50-247 CEC INDIAN POINT 2

RESPONSE TO NRC SEPT 22, 1997 RE IPEEE

REC'D W/LTR DTD 02/24/98....9802100152

# RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION, INDIVIDUAL PLANT EXAMINATION OF EXTERNAL EVENTS (IPEEE) SUBMITTAL

# INDIAN POINT NUCLEAR GENERATING STATION, UNIT NO. 2

# (TAC NO. M83631)

## Seismic Analysis

### Question 1:

**Throughout the submittal, the seismic Core Damage Frequency (CDF) is reported as 1.46x10-5/ry before a Component Cooling Water (CCW) surge tank support fix. This value is also reported in the "TOTAL CDF" entry in Table 3.1-8. However, if the individual CDF contributions from the seismic damage stated in that table are summed, the total CDF is found to be much higher (1.5x10-4/ry). Indeed, the CDF contribution from OP-IC alone is reported in the table to be 6.2x10-5/ry. Please explain the cause of these discrepancies, and either provide a corrected Table 3.1-8 or provide appropriate revisions to the remainder of the report to address the results of Table 3.1-8 if that table is correct in the submittal.**

### Response to Question 1:

The Core Damage Frequency (CDF) and Seismic Damage State (SDS) Frequency values provided in Table 3.1-8 for individual seismic plant damage states were incorrectly entered during preparation of the IPEEE due a formatting inconsistency in the treatment of scientific notation. A revised Table 3.1-8 is attached and reflects the actual results of the analysis. As noted in your question, the total Core Damage Frequency value provided in the existing table had already been corrected and is consistent with the remainder of the analysis documentation. We are also providing a corrected Table 3.1-6. The values in the existing Table 3.1-6 were inadvertently drawn from earlier stages of the analysis. The revised table reflects the final analysis and is consistent with the revised Table 3.1-8.

Table 3.1.6
SEISMIC DAMAGE STATE RESULTS

| SDS | SEISMIC FAILURES | FREQUENCY | | | | STATUS | TRANSFER TO |
|---|---|---|---|---|---|---|---|
| | | MEAN | 5 % | MEDIAN | 95% | | |
| 1 | S | 1.6E-3 | 1.4E-3 | 1.6E-3 | 1.7E-3 | OK | NA |
| 2 | R | 1.6E-6 | 5.8E-11 | 1.6E-7 | 8.0E-6 | OK | GEN TRANSIENT |
| 3 | R-CF | 1.6E-8 | 6.3E-16 | 1.1E-10 | 6.3E-8 | OK | GEN TRANSIENT |
| 4 | S2 | 2.7E-8 | 3.1E-18 | 5.4E-12 | 5.5E-8 | OK | SLOCA |
| 5 | S2-R | 9.2E-9 | 4.0E-18 | 1.8E-9 | 2.0E-7 | CD | SLOCA |
| 6 | CW | 9.1E-7 | 2.3E-10 | 8.3E-8 | 4.1E-6 | CD | Seal LOCA |
| 7 | CW-FC | 1.3E-8 | 3.0E-15 | 4.6E-11 | 4.6E-8 | CD | NA |
| 8 | CT | 8.2E-8 | 3.4E-16 | 1.4E-10 | 2.4E-7 | OK | GEN TRANSIENT |
| 9 | CT-R | 3.5E-8 | 2.3E-17 | 3.8E-11 | 1.2E-7 | CD | GEN TRANSIENT |
| 10 | CT-S2 | 8.4E-10 | 1.3E-21 | 1.6E-14 | 7.8E-10 | OK | SLOCA |
| 11 | CT-S2-R | 1.3E-9 | 6.5E-22 | 2.5E-14 | 1.2E-9 | CD | SLOCA |
| 12 | CT-CW | 1.9E-8 | 1.4E-17 | 1.8E-11 | 6.5E-8 | CD | Seal LOCA |
| 13 | SW | 1.2E-7 | 2.8E-14 | 1.0E-9 | 5.0E-7 | CD | Loss of SW |

Table 3.1.6
SEISMIC DAMAGE STATE RESULTS

| SDS | SEISMIC FAILURES | FREQUENCY | | | | STATUS | TRANSFER TO |
|---|---|---|---|---|---|---|---|
| | | MEAN | 5 % | MEDIAN | 95% | | |
| 14 | RV | 5.6E-8 | 4.0E-16 | 2.2E-11 | 1.5E-7 | OK | ATWS |
| 15 | RV-R | 2.3E-8 | 5.6E-18 | 1.0E-11 | 5.8E-8 | CD | ATWS |
| 16 | RV-CW | 2.0E-8 | 2.6E-18 | 7.1E-12 | 4.0E-8 | CD | ATWS |
| 17 | RV-CT | 6.3E-9 | 2.0E-19 | 4.6E-13 | 1.3E-8 | CD | ATWS |
| 18 | RV-SW | 7.1E-9 | 1.6E-19 | 1.4E-12 | 2.0E-7 | CD | ATWS |
| 19 | OP | 8.0E-5 | 5.5E-7 | 4.3E-5 | 2.7E-4 | OK | LOP |
| 20 | OP-FC | 1.6E-7 | 5.2E-10 | 3.7E-8 | 7.2E-7 | OK | LOP |
| 21 | OP-R | 4.3E-6 | 9.0E-78 | 2.5E-6 | 1.4E-5 | OK | LOP |
| 22 | OP-R-FC | 1.3E-7 | 9.0E-10 | 4.3E-8 | 5.8E-7 | OK | LOP |
| 23 | OP-S2 | 9.2E-8 | 4.3E-13 | 1.7E-9 | 3.8E-7 | OK | SLOCA-LOP |
| 24 | OP-S2-R | 7.0E-8 | 1.6E-12 | 3.6E-9 | 3.2E-7 | CD | SLOCA-LOP |
| 25 | OP-CW | 2.7E-6 | 7.3E-08 | 1.2E-6 | 1.0E-5 | CD | Seal LOCA-LOP |
| 26 | OP-CW-FC | 1.3E-7 | 1.3E-9 | 4.7E-8 | 5.2E-7 | CD | Seal LOCA-LOP |

Table 3.1.6
SEISMIC DAMAGE STATE RESULTS

| SDS | SEISMIC FAILURES | FREQUENCY | | | | STATUS | TRANSFER TO |
|---|---|---|---|---|---|---|---|
| | | MEAN | 5 % | MEDIAN | 95% | | |
| 27 | OP-CT | 2.6E-7 | 2.3E-11 | 2.4E-8 | 1.3E-6 | OK | LOP-Feed & Bleed |
| 28 | OP-CT-FC | 1.1E-8 | 8.4E-13 | 7.7E-10 | 5.3E-8 | OK | LOP-Feed & Bleed |
| 29 | OP-CT-R | 2.1E-7 | 6.8E-11 | 3.3E-8 | 9.8E-7 | CD | LOP |
| 30 | OP-CT-R-FC | 2.3E-8 | 7.0E-11 | 2.7E-9 | 1.1E-7 | CD | NA |
| 31 | OP-CT-S2 | 6.3E-9 | 1.6E-14 | 5.0E-11 | 2.3E-8 | OK | SLOCA-LOP |
| 32 | OP-CT-S2-R | 1.0E-8 | 1.2E-13 | 2.5E-10 | 4.9E-8 | CD | SLOCA-LOP |
| 33 | OP-CT-CW | 1.8E-7 | 1.3E-10 | 3.6E-8 | 8.3E-7 | CD | Seal LOCA-LOP |
| 34 | OP-CT-CW-FC | 2.9E-8 | 2.0E-10 | 5.2E-9 | 1.4E-7 | CD | NA |
| 35 | OP-SW | 9.6E-7 | 1.5E-8 | 3.9E-7 | 3.6E-6 | CD | NA-SBO |
| 36 | OP-EP | 1.1E-6 | 1.1E-8 | 4.30E-7 | 4.5E-6 | CD | NA-SBO |
| 37 | OP-IC | 6.2E-6 | 2.2E-6 | 5.5E-6 | 1.2E-5 | CD | NA |
| 38 | OP-RV | 2.2E-7 | 1.4E-11 | 1.2E-8 | 1.1E-6 | OK | ATWS-LOP |
| 39 | OP-RV-FC | 1.1E-8 | 9.3E-13 | 6.0E-9 | 4.6E-8 | OK | ATWS-LOP |

Table 3.1.6
SEISMIC DAMAGE STATE RESULTS

| SDS | SEISMIC FAILURES | FREQUENCY | | | | STATUS | TRANSFER TO |
|---|---|---|---|---|---|---|---|
| | | MEAN | 5 % | MEDIAN | 95% | | |
| 40 | OP-RV-R | 1.8E-7 | 5.9E-11 | 2.3E-8 | 9.4E-7 | CD | ATWS-LOP |
| 41 | OP-RV-R-FC | 2.0E-8 | 6.1E-12 | 2.3E-9 | 9.4E-8 | CD | NA |
| 42 | OP-RV-CW | 1.7E-7 | 1.3E-10 | 2.8E-8 | 7.7E-7 | CD | ATWS-LOP |
| 43 | OP-RV-CW-FC | 3.1E-8 | 2.4E-11 | 5.0E-9 | 1.4E-7 | CD | NA |
| 44 | OP-RV-CT | 1.0E-7 | 1.8E-11 | 9.6E-9 | 4.9E-7 | CD | ATWS-LOP |
| 45 | OP-RV-SW | 1.6E-7 | 2.8E-10 | 4.0E-8 | 7.0E-6 | CD | NA |
| 46 | OP-RV-EP | 2.0E-7 | 3.9E-10 | 5.2E-8 | 9.2E-7 | CD | NA |
| 47 | OP-RV-IC | 3.6E-7 | 1.4E-9 | 1.6E-7 | 1.4E-6 | CD | NA |

## Table 3.1-8
## SEISMIC QUANTIFICATION RESULTS

| SDS | SEISMIC FAILURES | SDS FREQUENCY (PER YEAR) | CORE DAMAGE FREQUENCY (PER YEAR) |
|---|---|---|---|
| 1 | S | 1.6E-03 | negl |
| 2 | R | 1.6E-06 | 7.8E-10 |
| 3 | R-FC | 1.6E-08 | 1.6E-08 |
| 4 | S2-(FC) | 2.7E-08 | 1.0E-10 |
| 5 | S2-R-(FC) | 9.2E-09 | 9.2E-9 |
| 6 | CW | 9.1E-07 | 9.1E-7 |
| 7 | CW-FC | 1.3E-08 | 1.3E-08 |
| 8 | CT | 8.2E-08 | 6.9E-09 |
| 9 | CT-R-(FC) | 3.5E-08 | 3.5E-08 |
| 10 | CT-S2 | 8.4E-10 | negl |
| 11 | CT-S2-R | 1.3E-09 | negl |
| 12 | CT-CW-(FC) | 1.9E-08 | 1.9E-08 |
| 13 | SW | 1.2E-07 | negl |
| 14 | RV-(FC) | 5.6E-08 | 5.0E-08 |
| 15 | RV-R-(FC) | 2.3E-08 | 2.3E-08 |
| 16 | RV-CW-(FC) | 2.0E-08 | 2.0E-08 |
| 17 | RV-CT-(FC) | 6.3E-09 | negl |
| 18 | RV-SW | 7.1E-09 | negl |
| 19 | OP | 8.0E-05 | 4.6E-07 |
| 20 | OP-FC | 1.6E-07 | 1.3E-10 |
| 21 | OP-R | 4.3E-06 | 1.4E-08 |
| 22 | OP-R-FC | 1.3E-07 | 1.1E-10 |
| 23 | OP-S2-(FC) | 9.2E-08 | 1.5E-09 |
| 24 | OP-S2-R-(FC) | 7.0E-08 | 6.9E-08 |
| | | | |

(FC): fan cooler failure is conservatively assumed for these low frequency sequences

## Table 3.1-8
## SEISMIC QUANTIFICATION RESULTS
## (continued)

| SDS | SEISMIC FAILURES | SDS FREQUENCY (PER YEAR) | CORE DAMAGE FREQUENCY (PER YEAR) |
|---|---|---|---|
| 25 | OP-CW | 2.7E-06 | 2.7E-06 |
| 26 | OP-CW-FC | 1.3E-07 | 1.3E-07 |
| 27 | OP-CT | 2.6E-07 | 6.4E-08 |
| 28 | OP-CT-FC | 1.1E-08 | 2.2E-09 |
| 29 | OP-CT-R | 2.1E-07 | 2.1E-07 |
| 30 | OP-CT-R-FC | 2.3E-08 | 2.2E-08 |
| 31 | OP-CT-S2-(FC) | 6.3E-09 | negl |
| 32 | OP-CT-S2-R-(FC) | 1.0E-08 | 9.5E-09 |
| 33 | OP-CT-CW | 1.8E-07 | 1.8E-07 |
| 34 | OP-CT-CW-FC | 2.9E-08 | 2.9E-08 |
| 35 | OP-SW | 9.6E-07 | 9.6E-07 |
| 36 | OP-EP | 1.1E-06 | 1.1E-06 |
| 37 | OP-IC | 6.2E-06 | 6.2E-06 |
| 38 | OP-RV | 2.2E-07 | 2.0E-07 |
| 39 | OP-RV-FC | 1.1E-08 | 9.2E-09 |
| 40 | OP-RV-R | 1.8E-07 | 1.8E-07 |
| 41 | OP-RV-R-FC | 2.0E-08 | 1.9E-08 |
| 42 | OP-RV-CW | 1.7E-07 | 1.7E-07 |
| 43 | OP-RV-CW-FC | 3.1E-08 | 2.4E-08 |
| 44 | OP-RV-CT-(FC) | 1.0E-07 | 9.8E-08 |
| 45 | OP-RV-SW | 1.6E-07 | 1.6E-07 |
| 46 | OP-RV-EP | 2.0E-07 | 2.0E-07 |
| 47 | OP-RV-IC | 3.6E-07 | 3.6E-07 |
| | | TOTAL CDF | 1.46E-05 |

(FC): fan cooler failure is conservatively assumed for these low frequency sequences

## Fire Analysis

**Question 1:**

**The modeling of the potential for smoke induced abandonment of the control room is based on a misinterpretation of control room fire testing experience as presented in NSAC/181. Do all Indian Point control room cabinets contain smoke detectors? If not, please provide an analysis of the effect on fire induced CDF if a more typical past fire probabilistic risk assessment control room abandonment probability of 0.1 is employed.**

**Response**

The specific data and quantification models adopted from NSAC 181, "Fire PRA Requantification Studies," are presented or referenced in Section A1.4.3 of our IPEEE submittal. This approach is considered technically acceptable for meeting the IPEEE analysis requirements; it is essentially the same methodology presented in the report EPRI "Fire PRA Implementation Guide", EPRI TR 3385, which is also referenced in our submittal. For the example cited in the NRC's request, the failure probability for manual suppression of Control Room fires prior to the need for evacuation (3.4E-03 per demand) is reasonable for cabinets which have no internal fire detectors, given the size of the Indian Point Unit 2 control room and the fact that it is a continuously manned area. This same value was also used, conservatively, for cabinets which are protected by in-cabinet fire detection. Additional information supporting these positions is presented below:

The likelihood that operators will be required to evacuate the control room is a function of the amount of time available following detection, to suppress the fire before smoke reduces the visibility at the main control boards. To determine how much time might be available, the Sandia National Laboratory cabinet fire test data (NUREG/CR 4587) on smoke production was reviewed. This is the only such data known to be currently available which provides any insights into cabinet fire growth rates and the impact on control room environments.

Three electrically initiated cabinet fire tests were performed; One of the tests (PCT5 ) utilized a smaller enclosure (11016 $ft^3$) with a ventilation rate of 14 room changes per hour. The other two tests (24 and 25) used larger enclosures (48000$ft^3$) with ventilation rates of 1 and 8 room changes per hour (800cfm and 6400 cfm, respectively). In the smaller enclosure, the control board was obscured within about 13.5 minutes after smoke was first seen leaving the cabinet. In the larger enclosure, the board was obscured within approximately 15.5 minutes with the lower ventilation rate and within 19.5 minutes with the higher ventilation rate. (The timings were based on visual observations.) Test 25 was performed with an in-cabinet smoke detector in place. The detector gave an alarm about 30 seconds after smoke was visually observed coming from the cabinet.

The Sandia cabinets fire tests clearly indicate that the size of the control room, as well as the ventilation rates, play a significant role in determining the rate at which smoke will buildup and begin to impact the ability of the operators to function in the control room.

The total volume of the Indian Point Unit 2 central control room is 102,400 $ft^3$ which is greater than twice the volume of the larger of the two test enclosures. Even discounting the space taken up by the central alarm station, kitchen and bathroom areas as well as the space above the suspended ceiling, the total free volume in the control room is about 78000 $ft^3$, or about 60% greater than the larger of the Sandia test enclosures and the design fresh air make up rate is 920 cfm. Approximately 50% of the control room cabinets, by floor area, are fitted with fire detectors.

The free volume of the Indian Point Unit 2 control room significantly exceeds that of the Sandia Test 24, while the fresh air make up rate is about the same as was available during that test. Based on a comparison to the Sandia result, it would be reasonable to expect that the Indian Point Unit 2 control room would take several minutes longer to obscure the control board (from the time at which smoke would first leave the cabinet) than the 15.5 minute period documented in the Sandia test.

Fires in those cabinets which are not fitted with fire detectors may not be detected at the exact time that the smoke first leaves the cabinet, and the time available for suppression could, therefore, be less. However, given that the control room is continuously manned, it is unlikely that detection, by visual observation or smell, would be extended by longer than a few minutes. It is also quite probable that spurious signals on the control board would alert operators to the fire even in advance of direct observation. Thus, even for those fires originating in cabinets without detectors, we believe 15 minutes is a very reasonable estimate of the time between detecting the fire and evacuating the control room, given the physical characteristics of the Indian Point Unit 2 control room.

The Indian Point Unit 2 control room fire analysis assigned a 15 minute period between fire detection and control room evacuation for all cabinet fires. Based on the above discussion, it is reasonable to expect that there would be several minutes longer for fires which start in those cabinets which are fitted with smoke detectors. The use of the same 15 minute time available in the Indian Point Unit 2 analysis for those fires originating in cabinets with fire detectors therefore represents additional conservatism.

Based on the above discussion, we therefore believe that the probability of CCR evacuation due to fire assigned in the Indian Point Unit 2 IPEEE to be reasonable and appropriate. Nonetheless, given your request to assess the impact of using a CCR evacuation probability of 0.1 where in-cabinet smoke detectors are not present, we have performed such an assessment.

The core damage frequency due to fires which result in control room evacuation is determined from the product of three factors, namely; the control room cabinet fire frequency (FC), the probability of control room evacuation given a fire occurs (PEVAC), and the conditional core damage frequency (CCDF) given the control room is evacuated. As discussed above, the Indian Point Unit 2 analysis did not specifically credit cabinet detectors in determining the time available prior to control room evacuation. Your request for information is directed toward evaluating this impact however and, therefore for this assessment, the PEVAC term is dependent upon the whether or not in-cabinet fire detectors are present in the cabinet where the fire originates. The CCDF is dependent upon whether the fire is located in a cabinet which results in the potential for a spurious Pressurizer Power Operated Relief Valve (PORV) opening. For those scenarios where the fire does result in such spurious opening, the operators would be required to isolate the loss of primary coolant by attempting to close the associated block valve. Establishing secondary side heat removal and RCS seal injection or seal cooling is required in either case. The core damage frequency calculation therefore addresses four possible types of cabinet fire, as shown in the equation below:

$$CDF_{evac} = (FC_{ndnp} * PEVAC_{nd} * CCDF_{np}) + (FC_{ndp} * PEVAC_{nd} * CCDF_{p}) + (FC_{dnp} * PEVAC_{d} * CCDF_{np}) + (FC_{dp} * PEVAC_{d} * CCDF_{p}) \quad .......(1)$$

where:

$CDF_{evac}$ ≡ Core damage frequency associated with CCR evacuation scenarios, using a 0.1 evacuation frequency for fires in cabinets without detectors

$FC_{ndnp}$ ≡ Frequency of fires in cabinets without in-cabinet fire detectors which do not challenge spurious PORV opening (4.45E-03)

$FC_{ndp}$ ≡ Frequency of fires in cabinets without in-cabinet fire detectors which do challenge spurious PORV opening (1.84E-04)

$FC_{dnp}$ ≡ Frequency of fires in the supervisory panel (which has in-cabinet detectors) which do not challenge spurious PORV opening (3.14E-03)

$FC_{dp}$ ≡ Frequency of fires in the flight panel (which has in-cabinet detectors) which do challenge spurious PORV opening (1.63E-03)

$PEVAC_{nd}$ ≡ Probability of control room evacuation given a fire occurs in a cabinet without a fire detector (0.1)

$PEVAC_{d}$ ≡ Probability of control room evacuation given fire occurs in a cabinet with a fire detector (3.4E-03)

$CCDF_{np}$ ≡ Probability of failing to achieve safe shutdown from outside the control room due to fires which do not challenge a spurious PORV opening (scenario A3-17A) (4.69E-02)

$CCDF_{p}$ ≡ Probability of failing to achieve safe shutdown from outside the control room due to fires which do challenge a spurious PORV opening (scenario A3-17B) (6.1E-02)

Substituting into equation (1) above:

$$CDF_{evac} = (4.45E\text{-}03 \times 0.1 \times 4.69E\text{-}02) + (1.84E\text{-}04 \times 0.1 \times 6.1E\text{-}02) +$$

$$(3.20E\text{-}03 \times 3.4E\text{-}03 \times 4.69E\text{-}02) + (1.6E\text{-}03 \times 3.4E\text{-}03 \times 6.1E\text{-}02)$$

$$= 2.29E\text{-}05/yr$$

Please note again that this sensitivity study has been provided in order to be responsive to your request for information. We continue to believe that the value of 0.1 cited in your question is unduly pessimistic and does not provide a true representation of the plant risk due to such scenarios. It should be noted that none of the fires which have occurred in control rooms in U.S. plants to date have required evacuation.

**Fire Analysis**

**Question 2:**

**Fire propagation was assumed "not possible" if cabinets are not ventilated and all cable entries are via continuous conduit. Fire data indicates that 440V motor control centers and switchgear and high voltage 4.1kV switchgear have experienced fires which have not been contained interior to the cabinet. Please provide analysis of fire induced CDF if the fires in 440V and above switchgear are assumed to be capable of propagating exterior to the cabinet where the fire originates.**

**Response**

The analysis performed for Indian Point Unit 2 followed the draft EPRI Fire PRA Implementation Guide, Appendix I (January 1994), which does not distinguish between high energy and other types of electrical cabinet fires. This guidance permitted the exclusion of fire propagation from all cabinets that complied with the specific criteria on the grounds cited in the NRC's question (i.e. no ventilation and cable entry via continuous conduit).

This guidance was used to screen out fire propagation from the following 480V AC Motor Control Centers (MCCs) located in the Cable Spreading Room, as indicated in Table A1-1 of the IPEEE submittal:

MCC 26
MCC 29
MCC 29A

Fire propagation from the remaining 480V AC switchgear located in the Cable Spreading Room (Rod Control Switchgear) as well as that located in the 480V Switchgear Room (Buses 5A, 6A, 2A and 3A) was explicitly modeled, since these cabinets are ventilated and have exposed cable entries. All other plant 480V Motor Control Centers and switchgear are located in plant areas which were screened out separately using guidance provided in the FIVE methodology.

The final version of the EPRI guidance, EPRI TR-105928 (Appendix E), published in December 1995, does, however, makes specific reference to special considerations for high energy electrical cabinets. The guide indicates that an electrical fault in switchgear or MCC may produce an energetic fire which could breach the integrity of the cabinet allowing external fire propagation. Based on a review of Appendix D, Table D.3-2 of the guide, it is apparent that one of the 17 fires (INO #434) may have been energetic enough to have breached a cabinet and resulted in fire damage outside the cabinet.

The impact on core damage frequency of assuming that a fire originating in MCC26C, MCC29 or MCC29A can propagate to the exterior of the cabinets, can be conservatively bounded as follows:

$$CDF_i = FMCC_i * P_{RP} * P_{NS} * CCDP \qquad \text{......... (2)}$$

where:

| | | |
|---|---|---|
| $CDF_i$ | $\equiv$ | Core Damage Frequency associated fire originating in $MCC_i$ |
| $FMCC_i$ | $\equiv$ | Frequency of fire in $MCC_i$ |
| $P_{RP}$ | $\equiv$ | Probability of propagation |
| $P_{NS}$ | $\equiv$ | Probability of non suppression |
| CCDP | $\equiv$ | Conditional core damage probability given damage due to fire propagation |

*The frequency of fires in MCC 26C, MCC 29 and MCC 29A ($FMCC_i$)*

The cable spreading room cabinet fire frequency (3.2E-03 /yr) was distributed among the 480V AC cabinets in the Cable Spreading Room according to the relative size (floor area) of the respective cabinets. Using this approach, the total frequency of fires in all three MCCs (29, 29A and 26C) was determined to be 4.85E-04 /yr.

*The probability of fire propagation ($P_{RP}$)*

Based on the analysis of 480 V switchgear and MCC fires provided in the EPRI Fire PRA Implementation Guide (Table D.3-2), only one of the seventeen fires appears to have been energetic enough to have breached the integrity of a cabinet and have resulted in a self-sustaining fire. Thus the probability of fire propagation from a sealed cabinet is assigned as 1/17 or 5.88E-02.

*The probability of non suppression ($P_{NS}$)*

The probability of non-suppression is conservatively set equal to 1.0 for this bounding analysis.

*The Conditional Probability of Core Damage (CCDP)*

If we conservatively assume a total loss of all equipment and cable in the fire zone, and the only equipment remaining undamaged is that associated with the Alternate Safe Shutdown System, which is located outside the affected zone, the conditional core damage probability is 6.10E-2 (which represents shutdown from outside the control room with the potential for PORV spurious opening). This is scenario A3-17B in the IPEEE fire analysis). The assumption that a spurious PORV opening must be mitigated is additionally conservative since not all fire scenarios in this fire zone would challenge the PORVs.

*Core Damage Frequency (CDF)*

Substituting in equation (2), above, the total impact on CDF due to MCC fires in the Cable Spreading Room given this bounding analysis would be:

$$\Sigma CDF_i = 4.85E\text{-}04 \times 5.88E\text{-}02 \times 1.0 \times 6.1E\text{-}2$$

$$= 1.74E\text{-}06 \text{ /yr}$$

**Fire Analysis**

**Question 3:**

**It has been assumed that welding fires damaging fixed combustibles and cable junction box fires should not be considered credible. Please provide further justification for this assumption.**

**Response**

As stated in Section 4.3.2.2 of the IPEEE, junction box fires were excluded from all phases of the analysis, and cable fires due to welding activities were excluded from further consideration in the detailed analysis phase. Further justification of this is given below.

Welding fire damaging fixed combustibles

Welding-induced fire damage to fixed combustible material, other than cable, is not explicitly addressed in the FIVE or EPRI PSA methodology, which was the basis for the Indian Point Unit 2 IPEEE fire analysis. However, based on a walkdown of the plant areas, no significant amounts of exposed combustible material apart from cable, were identified. Moreover, open flame welding is prohibited by procedure in the critical Indian Point
Unit 2 fire zones as described below. The frequency of such fires compared with other fire sources is negligible as evidenced by the lack of such fires reported in the fire events data base.

Station Administrative Order (SAO) 702 governs the control of all ignition sources at Indian Point Unit 2, including welding and cutting. A fire watch is required during all work activities that involve an ignition source. Station Administrative Order 705 defines the requirements of a fire watch including:

> Assignment of a person to the fire watch duty and equipping them with an appropriate fire extinguisher;
>
> Coverage of all combustible material within a 35' radius of the open flame with a fire blanket;
>
> Extension of the fire watch for 30 minutes after the ignition source has been extinguished.

Furthermore, the use of open flames is prohibited in the Electrical Penetration Area, Cable Spreading Room, Electrical Tunnel, 480V Switchgear Room and Diesel Generator Building.

The controls stated above are stringent and, we believe, support the conclusion that the industry welding fire ignition source frequency may be overly conservative. Nevertheless, the generic frequency for fixed combustible fires induced by welding provided in the FIVE methodology (5.1E-3 per unit /yr) was used to determine the associated fire frequency contribution for individual fire zones at Indian Point Unit 2. The contribution from such fires, 6.4E-05 per year per zone, was found to be small compared with the total contribution from other fire sources which was generally greater than 1E-03 per year per zone. Furthermore, if such fires were to occur, there would be a very high likelihood of successful suppression due to the presence of a fire watch during and 30 minutes after the welding activity. This assumption is validated by the experience reported in the Fire Events Data Base (NSAC/178L, page 3-42).

As mentioned above, for those fire zones which did not screen out during the quantitative screening process, the only significant exposed fixed combustible material identified is cable insulation Since the properties of the cable insulation material used in open cable trays at Indian Point Unit 2 has been demonstrated as equivalent to IEEE 383 rated, a sustained cable fire in the absence of exposure to a significant heat source is not considered credible. A localized hot spot caused by rapidly cooling welding slag will not cause damage beyond the few cables that it comes into contact with.

Thus, although welding-related fires were included in the screening process, they were subsequently excluded as potentially significant risk contributors for the fire zones considered in the detailed analysis.

Cable Junction Boxes

The cable insulation installed in open cable trays at Indian Point Unit 2 has been shown to be IEEE 383 rated or equivalent. Thus fires induced by electrical faults in the absence of an external heat source (exposure fire) have been ruled out. This is consistent with the FIVE methodology. Although junction boxes may be possible sites for electrical faults in cable runs, the possibility of propagation in the absence of transient combustible materials is limited by the properties of the cable insulation. Only two occurrences of junction box fires in qualified cable are recorded in the Fire Events Data Base (NSAC 178L). Both were extinguished within 10 minutes without propagation occurring.

Thus fires which may occur due to electrical faults in junction boxes were excluded from the analysis. This approach is consistent with the approach adopted in NSAC 181.

**Fire Analysis**

**Question 4:**

**From the submittal, it is clear that consideration has been given to the possibility of interfacing system and power operated relief valve loss of coolant accidents. Hot shorts can also affect normal system operation by moving valves from their normal operating positions. The possibility is especially important when there are cross-ties between redundant trains of a system. Please provide a discussion regarding the inclusion of the possibility of valves moving from their safe position as a result of hot shorts.**

**Response**

The potential impact of all possible fire induced cable faults, including valve control cable hot shorts, was considered in the Indian Point Unit 2 analysis. The attached Table 4-1 addresses the various failure modes, associated probabilities and credited recovery actions assumed in the study.

**Table 4-1a**

**Potential Damage to Auxiliary Feedwater System Valves**

| Component | Fire Induced Failure Mechanism | IPEEE Fire Modeling Approach | Recovery Actions Modeled |
|---|---|---|---|
| Flow Control Valves | | | |
| FCV 405A,<br>FCV 405B<br>FCV 405C<br>FCV 405D<br>FCV 406A<br>FCV 406B<br>FCV 406C<br>FCV 406D | These FCVs are normally closed, air operated valves which fail to the safe position (open) on loss of DC power or instrument air. Therefore, the only failure mode which may result in loss of component function is a hot short in control cable/power cable which would prevent the valve from opening. | Conservatively assumed all fires which damage associated cables result in valves failing closed. | Operators re-align valves in accordance with Abnormal Operating Instruction A27.1.9. |
| Turbine Driven AFW Pump Steam Inlet Valve | | | |
| PCV-1139 | Identical to AFW Flow Control Valves discussed above. | Conservatively assumed all fires which damage associated cables result in valves failing closed. | Operators re-align valves in accordance with Abnormal Operating Instruction A27.1.9. |
| CW Supply to AFW Pump Suction | | | |
| PCV-1187<br>PCV-1188<br>PCV-1189 | These normally closed, air operated valves fail closed on loss of DC or instrument air. Therefore, open circuit and ground faults may result in loss of component function. | Assume all fires which damage associated cables result in valves failing closed, preventing use of the City Water backup. | None. Procedures do not direct local re-alignment. |

**Table 4-1a**
**(continued)**

**Potential Damage to Auxiliary Feedwater System Valves**

| Component | Fire Induced Failure Mechanism | IPEEE Fire Modeling Approach | Recovery Actions Modeled |
|---|---|---|---|
| Condenser Hotwell Feed | | | |
| LCV-1128<br>LCV-1158 | These are normally open, air operated valves. Upon loss of DC power or instrument air, LCV 1128 fails open and LCV 1158 fails safe (closed). Therefore, an open circuit or ground fault may result in loss of the LCV 1128 isolation function. A hot short may result in loss of the LCV 1158 isolation function | Conservatively assumed all fires which damage associated cables result in valves failing open. | Operators close manual valve CT-7 in accordance with Abnormal Operating Instruction A27.1.9 |

**Table 4-1b**

**Potential Fire Damage to Safety Injection System Valves**

| Component | Fire Induced Failure Mechanism | IPEEE Fire Modeling Approach | Recovery Actions Modeled |
|---|---|---|---|
| MOVs Outside Containment | | | |
| MOV 887A[1]<br>MOV 887B<br>MOV 851A<br>MOV 851B | These are normally open MOVs which are required to remain open. Therefore, the only failure mode which may result in loss of component is a hot short in the 120V-AC control cable | Assign a probability of 0.1 that a hot short will occur given fire damage to control cable.<br>The potential for phase to phase hot shorts in power cables was considered to be negligible. | None. (Short term action required - no procedural guidance provided). |

1. These are the only MOVs in the Safety Injection suction or discharge path which may be susceptible to spurious operation. MOVs 856A, C, D & E are de-energized in the open position. MOVs 856B and F are de-energized in the closed position. (Reference Indian Point 2 Fire Protection Evaluation Report, page 10-33)

| Table 4-1c<br>PORV Paths | | | |
|---|---|---|---|
| **Component** | **Fire Induced Failure Mechanism** | **IPEEE Fire Modeling Approach** | **Recovery Actions Modeled** |
| PCV 455C<br>PCV 456 | These normally closed, air operated valves are required to open on demand in order to establish primary bleed in the event of failure of secondary side heat removal.<br><br>The valves are required to remain closed when not required for primary bleed.<br><br>Upon loss of power or instrument air, the valves will close (or remain closed). A hot short in the DC power/ control circuit may cause the valves to open (or remain open). | Assume the valve fails to open on demand given fire damage.<br><br>Assign a probability of 0.1 that a hot short will occur given fire damage to the DC power/ control circuit. (valve spuriously opens, or remains open, when required to be closed). | None |
| MOV 535<br>MOV 536 | These valves may be normally open or closed. These MOVs are required to be open for the primary bleed function or to close in the event that a PORV spuriously opens.<br><br>Upon loss of power, the valve would fail as is. A hot short may cause the valve to move to an unwanted position or prevent moving to the required position. An open circuit or ground fault would cause the valve to fail as is. | Assign a probability of 0.1 that a hot short will occur given fire damage to the control cable.<br><br>The potential for phase to phase hot shorts in power cables was considered to be negligible. | For damage to control cables only, valves may be closed from Motor Control Centers 26A and 26B in accordance with A27.1.9. (This recovery action is only allowed when power is available to the MCC). |

**Table 4-1d**

**Potential Damage to Chemical Volume and Control (Charging) System Power Operated Valves (for RCP Seal Injection)**

| Component | Fire Induced Failure Mechanism | IPEEE Fire Modeling Approach | Recovery Actions Modeled |
|---|---|---|---|
| RCP Seal Injection Supplies | | | |
| MOV 4925<br>MOV 250A<br>MOV 4926<br>MOV 250B<br>MOV 4927<br>MOV 250C<br>MOV 4928<br>MOV 250D | These are normally open MOVs which are required to remain open. Therefore the only failure mode which may result in loss of seal injection is a hot short in the 120V-AC control cable. | Since any single valve closure will result in loss of RCP seal injection and cables are routed in close proximity, it was assumed that all fires which damage control cables result in loss of injection. | Operators re-align valves in accordance with Abnormal Operating Instruction A27.1.9 |
| Valve from Refueling Water Storage Tank Supply Line | | | |
| LCV-112B | This normally closed, air operated valve fails closed on loss of power or air. | Conservatively assumed all fires which damage control cable result in the valve failing closed. | Locally open manual bypass valve in accordance with Abnormal Operating Instruction A27.1.9 |

| Table 4-1e<br>Potential Damage to Component Cooling Water Valves | | | |
|---|---|---|---|
| **Component** | **Fire Induced Failure Mechanism** | **IPEEE Fire Modeling Approach** | **Recovery Actions Modeled** |
| CCW Supply Valves to RHR Heat Exchangers (Inside Containment) | | | |
| MOV 822A<br>MOV 822B | These are normally closed MOVs which are required to open, and fail as is on loss of power. A ground or open circuit fault may cause loss of function. | Fire damage to targets is assumed to result in loss of function. | For fires which result in loss of 120V-AC control circuit only, valves may be manually operated from the MCC. |
| Reactor Coolant Pump Thermal Barrier Supply | | | |
| MOV 769<br>MOV 797<br>MOV 789<br>FCV 625 | These are normally open MOVs which are required to remain open. Therefore the only failure mode which may result in loss of component function is a hot short in the 120V-AC control cable. | Since any single valve closure will result in loss of RCP seal cooling and cables are routed in close proximity, it was assumed that all fires which damage control cables result in loss of cooling water supply. | Operators re-align valves in accordance with Abnormal Operating Instruction A27.1.9 |

**Table 4-1f**

**Potential Damage to Reactor Head Vent Valves**

| Component | Fire Induced Failure Mechanism | IPEEE Fire Modeling Approach | Recovery Actions Modeled |
|---|---|---|---|
| Reactor Head Vent Valves | | | |
| MOV 3100<br>MOV 3101 | These are normally closed MOVs which are required to remain closed. The only failure mode which causes spurious operation is a hot short in the control circuits. | Assign a probability of 0.1 that a hot short would occur in each valve given fire damage to control cable.<br>The potential for phase to phase hot shorts in power cables was considered to be negligible. | For damage to control cables only, valves may be closed from Motor Control Centers 26A and 26B in accordance with Abnormal Operating Instruction A27.1.9. (This recovery action is only allowed when power is available to the MCC). |

Note: The current plant operating practice is to maintain the reactor head vent power supplies disconnected at their respective Motor Control Centers while the plant is operating. Thus, the Reactor head Vent valves no longer represent a potential hi-lo interface pathway due to fires.

**Table 4-1g**

**Potential Damage to Recirculation System Valves**

| Component | Fire Induced Failure Mechanism | IPEEE Fire Modeling Approach | Recovery Actions Modeled |
|---|---|---|---|
| Normally Closed MOVs Inside Containment(1) | | | |
| MOV 1802A<br>MOV 1802B<br>MOV 746<br>MOV 747 | These normally closed MOVs are required to open in order to establish recirculation flow.<br>An open circuit or ground fault in the 120 ac or 480 vac circuits will result in loss of function | For valves which are normally closed, fire damage to targets will cause loss of function. | For damage to control cables only, valves may be repositioned from Motor Control Centers 26A and 26B. (This recovery action is only allowed when power is available to the MCC). |
| Normally Open MOVs Inside Containment | | | |
| HCV 640<br>HCV 638<br>MOV 745A<br>MOV 745B | These are normally open MOVs which are required to establish recirculation flow. The MOVs fail as is upon loss of power. A hot short of the 120 vac control circuit would be required to cause loss of function. | Assign a probability of 0.1 that a hot short would occur given fire damage to control cable.<br>The potential for phase to phase hot shorts in power cable is considered to be negligible. | For damage to control cables only, valves may be repositioned from Motor Control Centers 26A and 26B. (This recovery action is only allowed when power is available to the MCC). |

1. These are the only valves in the recirculation path which are located inside the containment and are subject to fire damage. MOVs 856A,C, D & E are de-energized in the open position. MOVs 856B & F are de-energized closed (reference FPER, Page 10-33). MOVs outside containment may be operated manually given that several hours are available prior to the requirement to enter recirculation following a small LOCA.

| Table 4-1h<br>Potential Damage to Containment Spray System Valves | | | |
|---|---|---|---|
| **Component** | **Fire Induced Failure Mechanism** | **IPEEE Fire Modeling Approach** | **Recovery Actions Modeled** |
| Containment Spray Header Valves | | | |
| MOV 889A<br>MOV 889B | These are normally closed MOVs which are required to open.. A ground or open circuit fault may cause loss of function. | Damage to associated power and control cables results in loss of function. | For damage to control cables only, valves may be closed from MCC26A/26B given several hours are available prior to any requirement for initiating sprays. This recovery is only allowed when power is available to the MCCs. |

| Table 4.1-i<br>Containment Fan Cooler Unit Flow Control Valves | | | |
|---|---|---|---|
| **Component** | **Fire Induced Failure Mechanism** | **IPEEE Fire Modeling Approach** | **Recovery Actions Modeled** |
| Note: FCU dampers are air operated and fail to their accident mitigation position upon loss of power or air. Since FCUs are not required for several hours following a fire induced accident to avoid Containment overpressurization, it was assumed that operators will be able recover from any fire damage by de-energizing their associated circuits or isolating/venting air pressure from the valve actuators. | | | |

| Table 4.1-j<br>Potential Fire Damage to Service Water Power Operated Valves | | | |
|---|---|---|---|
| **Component** | **Fire Induced Failure Mechanism** | **IPEEE Fire Modeling Approach** | **Recovery Actions Modeled** |
| There are no power operated valves of concern in the service water system. The Containment Fan Cooler service water supply valves are located outside containment are not required for several hours following an accident. It is assumed that operators will be able recover from any fire damage to their associated circuits by manually operating the valves if necessary. The Emergency Diesel Generator service water flow control valves are normally aligned in their accident position and fail as is on loss of power. Spurious actuation is not a concern since their control circuits are located in the EDG building which was evaluated and screened out separately using the FIVE screening approach. | | | |

## Fire Analysis

**Question 5:**

**Since the potential for cross area fire and smoke spread was not considered, provide justification for its exclusion. Please provide an analysis of the effect on fire induced CDF if the potential for active barrier components such as doors and dampers, and consequential cross zone fire propagation is considered for high hazard areas such as the turbine building switchgear rooms and lube oil storage areas.**

**Response**

The methodology presented in NUREG 1407 was utilized in conducting the Indian Point Unit 2 IPEEE study. In particular, the EPRI "Fire Induced Vulnerability Examination (FIVE)" methodology, which was approved by the NRC for conducting IPEEE fire analyses, was implemented. In this methodology, fire areas and compartments may be treated independently without the need to explicitly address the implications of inter-area/ compartment propagation, providing the corresponding boundaries satisfy appropriate criteria. The Indian Point Unit 2 area and compartment boundaries satisfy such criteria.

The concern regarding the reliability of active barrier elements such as doors and dampers has been addressed by our submittal (i.e., Section 4.8.2) in the context of the Fire Risk Scoping Study (FRSS) evaluation, which was conducted according to the approach prescribed by the FIVE methodology. This evaluation concluded that fire barrier elements were being properly maintained and tested. Their effectiveness has therefore been demonstrated in accordance with the approved FIVE methodology.

The above justification notwithstanding, an inter-compartment fire propagation analysis has been performed consistent with the guidance provided in the EPRI Fire PRA Implementation Guide (December 1995). This analysis is provided in Attachment 1.

# Attachment 1
# Inter-Compartment Analysis

## 1.0 Introduction

The purpose of this analysis is to evaluate the risk from fire scenarios which propagate from one fire compartment to the next, including propagation across rated fire barriers. The scope of the analysis is inclusive, in that the analysis is performed for all fire compartments including those which were screened out during the qualitative and quantitative screening processes.

## 2.0 Method

The first step in the analysis was to identify the interfaces between the fire compartments. This has been completed and is shown in Table 1. Based on this review it is clear that several fire compartments are physically separated from all other compartments; namely the IP-1 Screenwell House (L), the Gas Turbine (M), the Intake Structure (I) and the Manhole area (M). As such, these compartments will not be addressed further in this study.

The second step is to fully describe and evaluate the compartment interfaces. Several of the compartments are quite large and are comprised of a number of fire zones. The compartment interfaces have therefore been described in terms of their associated fire zone boundary interfaces. An evaluation of the potential for fire propagation across these zone/compartment boundaries and the risk significance of such propagation has been performed under the following assumptions:

1. Only fire propagation to adjacent fire zones is considered credible unless there is the potential for hot gases or combustible liquids to communicate the fire beyond the adjacent zones.

2. If the potential fire damage resulting from fire propagation is limited to that which has already been postulated in the exposing fire zone, no further analysis is required.

3. In the event that both the exposed and the exposing zones both have low combustible loading (i.e. <20,000 BTU $ft^2$), fire propagation is not considered possible (based on the Fire Compartment Interaction Analysis screening criteria).

The frequency of fire propagation between fire zones (i.e. the frequency of a multi-compartment scenario ) can be represented by:

$$FMS_i = IF_e \times SF_e (A_{se} \times A_{sa}) \times B_{ea}$$

where:

$IF_e$ ≡ the Ignition Frequency in the exposing compartment

$SF_e$ ≡ a severity factor which accounts for that fraction of fires which were of minor significance (i.e. those fires which were self-extinguishing or easily extinguished using manual extinguishers)

$A_{se}$ ≡ Failure on demand of suppression (beyond use of manual extinguishers) in the exposing compartment

$A_{sa}$ ≡ Failure on demand of suppression in the adjacent (exposed) compartment

$B_{ea}$ ≡ Failure probability of the barrier between the exposing and adjacent (exposed) compartments

For all compartments (with the exception of the transformer yard), the factors $A_{se}$ and $A_{sa}$ were conservatively set to 1.0. The failure on demand of suppression in the transformer yard was derived from the EPRI Fire Events Database.

The resulting core damage frequency from multiple compartment scenarios ($CDF_{mcs}$) is:

$$CDF_{mcs} = FMS_i \times CCDP_{ea}$$

where:

$FMS_i$ ≡ The frequency of a multi-compartment scenario

$CCDP_{ea}$ ≡ Conditional Core Damage Probability of that multi-compartment scenario

The Fire PRA Implementation Guide recommends the use of fire barrier failure probabilities derived from NUREG/CR 4840 as follows:

| Barrier Type | Barrier Failure Probability /Demand |
|---|---|
| Type 1 Fire security and watertight doors | 7.4E-03 |
| Type 2 Fire and Ventilation Dampers | 2.7E-03 |
| Type 3 Penetration Seal | 1.2E-03 |

The scenario specific probability is obtained by determining the number of barriers of each type, multiplying by the corresponding probability and summing the contributions.

## 3.0 Results

The results are provided in Tables 2 through 14 each of which presents the risk associated with potential fire propagation for one (exposing) fire compartment. Each table lists all the fire zones associated with that particular compartment and identifies those adjacent (exposed) fire zones which are associated with a different fire compartment. Adjacency was derived from the Fire Compartment Interaction Analysis (FCIA) performed as part of the IPEEE. Each table also includes the fire barrier failure probabilities, the fire ignition frequencies and the severity factors.

In general, the fire ignition frequencies are identical to those derived in the Fire IPEEE, which were based on the FIVE methodology. In some cases, however, (e.g. for Compartment J) frequencies were not derived in that study as the compartments were screened out during the qualitative screening phase). In such cases, it was necessary to derive fire frequencies as part of this analysis. Average severity factors were determined as a function of the individual ignition source frequencies and severity factors as follows:

$$SF_e \equiv \sum_i (F_{si} \times SF_i) / \sum_i F_{si}$$

where:

$SF_e$ ≡ Weighted average exposing zone fire severity factor
$F_{si}$ ≡ Ignition frequency associated with ignition source "i"
$SF_i$ ≡ Severity factor associated with ignition source "i"

Severity factors are taken from the EPRI Fire PSA guide.

The conditional core damage probabilities ($CCDP_{ea}$) presented in the tables are based on the current fire sequence analysis where corresponding damage states were available. Where such damage states were not available, additional calculations were performed. Finally, the core damage frequencies presented for each propagation scenario ($CDF_{mcs}$) were derived as described above.

## Table 1

### Summary of Indian Point Unit 2 Inter-Compartment Interfaces

| | | A1 | A2 | A3 | A4 | B | C | D | E | F | G | H | I | J | K | L | M | N | P | Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | PAB Pipe Tunnel, Cont Spray etc | | | | | | | | | | | | | | | | | | | |
| A2 | PAB 15', 42', 68' | x | | | | | | | | | | | | | | | | | | |
| A3 | Control Building | x | x | | | | | | | | | | | | | | | | | |
| A4 | PAB Waste Hold Up Tank etc | | x | | | | | | | | | | | | | | | | | |
| B | RHR Pump 21 | | x | | | | | | | | | | | | | | | | | |
| C | Auxiliary Feed Pump Room | | | | | | | | | | | | | | | | | | | |
| D | Fuel Storage Building | | | | | | | | | | | | | | | | | | | |
| E | No 21 Charging Pump Room | x | | | | | | | | | | | | | | | | | | |
| F | PAB Upper Elev., Fan House | x | x | x | | | | x | x | | | | | | | | | | | |
| G | Diesel Generator Room | | | x | | | | | | | | | | | | | | | | |
| H* | Containment | x | | | | | x | | | | | | | | | | | | | |
| I | Intake Structure | | | | | | | | | | | | | | | | | | | |
| J | ASSS Area (incl. Turbine Bldg) | | | x | | | | | | | | | | | | | | | | |
| K | Steam/Feedwater Piping Area | | | | | | x | | | | | | | | | | | | | |
| L | IP-1 Screen well Area | | | | | | | | | | | | | | | | | | | |
| M | Gas Turbine Bldg | | | | | | | | | | | | | | | | | | | |
| N | Manhole | | | | | | | | | | | | | | | | | | | |
| P | CCW Pump Area | x | x | | | | | | | x | | | | | | | | | | |
| Q** | Penetration H 20 | x | | | | | | | | | | | | | | | | | | |
| YARD | Transformer Yard | | | x | | | | | | | | | | x | | | | | | |

* The potential for Containment Barrier breach is considered negligible. No propagation analysis required.

** Penetration H 20 is completely enclosed by a local fire barrier

**Fire Compartment Propagation Analysis**

**EXPOSING COMPARTMENT A1**

| Exposing Fire Zone | Exposed Fire Compart-ment | Exposed Fire Zone | Barrier Failure Probability (Bea) | Ignition Frequency (IFe) | Severity Factor (SFe) | CCDPea | CDFmcs | Comment |
|---|---|---|---|---|---|---|---|---|
| 1A | A3 | 32A | 9.80E-03 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | F | 7A | 0.00E+00 | | | | | No barrier penetrations |
| | F | 59A | 0.00E+00 | | | | | No barrier penetrations |
| | F | 8A | 2.40E-03 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | H | 72A | 0.00E+00 | | | | | Containment interface - probability of barrier breach considered negligible |
| | H | 75A | 0.00E+00 | | | | | " " " |
| | A2 | 13A | 0.00E+00 | | | | | No barrier penetrations |
| | A2 | 31A | 1.00E+00 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| 2 | A2 | 31A | 1.94E-02 | | | | 0.00E+00 | " " " |
| | F | 7A | 1.00E+00 | | | | 0.00E+00 | " " " |
| | F | 8 | 1.00E+00 | | | | 0.00E+00 | " " " |
| 2A | A2 | 31A | 1.20E-02 | | | | 0.00E+00 | " " " |
| | F | 7A | 0.00E+00 | | | | | No barrier penetrations |
| | P | 1 | 1.00E+00 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| 6A | E | 5 | 2.40E-03 | | | | 0.00E+00 | " " " |
| | F | 5A | 0.00E+00 | | | | | No barrier penetrations |
| | F | 21A | 0.00E+00 | | | | | No barrier penetrations |
| | F | 22A | 0.00E+00 | | | | | No barrier penetrations |
| | F | 23A | 0.00E+00 | | | | | No barrier penetrations |
| | F | 24A | 0.00E+00 | | | | | No barrier penetrations |
| | F | 25A | 0.00E+00 | | | | | No barrier penetrations |
| | F | 7A | 1.13E-02 | 4.14E-04 | 0.13 | 3.04E-04 | 1.81E-10 | Loss of all normal and ASSS supply to the charging pumps |
| 30A | A2 | 3 | 1.00E+00 | 4.54E-04 | 0.14 | 3.11E-03 | 1.91E-07 | Loss of RHR Pumps, SI Pumps and associated valves in Zones 3, 3A, 9 and 18A |
| | A2 | 3A | 1.00E+00 | | | | * | See Note |
| | A2 | 9 | 1.00E+00 | | | | * | See Note |
| | A2 | 14A | 0.00E+00 | | | | | No barrier penetrations |
| | A2 | 18A | 1.00E+00 | | | | * | Normal power pump 21 and 22 damaged in 18A |
| | F | 5A | 1.00E+00 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | F | 7A | 1.00E+00 | | | | 0.00E+00 | " " " |
| | F | 23A | 0.00E+00 | | | | 0.00E+00 | " " " |
| 74A | H | 72A | 0.00E+00 | | | | | Containment interface - probability of barrier breach considered negligible |
| | H | 75A | 0.00E+00 | | | | | " " " |
| | K | 65A | 3.24E-02 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | Q | 74B | 0.00E+00 | | | | | No barrier penetrations |
| | | | | | | Total CDF | 1.91E-07 | |

* Given the barrier configuration, it is assumed that a fire in Zone 30A can simultaneously propagate to Zones 3, 3A, 9 and 18A.
The scenario quantified for Zone 30A to Zone 3 represents the combined impact of damage to the equipment in all of these zones.

Table 3
Exposing Compartment A2

| Fire Compartment Propagation Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **EXPOSING COMPARTMENT A2** | | | | | | | | |
| **Exposing Fire Zone** | **Exposed Fire Compart-ment** | **Exposed Fire Zone** | **Barrier Failure Probability (Bea)** | **Ignition Frequency (IFe)** | **Severity Factor (SFe)** | **CCDPea** | **CDFmcs** | **Comment** |
| 3 | A1 | 30A | 1.00E+00 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| 3A | B | 4 | 2.70E-03 | | | | 0.00E+00 | " " " |
| | A1 | 30A | 1.00E+00 | | | | 0.00E+00 | " " " |
| 9 | A1 | 30A | 1.00E+00 | | | | 0.00E+00 | " " " |
| | F | 7A | 0.00E+00 | | | | | No barrier penetrations |
| 12A | A3 | 32A | 0.00E+00 | | | | | The combustible loading in fire zone 12A <20000 btu/sq ft. - no barrier challenge |
| | F | 7A | 1.44E-02 | | | | 0.00E+00 | " " " |
| 13A | A1 | 1A | 0.00E+00 | | | | | No barrier penetrations |
| | A3 | 32A | 0.00E+00 | | | | | No barrier penetrations |
| | F | 7A | 0.00E+00 | | | | | No barrier penetrations |
| 14A | A1 | 30A | 0.00E+00 | | | | | No barrier penetrations |
| | B | 4 | 0.00E+00 | | | | | No barrier penetrations |
| 15A | B | 4 | 0.00E+00 | | | | | No barrier penetrations |
| 18A | B | 4 | 4.80E-03 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | A1 | 30A | 1.00E+00 | | | | 0.00E+00 | " " " |
| 29A | B | 4 | 7.40E-03 | | | | 0.00E+00 | " " " |
| 31A | P | 1 | 0.00E+00 | | | | 0.00E+00 | The combustible loading in fire zone 31A <20000 btu/sq ft. |
| | A1 | 1A | 1.00E+00 | | | | 0.00E+00 | " " |
| | A1 | 2 | 1.94E-02 | | | | 0.00E+00 | " " |
| | A1 | 2A | 1.20E-02 | | | | 0.00E+00 | " " |
| | A3 | 32A | 0.00E+00 | | | | 0.00E+00 | " " |
| | A4 | 96A | 0.00E+00 | | | | 0.00E+00 | " " |
| | A4 | 97A | 0.00E+00 | | | | 0.00E+00 | " " |
| | A4 | 98A | 0.00E+00 | | | | 0.00E+00 | " " |
| | | | | | Total CDF | | 0.00E+00 | |

Table 4
Exposing Compartment A3

**Fire Compartment Propagation Analysis**

**EXPOSING COMPARTMENT A3**

| Exposing Fire Zone | Exposed Fire Compart-ment | Exposed Fire Zone | Barrier Failure Probability (Bea) | Ignition Frequency (IFe) | Severity Factor (SFe) | CCDPea | CDFmcs | Comment |
|---|---|---|---|---|---|---|---|---|
| 11 | J | 171 | 0.00E+00 | | | | | No Barrier Penetrations |
| | J | 39A | 4.80E-03 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | J | 141 | 7.80E-03 | | | | 0.00E+00 | " " " |
| | J | 160 | 6.00E-03 | | | | 0.00E+00 | " " " |
| | J | 170 | 0.00E+00 | | | | 0.00E+00 | " " " |
| | J | 201 | 0.00E+00 | | | | 0.00E+00 | " " " |
| | J | 270 | 9.80E-03 | | | | 0.00E+00 | " " " |
| 12 | J | 171 | 0.00E+00 | | | | | No Barrier Penetrations |
| 13 | J | 171 | 0.00E+00 | | | | | No Barrier Penetrations |
| 14 | J | 43A | 1.26E-03 | 1.20E-02 | 0.28 | 1.26E-01 | 5.39E-07 | ASSS Power to AFW Pump 21 |
| | J | 141 | 2.70E-03 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | J | 180 | 5.40E-03 | | | | 0.00E+00 | " " " |
| | J | 201 | 0.00E+00 | | | | | No Barrier Penetrations |
| 15/115 | J | 140 | ** | | | | | No significant additional impact beyond that resulting from exposing zone damage |
| | J | 141 | 0.00E+00 | | | | | No Barrier Penetrations |
| | J | 160 | 0.00E+00 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | J | 150 | 7.40E-03 | 9.50E-03 | 3.40E-03 | 0.1 | 2.39E-08 | ASSS power for CHP23, CCW23 and RHR 21 |
| | J | 251 | 2.40E-03 | 9.50E-03 | 3.40E-03 | 0.1 | 7.75E-09 | " " |
| 24 | J | 171 | 0.00E+00 | | | | | No Barrier Penetrations |
| | J | 270 | 0.00E+00 | | | | | No Barrier Penetrations |
| 32A | A1 | 1A | 9.80E-03 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | A2 | 12A | ** | | | | 0.00E+00 | " " " |
| | | 13A | ** | | | | 0.00E+00 | " " " |
| | | 31A | ** | | | | 0.00E+00 | " " " |
| | F | 8A | 1.20E-03 | | | | 0.00E+00 | " " " |
| | G | 10 | 2.40E-03 | | | | 0.00E+00 | " " " |
| | | | | | | | | |
| | | | | | | Total CDF | 5.71E-07 | |

** Propagation screened out based on lack of additional impact prior to determination of specific barrier configuration

Table 5
Exposing Compartment A4

| Fire Compartment Propagation Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **EXPOSING COMPARTMENT A4** | | | | | | | | |
| **Exposing Fire Zone** | **Exposed Fire Compart-ment** | **Exposed Fire Zone** | **Barrier Failure Probability (Bea)** | **Ignition Frequency (IFe)** | **Severity Factor (SFe)** | **CCDPea** | **CDFmcs** | **Comment** |
| 96A | A2 | 31A | ** | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| 97A | A2 | 31A | ** | | | | 0.00E+00 | " " " |
| 98A | A2 | 31A | ** | | | | 0.00E+00 | " " " |
| | | | | | | | | |
| | | | | | Total CDF | | 0.00E+00 | |

** Propagation screened out based on lack of additional impact prior to determination of specific barrier configuration

Table 6
Exposing Compartment B

| Fire Compartment Propagation Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **EXPOSING COMPARTMENT B** | | | | | | | | |
| **Exposing Fire Zone** | **Exposed Fire Compart-ment** | **Exposed Fire Zone** | **Barrier Failure Probability (Bea)** | **Ignition Frequency (IFe)** | **Severity Factor (SFe)** | **CCDPea** | **CDFmcs** | **Comment** |
| 4 | A2 | 29A | 2.70E-03 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | A2 | 3A | 2.70E-03 | | | | 0.00E+00 | " " " |
| | A2 | 14A | 0.00E+00 | | | | | No Barrier Penetrations |
| | A2 | 18A | 4.80E-03 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | Total CDF | 0.00E+00 | |

Table 7
Exposing Compartment C

| Fire Compartment Propagation Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| EXPOSING COMPARTMENT C | | | | | | | | |
| Exposing Fire Zone | Exposed Fire Compart-ment | Exposed Fire Zone | Barrier Failure Probability (Bea) | Ignition Frequency (IFe) | Severity Factor (SFe) | CCDPea | CDFmcs | Comment |
| 23 | H | 75A | 0.00E+00 | | | | | Containment Interface - potential for breach negligible |
| | H | 76A | 0.00E+00 | | | | | " " |
| | K | 60A | 4.32E-02 | 2.50E-03 | 0.23 | 1.86E-03 | 4.69E-08 | Power and control for ARVs, AFW Regulator valves and AFW pumps |
| | K | 62A | 1.01E-02 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | | | | | | | | |
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| | | | | | | | | |
| | | | | | | Total CDF | 4.69E-08 | |

Table 8
Exposing Compartment D

| Fire Compartment Propagation Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **EXPOSING COMPARTMENT D** | | | | | | | | |
| **Exposing Fire Zone** | **Exposed Fire Compart-ment** | **Exposed Fire Zone** | **Barrier Failure Probability (Bea)** | **Ignition Frequency (IFe)** | **Severity Factor (SFe)** | **CCDPea** | **CDFmcs** | **Comment** |
| 90A | F | 59A | ** | | | | 0.00E+00 | Loss of ASSS Instruments only / Normal power supply not affected |
| 91A | F | 59A | ** | | | | 0.00E+00 | " " " |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | Total CDF | 0.00E+00 | |

** Propagation screened out based on lack of additional impact prior to determination of specific barrier configuration

Table 9
Exposing Compartment E

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Fire Compartment Propagation Analysis** | | | | | | | | |
| **EXPOSING COMPARTMENT E** | | | | | | | | |
| **Exposing Fire Zone** | **Exposed Fire Compart-ment** | **Exposed Fire Zone** | **Barrier Failure Probability (Bea)** | **Ignition Frequency (IFe)** | **Severity Factor (SFe)** | **CCDPea** | **CDFmcs** | **Comment** |
| 5 | F | 6 | 3.60E-03 | 1.20E-03 | 0.20 | 3.40E-04 | 2.86E-10 | Charging Pump 22, cable for RWST suction to all CHPs |
| | F | 7A | 2.70E-03 | 1.20E-03 | 0.20 | 3.40E-04 | 2.14E-10 | Control cables for all charging pumps, ASSS feed for CHP23 |
| | A1 | 6A | 2.40E-03 | 1.20E-03 | 0.20 | 3.40E-04 | 1.91E-10 | Normal power cables for all CHPs |
| | | | | | | | | |
| | | | | | | | | |
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| | | | | | | | | |
| | | | | | | Total CDF | 6.91E-10 | |

Table 10
Exposing Compartment F

| Fire Compartment Propagation Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **EXPOSING COMPARTMENT F** | | | | | | | | |
| **Exposing Fire Zone** | **Exposed Fire Compart-ment** | **Exposed Fire Zone** | **Barrier Failure Probability (Bea)** | **Ignition Frequency (IFe)** | **Severity Factor (SFe)** | **CCDPea** | **CDFmcs** | **Comment** |
| 5A | A1 | 30A | 1.00E+00 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | A1 | 6A | 0.00E+00 | | | | | No barrier penetrations |
| 6 | E | 5 | 2.40E-03 | 1.20E-03 | 0.18 | 3.04E-04 | 1.59E-10 | Normal power cables for all charging pumps |
| 7A | E | 5 | 2.70E-03 | 1.14E-03 | 0.20 | 3.04E-04 | 1.89E-10 | Normal power cables for all charging pumps |
| | A2 | 9 | 0.00E+00 | | | | | No barrier penetrations |
| | A2 | 12A | 1.44E-02 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | A2 | 13A | 0.00E+00 | | | | | No barrier penetrations |
| | A1 | 30A | 1.00E+00 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | A1 | 2 | 1.00E+00 | | | | 0.00E+00 | Downward propagation path not credible - no flammable liquids |
| | A1 | 2A | 0.00E+00 | | | | | No barrier penetrations |
| | A1 | 6A | 1.12E-02 | 1.14E-03 | 0.20 | 3.04E-04 | 7.82E-10 | Normal power cables for all charging pumps |
| | P | 1 | 1.00E+00 | | | | 0.00E+00 | Downward propagation path not credible - no flammable liquids |
| | A1 | 1A | 0.00E+00 | | | | | No barrier penetrations |
| 8 | A1 | 2 | 1.00E+00 | | | | 0.00E+00 | Downward propagation path not credible - no flammable liquids |
| | P | 1 | 1.00E+00 | | | | 0.00E+00 | " " " |
| 8A | A3 | 32A | 1.20E-03 | 5.18E-04 | 0.12 | 0.21 | 1.55E-08 | Loss of normal power to pumps and MCCs / potential challenge to PORVs |
| | A1 | 1A | 2.40E-03 | 5.18E-04 | 0.12 | 0.21 | 3.10E-08 | " " " |
| 21A | A1 | 6A | 0.00E+00 | | | | | No barrier penetrations |
| 22A | A1 | 6A | 0.00E+00 | | | | | No barrier penetrations |
| 23A | A1 | 6A | 0.00E+00 | | | | | No barrier penetrations |
| | A1 | 30A | 0.00E+00 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| 24A | A1 | 6A | 0.00E+00 | | | | | No barrier penetrations |
| 25A | A1 | 6A | 0.00E+00 | | | | | No barrier penetrations |
| 59A | A1 | 1A | 8.40E-03 | | | | 0.00E+00 | Downward propagation path not credible - no flammable liquids |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | TOTAL CDF | | 4.76E-08 | |

Table 11
Exposing Compartment G

| Fire Compartment Propagation Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **EXPOSING COMPARTMENT G** | | | | | | | | |
| **Exposing Fire Zone** | **Exposed Fire Compart-ment** | **Exposed Fire Zone** | **Barrier Failure Probability (Bea)** | **Ignition Frequency (IFe)** | **Severity Factor (SFe)** | **CCDPea** | **CDFmcs** | **Comment** |
| 10 | A3 | 32A | 2.40E-03 | 8.57E-02 | 0.27 | 5.22E-03 | 2.90E-07 | Loss of EDGs and portions of Electrical Tunnel |
| | | | | | | | | |
| | | | | | | | | |
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| | | | | | | | | |
| | | | | | Total CDF | | 2.90E-07 | |

Table 12
Exposing Compartment J
(Page 1 of 2)

| Fire Compartment Propagation Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **EXPOSING COMPARTMENT J** | | | | | | | | |
| **Exposing Fire Zone** | **Exposed Fire Compart-ment** | **Exposed Fire Zone** | **Barrier Failure Probability (Bea)** | **Ignition Frequency (IFe)** | **Severity Factor (SFe)** | **CCDPea** | **CDFmcs** | **Comment** |
| | | | | | | | | |
| 16 | n/a | | 0.00E+00 | | | | | |
| 17 | n/a | | 0.00E+00 | | | | | |
| 18 | n/a | | 0.00E+00 | | | | | |
| 19 | n/a | | 0.00E+00 | | | | | |
| 20 | n/a | | 0.00E+00 | | | | | |
| 21 | n/a | | 0.00E+00 | | | | | |
| 25 | n/a | | 0.00E+00 | | | | | |
| 39A | A3 | 11 | 4.80E-03 | 5.18E-04 | 0.15 | 4.70E-02 | 1.748E-08 | Loss of normal control for multiple systems |
| 40A | A3 | 15/115 | 0.00E+00 | | | | | |
| 41A | n/a | | 0.00E+00 | | | | | |
| 42A | n/a | | 0.00E+00 | | | | | |
| 43A | A3 | 14 | 1.25E-03 | 8.02E-03 | 0.11 | 1.26E-01 | 1.427E-07 | Loss of normal power to multiple systems and ASSS to AFW 21 |
| 44A | n/a | | 0.00E+00 | | | | | |
| 45A | n/a | | 0.00E+00 | | | | | |
| 46A | n/a | | 0.00E+00 | | | | | |
| 47A | n/a | | 0.00E+00 | | | | | |
| 48A | n/a | | 0.00E+00 | | | | | |
| 49A | n/a | | 0.00E+00 | | | | | |
| 50A | n/a | | 0.00E+00 | | | | | |
| 51A | n/a | | 0.00E+00 | | | | | |
| 52A | n/a | | 0.00E+00 | | | | | |
| 53A | n/a | | 0.00E+00 | | | | | |
| 64A | n/a | | 0.00E+00 | | | | | |
| 130A | n/a | | 0.00E+00 | | | | | |
| 140 | A3 | 15/115 | 0.00E+00 | | | | | No Barrier Penetrations |
| 141 | A3 | 11 | 7.80E-03 | 4.54E-04 | 0.14 | 4.97E-02 | 2.383E-08 | Loss of normal control for multiple systems |
| | A3 | 14 | 2.70E-03 | 4.54E-04 | 0.14 | 4.97E-02 | 8.25E-09 | Loss of normal and EDG power supplies |
| | A3 | 15/115 | 0.00E+00 | | | | | No Barrier Penetrations |
| 150 | A3 | 15/115 | 7.40E-03 | 4.54E-04 | 0.14 | 1.00E-01 | 4.55E-08 | Loss of normal control and ASSS power |
| 160 | A3 | 11 | 6.00E-03 | 4.54E-04 | 0.14 | 4.70E-02 | 1.734E-08 | Loss of normal control for multiple systems |
| | A3 | 15/115 | 6.00E-02 | 4.54E-04 | 0.14 | 4.70E-02 | 1.734E-07 | Loss of normal control for multiple systems |
| 170 | A3 | 11 | 0.00E+00 | | | | | No Barrier Penetrations |
| 171 | A3 | 11 | 0.00E+00 | | | | | No Barrier Penetrations |
| | A3 | 12 | 0.00E+00 | | | | | No Barrier Penetrations |

Table 12
Exposing Compartment J
(Page 2 of 2)

| Fire Compartment Propagation Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **EXPOSING COMPARTMENT J** | | | | | | | | |
| **Exposing Fire Zone** | **Exposed Fire Compart-ment** | **Exposed Fire Zone** | **Barrier Failure Probability (Bea)** | **Ignition Frequency (IFe)** | **Severity Factor (SFe)** | **CCDPea** | **CDFmcs** | **Comment** |
| | A3 | 13 | 0.00E+00 | | | | | No Barrier Penetrations |
| | A3 | 24 | 0.00E+00 | | | | | No Barrier Penetrations |
| 180 | A3 | 14 | 0.00E+00 | | | | | No Barrier Penetrations |
| 201 | A3 | 11 | 0.00E+00 | | | | | No Barrier Penetrations |
| | A3 | 15/115 | 0.00E+00 | | | | | No Barrier Penetrations |
| | A3 | 14 | 1.20E-03 | 4.54E-04 | 0.14 | 4.97E-02 | 3.667E-09 | Loss of normal and EDG power supplies |
| 251 | A3 | 15/115 | 7.40E-03 | 4.54E-04 | 0.14 | 4.70E-02 | 2.138E-08 | Loss of normal control for multiple systems |
| 270 | A3 | 11 | 9.80E-03 | 4.54E-04 | 0.14 | 4.70E-02 | 2.832E-08 | Loss of normal control for multiple systems |
| 280 | A3 | 14 | 2.16E-02 | 4.54E-04 | 0.14 | 4.97E-02 | 6.6E-08 | Loss of normal and EDG power supplies |
| 350 | A3 | 15/115 | 7.40E-03 | 4.54E-04 | 0.14 | 4.70E-02 | 2.138E-08 | Loss of normal control for multiple systems |
| | | | | | Total CDF | | 5.692E-07 | |

Table 13
Exposing Compartment K

| Fire Compartment Propagation Analysis | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **EXPOSING COMPARTMENT K** | | | | | | | | | |
| **Exposing Fire Zone** | **Exposed Fire Compart-ment** | **Exposed Fire Zone** | **Barrier Failure Probability (Bea)** | **Ignition Frequency (IFe)** | **Severity Factor (SFe)** | **CCDPea** | **CDFmcs** | **Comment** |
| 60A | A1 | 74A | 0.00E+00 | | | | | |
| | C | 23 | 4.32E-02 | | | | 0.00E+00 | Downward fire propagation into 23 not credible ..see note 1 |
| | H | 75A | 0.00E+00 | | | | | Containmant Interface - potential for breach negligible |
| 62A | C | 23 | 1.01E-02 | 5.18E-04 | 0.15 | 2.24E-02 | 1.75E-08 | |
| 65A | A1 | 74A | 3.24E-02 | | | | 0.00E+00 | No significant additional impact beyond that resulting from exposing zone damage |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | Total CDF | 1.75E-08 | |

Table 14
Exposing Fire Compartment P

| Fire Compartment Propagation Analysis | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| EXPOSING COMPARTMENT P | | | | | | | | |
| Exposing Fire Zone | Exposed Fire Compartment | Exposed Fire Zone | Barrier Failure Probability (Bea) | Ignition Frequency (IFe) | Severity Factor (SFe) | CCDPea | CDFmcs | Comment |
| 1 | A1 | 2A | 1.00E+00 | | | | | Control for charging, normal power for CCW Pumps, Block Valves * |
| | A2 | 31A | 1.00E+00 | | | | | No fire susceptible SSD components/cables * |
| | F | 7A | 1.00E+00 | | | | | Normal power for Charging Pump 23, control power for all Charging Pumps, ASSS power for Charging Pump 23 & CCW Pump 23 * |
| | F | 8 | 1.00E+00 | | | | | No fire susceptible SSD components/cables * |
| | | | | | | | | |
| | | | | | | | | |
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* The IPEEE Detailed Fire Analysis and the fire modeling performed in support of the Indian Point 2 Fire Protection licensing basis demonstrated that fire propagation from area P into adjacent fire zones is not credible despite the lack of physical barriers. Fire Zone 1 is a separate Appendix R Fire Area (P).

Table 15
Exposing Compartment YARD

**Fire Compartment Propagation Analysis**

**EXPOSING COMPARTMENT YARD**

| Exposing Fire Zone | Exposed Fire Compart-ment | Exposed Fire Zone | Barrier Failure Probability (Bea) | Detection/ Suppression Fail Prob (Ase) x (Asa) | Ignition Frequency (IFe) | Severity Factor*** (SFe) | CCDPea | CDFmcs | Comment |
|---|---|---|---|---|---|---|---|---|---|
| YARD * | A3 | 14 | 8.10E-03 | 0.05 | 1.98E-02 | 0.70 | 4.97E-02 | 2.79E-07 | Loss of all normal and EDG power |
| | A3 | 11 | 2.16E-02 | 0.05 | 1.98E-02 | 0.70 | 4.97E-02 | 7.44E-07 | Loss of normal controls to all SSD equipment |
| | A3 | 15 | 2.70E-03 | 0.05 | 1.98E-02 | 0.70 | 4.97E-02 | 9.30E-08 | May impact control room habitability if HVAC is not secured |
| | J | 43A | **** | | | | | | |
| YARD ** | A3 | 14 | 8.10E-03 | 1.00 | 1.98E-02 | 0.12 | 4.97E-02 | 9.57E-07 | Loss of all normal and EDG power |
| | A3 | 11 | 2.16E-02 | 1.00 | 1.98E-02 | 0.12 | 4.97E-02 | 2.55E-06 | Loss of normal controls to all SSD equipment |
| | A3 | 15 | 2.70E-03 | 1.00 | 1.98E-02 | 0.12 | 4.97E-02 | 3.19E-07 | May impact control room habitability if HVAC is not secured |
| | J | 43A | **** | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | Total CDF | 4.942E-06 | |

YARD Transformer area consists of fire zones 55A,56A,57A

* Scenarios representing the fraction of severe transformer fires which are not energetic enough to challenge the installed suppression systems

** Scenarios representing the fraction of severe transformer fires which are energetic enough to challenge the installed suppression systems. For these scenarios, it is conservatively assumed that the suppression system fails with a probability of 1.0

*** The severity factor for each category (energetic and non-energetic) combines the fraction of total switchyard fires which fall into each of the above categories and the severity factor associated with the fire data for that category. The severity factor for energetic fires (which comprise 12% of the total), is assumed to be 1.0.

**** Based on analysis, propagation to Zone 43A is not considered credible