 PRA RAI 26	No unreviewed analysis or methods are used. No credible current transformer (CT) evaluation method is available. There is no change to the current fire model due to CT evaluations.	N/A
Circuit Failure Likelihoods	PRA RAI 27	Increase the circuit failure likelihoods to the interim guidance levels: • 0.54 for intra-cable and, • 0.176 for inter-cable.	Increase
Sensitive Electronics	PRA RAI 28	Reviewed all electronics. Determined that there is no impact to the existing analysis. The sensitive electronics are only used for indication and lighting. These are only related to human error events which are already impacted by the hot gas layer.	N/A
Bus Ducts	PRA RAI 29	Adjusted the Bus Duct frequencies to per foot and expanded the amount of conduits and trays impacted	Minor Increase
HRA Floor	PRA RAI 36	No model change. Per the PRA RAI 36 response, the HRA Floor has no significant impact on the results.	N/A
CCF Non-staggered Testing	PRA RAI 40	The common cause factors (CCF) for all non-staggered tested components in common cause groups were increased to account for non-staggered testing. As expected, this caused a negligible change in risk to the fire model. As the main risk impact of fire scenarios is the failure of one of two trains of equipment, common cause failures do not play a significant role in fire risk.	Negligible Increase
Intake Structure	PRA RAI 41	Included the INTAKE structure as a transient zone. As the transient frequency is based on parsing the overall site transient frequency, this caused a negligible risk reduction as there is nothing risk significant in the INTAKE structure.	Negligible Reduction

Impact	Related RAI	Description	Impact on Delta Risk
MCA Frequency Screening	PRA RAI 42	Eliminated the multi-compartment analysis (MCA) screening criteria based on frequency. There are 1252 scenarios in the current fire model. 26 of these scenarios are new with frequencies less than 1E-8. As expected, the inclusion of these scenarios caused a negligible increase in risk.	Negligible Increase
Fire Modeling	FM RAI 01	The critical damage points for several PRA targets were updated based on the fire modeling update.	Minor Increase
VFDR Modeling	NA	VFDR modeling was updated to account for higher spurious actuation likelihoods for LOCA related issues, and shorter HEMYC protection times than were originally considered. Previously, modifications that significantly reduced the likelihood of spurious operation (i.e., double isolation) were used to credit a deterministic resolution. However, due to the increase in the spurious actuation likelihood, deterministic resolution is no longer credited. This change only impacted the delta risk calculations. It did not affect the risks associated with the transition plant. Only the compliant plant risk is impacted.	Increase
Cable Database Update	NA	Updated to the latest version of the cable database. This version included additional cables which had not previously been identified.	Increase
Target Set Walkdowns	NA	While performing the detailed walkdowns to address the conduit additions in the transient analysis, any conduits outside the Zone-of-Influence (ZOI) for existing scenarios were also screened.	Reduction

Impact	Related RAI	Description	Impact on Delta Risk
2nd Injection Pump	NA	In addition to the original injection pump credited in the LAR submittal, a second diesel powered portable injection pump that can be aligned within two hours of a LOCA will be available. This pump will have the same capacity as the original injection pump and use the same injection and suction paths as the original pump. The second pump will be used if the installed pump fails. The tie-in point for the second pump will be hose connections. This essentially reduces the consequence of a hardware failure for the installed injection pump by providing a back-up pump for the small-small LOCA scenarios.	Reduction
LOCA Modeling	NA	In the LAR submittal, the HRA timing for a 0" to 2" LOCA (i.e. small-small [0" to 1"] and small LOCA [1" to 2"]) was conservatively assumed to be based on the 2" LOCA case. This simplification eliminated two different cases in the internal events analysis, but led to conservative results in the fire evaluation. By separating the human action recoveries, this allows the crediting of the 2nd portable injection pump for the small-small LOCAs.	Reduction

Impact	Related RAI	Description	Impact on Delta Risk
Procedure Changes	NA	Credit additional procedure changes associated with the new equipment. The new procedures will credit both the installed injection pump credited in the original LAR submittal as well as the portable injection pump now credited in this RAI analysis. The scope of the procedure changes has increased as well. Both the injection pumps (one at a time) will be credited during SGTR scenarios as well as fire scenarios. This slightly increases the internal events off-set compared to the LAR internal event off-set. The emergency response organization procedures will also be updated to require starting these new injection pumps on a confirmed fire in power block that results in confirmed equipment damage. This reduces the failure likelihood of the associated alignment actions. The final procedure improvement not credited in the LAR will be that operations will implement the required operator actions when 1-of-2 of the new pressurizer indications indicate a low pressurizer pressure given there is a confirmed fire in the power block with confirmed equipment loss following entry into the emergency response procedures. The required operator actions include starting the new installed injection pump, starting and aligning the new portable pump (if the installed pump fails), and placing the new disconnect switches in the fire-protected position (i.e. DC power removed to the solenoid valves and shorted). Although the updated spurious actuation duration likelihoods are not yet available, the disconnect switches and the associated auto closure feature may not be required if these likelihoods are incorporated into the model. Currently, all DC spurious actuation durations are considered infinite 100% of the time.	Reduction

Table W-4 Ginna Fire Area Risk Summary

Fire Area	Area Description	NFPA 805 Basis	Fire Area CDF/LERF	VFDR (Yes/No)	RAs	Fire Risk Eval Δ CDF/LERF	Additional Risk of RAs (Note 2)
ABBM	Auxiliary Building Basement/Mezzanine	4.2.4.2	5.35E-06 1.20E-07	Yes	Yes	4.80E-06 1.14E-07	1.11E-06 1.96E-08
ABI	Auxiliary Building Operating Floor and Intermediate Building	4.2.4.2	2.79E-06 1.47E-08	Yes	Yes	2.03E-06 9.37E-09	3.25E-07 2.44E-09
BOP	Balance of Plant (Bldgs CD, TSC, H2, Srv, TB, TO)	4.2.4.2	3.31E-06 2.37E-08	Yes	Yes	6.44E-07 2.79E-09	6.10E-07 2.75E-09
BR1A	Battery Room 1A, Elevation 253' 6"	4.2.4.2	1.01E-06 7.98E-09	Yes	Yes	4.99E-07 6.32E-09	4.76E-07 6.23E-09
BR1B	Battery Room 1B, Elevation 253' 6"	4.2.4.2	7.59E-07 6.14E-09	Yes	Yes	2.22E-07 2.51E-09	2.17E-07 2.48E-09
CC	Control Building Complex	4.2.4.2	1.16E-05 1.96E-07	Yes	Yes	6.50E-06 1.46E-07	5.74E-06 1.05E-07
CHG	Charging Pump Room, Elevation 235' 6"	4.2.4.2	6.62E-09 1.32E-10	Yes	No	6.38E-09 1.30E-10	N/A
CT	Cable Tunnel, Elevation 260' 6"	4.2.4.2	2.03E-06 1.03E-07	Yes	Yes	2.71E-07 4.36E-08	1.65E-07 1.50E-08
EDG1A	Diesel Generator Unit 1A (Including EDG Vault 1A), Elevation 253' 6"	4.2.4.2	2.50E-08 8.21E-11	Yes	Yes	1.14E-08 7.47E-11	1.14E-08 7.47E-11
EDG1B	Diesel Generator Unit 1B (Including EDG Vault 1B), Elevation 253' 6"	4.2.4.2	1.17E-06 3.66E-09	Yes	Yes	6.12E-07 1.23E-09	6.12E-07 1.23E-09
INTAKE	228', Intake Structure and Intake Tunnel	4.2.4.2	2.50E-09 1.03E-11	No	No	N/A	N/A

Table W-4 Ginna Fire Area Risk Summary

Fire Area	Area Description	NFPA 805 Basis	Fire Area CDF/LERF	VFDR (Yes/No)	RAs	Fire Risk Eval Δ CDF/LERF	Additional Risk of RAs (Note 2)
OFFSITE	Controlled Area South of Lake Road	N/A	1.76E-08 5.35E-11	No	No	N/A	N/A
PA	Protected Area	4.2.4.2	4.66E-09 1.13E-11	Yes	Yes	2.89E-09 6.64E-12	6.09E-10 3.89E-12
RC	Reactor Containment Building	4.2.4.2	4.35E-07 4.36E-10	Yes	Yes	4.13E-08 3.60E-11	3.42E-08 2.58E-11
SAF	Standby Auxiliary Feedwater Pump Building, Elevation 271' 0"	4.2.4.2	1.12E-09 2.29E-12	Yes	No	9.47E-10 1.33E-12	N/A
SH	Screen House Building	4.2.4.2	1.05E-06 4.87E-09	Yes	Yes	8.42E-07 4.26E-09	8.40E-07 4.25E-09
STA13ACH	Station 13A Control House	N/A	1.38E-08 4.22E-11	No	No	N/A	N/A
YARD	Transformer Yard General Area	4.2.4.2	1.38E-08 4.40E-11	Yes	Yes	4.17E-09 2.66E-11	4.17E-09 2.66E-11
Internal Events See Note 1.	(incl. Internal Floods)		1.59E-05 2.04E-06	N/A	N/A	-7.15E-06 -2.68E-07	N/A
	Total		4.55E-05 2.52E-06			9.34E-06 6.29E-08	1.01E-05 1.60E-07

Notes:

1.) The Internal Events risk numbers shown here cover random failures and internal floods; fires are not included because their risk numbers are given separately for each fire area. For internal events, the total CDF and LERF of the post-transition plant are shown under the heading "Fire Area CDF/LERF". The difference in risk between the post-transition plant and the pre-transition plant (i.e., the as-built as-operated plant) are shown under the heading "Fire Risk Eval ΔCDF/LERF".

2.) The additional risk of recovery actions is conservatively assumed to be any action credited in the cutsets.