IGNITION SOURCE FREQUENCY

From ~~field inspection~~ the components tabulated below were identified by the NRC as potential ignition sources in zones 98-J and 99-M. The total ignition source frequency for each zone would also evaluate transients and welding fires. Included in the tabulation is the generic ignition source frequency number that reflects the EPRI Fire Risk Analysis Implementation Guide.

GENERIC IGNITION SOURCE FIRE FREQUENCY

98-J (Auxiliary Building)	**Fire Frequency**	**99-M** (Switchgear Room)	**Fire Frequency**
Electrical Cabinets	1.9×10^{-2}	Electrical cabinets	1.5×10^{-2}
Battery Chargers	4.0×10^{-3}		
Ventilation subsystems	9.5×10^{-3}	Ventilation subsystems	9.5×10^{-3}
Fire Protection panels	2.4×10^{-3}		
Chiller Pump	9.5 E-3	Transformers	7.9×10^{-3}
Welding – Cables	5.1×10^{-3}	Welding – Cables	5.1×10^{-3}
Welding – Transients	3.1×10^{-2}	Welding – Transients	3.1×10^{-2}
Transients	1.3×10^{-3}	Transients	1.3×10^{-3}

The generic fire frequency is adjusted by a location weighting factor (WF_L) and by an ignition source weighting factor (WF_I). In addition, the EPRI guidance specifies that a severity factor can be applied to the fire frequency. The severity factor adjusts the fire frequency number to reflect the number of fires that are of sufficient magnitude to potentially cause cable damage to components/cables other than the component of fire origination.

With the exception of the electrical cabinets, all the items listed above are considered "Plant Wide" components and thus are assigned a $WF_L = 2$ (number of units per site). The electrical cabinets are assigned a value according to the room location. For 98-J (i.e. auxiliary building), $WF_L = 1$ (number of units per site divided by the number of auxiliary buildings). For 99-M (i.e. switchgear room) $WF_L = 0.25$ (number of units per site divided by the number of switchgear rooms or 2/8).

Note : Although ANO has only 6 distinct switchgear areas, the EPRI guidelines indicates that "weight" of a switchgear room should be assigned according to the amount of electrical equipment located in the location. Each of the two switchgear areas located in the turbine building have approximately twice the electrical equipment located in the individual auxiliary building switchgear rooms. Consequently, the number of switchgear rooms was increased from six (i.e. based on physical areas) to eight (i.e. based on amount of electrical equipment).

In the switchgear room, $WF_I = 1$ for electrical cabinets. In corridor 98 (i.e. auxiliary building), WF_I is calculated by dividing the number of cabinets in the corridor by the total number of cabinets in the auxiliary building (i.e. 147/1452 or .101).

Same

WF_I for the plant wide components was obtained by dividing the number of components in the specified room by the total number of components in the plant. In 98-J, there are four ventilation subsystems, whereas in 99-M there are two. In 98-J, there are two fire protection panels, whereas there are none in 99-M. In 98-J, there are no transformers whereas there are two transformers in 99-M. In 98-J, there are two battery chargers, whereas there are none in 99-M. From Calculation 85-E-0053-47, the total number of ventilation sub-systems is 357, total number of fire protection panels is 86 and the total number of transformers is 98. The calculation lists the total number of battery chargers as 19. However, the calculation does not reflect recent modifications that added a battery charger in Zone 98-J and Zone 110-L. Therefore, the plant wide total has been increased to 21.

EPRI's Fire PRA Implementation Guide (EPRI TR-105928) Appendix D provides severity factors (SF) for various ignition sources. For switchgear room electrical cabinet fires, the suggested severity factor is 0.12. For indoor transformer fires, the suggested severity factor is 0.10. For ventilation subsystem fires, the suggested severity factor is 0.08. The two fire protection panels located in 98-J are completely enclosed with a minimal amount of combustible material located inside. Consequently, these panels were not deemed as credible ignition sources and were assigned a severity factor of zero.

There are other electrical panels in 98-J that are totally enclosed and thus are not credible ignition sources, but were left in the total number of cabinets for conservatism. Likewise, one of the transformers in 99-M is an instrument transformer, while the other is cooled with a non-combustible gas. Neither is deemed to be a credible ignition source, but both were conservatively included in the ignition source frequency calculation.

ANO complies with the NFPA requirements for the establishment of a fire watch in conjunction with welding activities. In essence, this equates to readily available manual suppression system. A pre-action suppression system is assigned an unavailability of 0.05. It is reasonable to assume that an established fire watch would be able to prevent a welding related fire from developing into a 'severe' fire at least on par with the unavailability of a pre-action suppression system. Consequently, the severity factor of welding related fires was set to 0.05.

The EPRI guidance did not provide specific severity factor values for electrical cabinets located in the Auxiliary building, for battery chargers or for transients. The highest severity factor provided for specific ignition sources was for Control Room electrical cabinets and pumps, both of which were assigned a value of 0.2. Accordingly, it is reasonable to assign a severity factor of .75 to those ignition sources that were not assigned a severity factor in the EPRI guidance. Practical plant experience indicates that assuming 3 out of every 4 fires involving these types of ignition sources will develop into a 'severe' fire is an extremely conservative assumption.

Combining all these factors yields the following ignition source frequencies associated with fires that may damage target cables/components (i.e. external to the ignition source).

F(S)(Generic F.)

	Generic	WF_L	WF_I	SF	Total
98-J					
Electrical Cabinets	1.9×10^{-2} ✓	1 ✓	1.01×10^{-1} ✓	0.75 ✓	1.44×10^{-3}
Battery Charger	4.0×10^{-3} ✓	2 ✓	9.52×10^{-2} ✓	0.75 ✓	5.71×10^{-4}
Ventilation subsystems	9.5×10^{-3} ✓	2 ✓	1.12×10^{-2} ✓	0.08 ✓	1.70×10^{-5}
Fire Protection panels	2.4×10^{-3} ✓	2 ✓	2.33×10^{-2} ✓	0 .12	0
Welding – Cables	5.1×10^{-3}	2	1.75×10^{-2}	0.05	8.95×10^{-6}
Welding – Transients	3.1×10^{-2}	2	1.75×10^{-2}	0.05	5.44×10^{-5}
Transients	1.3×10^{-3}	2	1.75×10^{-2}	0.75	3.42×10^{-5}
TOTAL					2.13×10^{-3}
added Chiller pump	9.5E-5	2	2.8E-3	.08	4.26E-6
99-M					
Electrical cabinets	1.5×10^{-2} ✓	0.25 ✓	1 ✓	0.12 ✓	4.50×10^{-4}
Ventilation subsystems	9.5×10^{-3} ✓	2 ✓	5.6×10^{-3} ✓	0.08 ✓	8.52×10^{-6}
Transformers	7.9×10^{-3} ✓	2 ✓	2.04×10^{-2} ✓	0.10 ✓	3.22×10^{-5}
Welding – Cables	5.1×10^{-3}	2	1.75×10^{-2}	0.05	8.95×10^{-6}
Welding – Transients	3.1×10^{-2}	2	1.75×10^{-2}	0.05	5.44×10^{-5}
Transients	1.3×10^{-3}	2	1.75×10^{-2}	0.75	3.42×10^{-5}
TOTAL					5.88×10^{-4}

not used

Not used

FIRE MODELING PROGRAM – FIVE

Due to the simplicity and conservative results, the FIVE program was utilized to perform fire models of the zones analyzed by this SDP. To facilitate the compilation of results, an Excel spreadsheet was developed that utilized the formulas specified in EPRI TR-100443, *Methods of Quantitative Fire Hazards Analysis* and mirrored the worksheets specified in the FIVE methodology. As the results were compared, it was noted that the FIVE program was predicting results that differed from the Excel spreadsheet calculations. By analyzing the data, it was determined that the FIVE program failed to properly convert a temperature (i.e. ΔT) from Fahrenheit to Rankine.

The error involved the calculation of "Net energy addition per unit volume to achieve critical temperature rise." The equation (in English units) is specified as :

$Q_{net}/V = 9.54 \ln(\Delta T/T_0 + 1)$, where both temperature values are given in Rankine.

With the use of a lower value (i.e. Fahrenheit temperature) in the numerator, conservative results were produced by the FIVE program as the program predicted a smaller quantity of energy required to produce a temperature rise to 'damage' levels. Consequently, the spreadsheet was revised to reflect the proper temperature conversion and generate more realistic results. (Note : to verify the validity of the spreadsheet, the "metric" equation was utilized and results identical to the 'corrected' English formula were obtained).

As more results were compiled, it was noted that for those targets that reached critical damage temperatures, the FIVE program was predicting failures in the hot gas layer prior to failures in the ceiling jet. Therefore, the equations utilized to calculate the time to failure were examined. It was discovered that rather than utilizing the equations for calculating total heat flux, the FIVE program divides the number of the total energy release needed to raise the average layer temperature to the critical value (i.e. Q_{crit} in BTUs) by the peak fire intensity (i.e. heat release rate in BTU/sec). This simplistic equation does not reflect the methodology specified in the FIVE user's guide nor in the previously referenced EPRI report. Rather than attempting to reproduce the equations for evaluating the hot gas layer on the Excel spreadsheet, any target located in the hot gas layer that could be damaged was "relocated" into the ceiling jet. This was accomplished by redefining the height of the target to a value that simulate a location in the ceiling jet portion of the room. Obviously, the calculated damage time for a target in the ceiling jet is a conservative bound of the damage time for a target located in the hot gas layer.

A third conservative error of the FIVE program was noted in the calculation of time to damage for a plume scenario. TR-100443 specifies that the convective heat flux for the plume is calculated as :

$$q_{c,pl} = 0.3 * (k_{LF}Q) / H^2 \qquad \text{(reference equation 12, p. A-4).}$$

H is defined as the fire source to ceiling height. However, the FIVE program utilizes the distance from the fire source to the target, when computing this value for a plume scenario (Note : the program correctly utilizes H (i.e. fire source to ceiling height) when calculating the convective heat flux in the ceiling jet). Obviously, the distance from the source to the target is always less than the distance from the source to the ceiling. Therefore, the calculated denominator is smaller than it should be. A smaller denominator in the equation yields a larger value for $q_{c,pl}$. The larger the value of $q_{c,pl}$ the less time there is until damage temperatures are reached. Consequently, the spreadsheet was revised to reflect the proper utilization of H such that more realistic results would be generated.

When calculating the time to damage, it was noted that in a ceiling jet scenario, the shortest time to damage occurred when the target was placed at the ceiling jet/hot gas layer transition (i.e. 85% of the target height to ceiling height ratio). To ensure conservative results, those targets located within the ceiling jet were assigned a target height that equates to the 85% value of the ratio.

Per the supplemental guidance contained in EPRI report SU-105928, since the Heat Loss Factor was conservatively assigned a value of 0.7, the virtual surface of the fire (for electrical cabinets) was placed at the floor.

When considering the combustible loading associated with an individual cabinet, the Plant Data Management System (PDMS) was used to determine the type of cables located in the cabinet and the associated BTU value. Attachment xx indicates combustible loading for various cabinets that were considered as ignition sources. For an MCC, the length of each cable inside the cubicle was conservatively estimated to be four feet. The BTU value associated with each cable is based on vendor information.

COMBUSTIBLE LOADING

The combustible loading in 98-J consists almost entirely of cables in the cable trays. There is less than one gallon of lubricating oil in an emergency chiller unit (C51) located in the eastern part of the corridor. In comparison to the loading associated with the cabling, the oil is a minor factor in the total loading value. Considering all available in-situ combustibles and over 100 pounds of transients, the fire duration in 98-J is estimated to be 2 hours and 15 minutes.

The combustible loading in 99-M is similar to 98-J, in that it primarily consists of cable insulation in open cable trays. Considering all available in-situ combustibles and over 100 pounds of transients, the fire duration in 99-M is estimated to be 30 minutes.

Procedure 1000.047 (Control of Combustibles) limits the amount of ordinary combustibles that may be left unattended to 100 pounds. Transient combustibles in excess of 100 pounds and flammable liquids require the attendance of a continuous firewatch.

HEAT RELEASE RATES

Electrical cabinets in Zone 99-M consist of 4160V switchgear, 480V MCCs, Inverters and a 480V load center. A heat release rate (HRR) of 190 BTU/s was assigned to electrical cabinets that contained cable that was not known to be IEEE-383 rated. Newer electrical cabinets (i.e. those that contained IEEE-383 rated cable) were assigned a heat release rate of 65 BTU/s. These values are based on the guidance provided in EPRI report SU-105928. Many of these cabinets are totally enclosed with no vents or openings. Consequently, fire propagation is not credible. However, all cabinets were considered in the calculation of the fire frequency.

3.8 Justifications assumptions

Zone 98-J contains 480V MCCs, DC distribution panels, battery chargers and small, totally enclosed cabinets. Cabinets considered as credible ignition sources were assigned a HRR of either 65 or 190 BTU/s, dependent on the known type of cable installed.

70kW 200kW

In 98-J there are two emergency ventilation units (VUC14A and VUC14C) that provide cooling to the battery rooms. These units have a very limited run time, as they are only relied upon when normal ventilation is lost. Like the corridor cooler (i.e. VUC13B), these units consists of a small motor. Likewise, Zone 99-M contains two ventilation units, each with a small motor. There is a minimal amount of combustible material associated with the windings of these motors. However, for conservatism, these units were included in the fire frequency calculation and assigned a HRR of 65 BTU/s.

β: T
Δ

VUC4A/C51 is an emergency chiller for the A4 switchgear room. Other than surveillance runs, this unit is only operated during emergency conditions. The oil is contained within the compressor and does not pose a fire hazard. The chiller is mounted on a skid assembly that would confine any leaking oil to the area directly under the chiller unit. Due to the small amount of oil available, is was assumed that the footprint of an oil fire would be 1.5 square feet or less. Assuming the compressor oil has a HRR of 135 BTU/s/ft^2, the HRR associated with oil leaking from the compressor was set to 203 BTU/s. Although slightly larger than the other ventilation units, the motor associated with the chiller has a limited amount of combustible material and was assigned a HRR of 65 BTU/s.

Nec – 295

The transformer associated with the 480V load center (B6) is a dry type transformer. The EPRI guidance indicates that this type of transformer has a minimal amount of combustible material and was consequently assigned a HRR of 65 BTU/s. The instrument transformer (X62) is not considered a credible ignition source and was excluded from fire modeling.

CABLE DAMAGE THRESHOLD

Research on the qualification status of individual cables in mild environments has not been performed. Consequently, all target cabling was assumed to be non-383 rated cable and assigned a damage temperature of 425°F. In order for certain components to fail in an unwanted condition, a hot short has to occur that results in the spurious operation of the component. Recent testing performed by Sandia, the NRC and the Nuclear Energy Institute confirmed that hot shorts do not occur instantaneously when 'damage' temperatures are reached. However, for the purposes of this evaluation, it was conservatively assumed that when the gas temperature reaches the damage threshold (i.e. 425°F), the hot short is subject to occur.

MANUAL SUPPRESSION CAPABILITIES

Both Zone 98-J and Zone 99-M are readily accessible from the Turbine building, elevation 372'. The central fire brigade locker is located one elevation above, thus minimizing the travel time of the brigade from the locker to the fire scene. Both zones are equipped with ionization detection systems that will detect fires in the incipient stages. Due to it's close proximity to the control room, Operations personnel can promptly respond to verify fire conditions. Although no recent fire brigade drills have been performed on these zones, recent drills were performed on Zone 100-N, which is adjacent to Zone 99-M. Response times of the entire brigade for these drills averaged less than 10 minutes. Due to the favorable conditions with respect access and response, it is conservatively estimated that any fire scenario requiring greater than 20 minutes to sustain cable damage will be suppressed by the fire brigade.

99-M SPECIFIC ANALYSIS

Attachment 1 provides a summary of the various fire models that were completed for Zones 99-M. Due to the number of raceways present in 99-M and the presence of green train electrical cabinets that serve as ignition sources, most fire models were developed toward accessing damage to the closest red train raceway. If the closest red train raceway was undamaged by the ignition source, it was assumed that all red train components would be unaffected by the ignition source. In certain cases, the red train raceway could sustain damage, if the fire was not suppressed and/or if enough combustible material was available to generate the necessary heat.

For those raceways that required more than 20 minutes to reach the critical temperature, credit was taken for the ability to provide manual suppression. The related cables were considered undamaged and the associated components were assigned the 'normal' failure probability.

98-J SPECIFIC ANALYSIS

Zone 98-J can be realistically analyzed by dividing the corridor into an east half and a west half. The corridor is separated by a block wall including a non-rated metal door. Although raceways penetrate this wall, the construction is such that the hot gas layer effects in the east portion of the corridor will have a negligible effect on cables located in the west portion of the corridor and vice versa.

Attachment 2 provides a summary of the various fire models that were completed for Zones 98-J. Due to the large number of raceways present in 98-J and the presence of green train electrical cabinets that serve as ignition sources, most fire models were developed toward accessing damage to the closest red train raceway (refer Figure 1). If the closest red train raceway was undamaged by the ignition source, it was assumed that all red train components would be unaffected by the ignition source. In certain cases, the red train raceway could sustain damage, if the fire was not suppressed and/or if enough combustible material was available to generate the necessary heat.
In certain cases, specific green train or non-safety related raceways were subjected to fire models. These raceways were selected based on the risk significance of the included cables. For example, in order to ensure off-site power was available without requiring external control room action, the DC control power for the breaker that aligns the start-up transformer to the A1 4160V bus was modeled. Similarly, certain green train powered EFW valves were modeled to determine their availability.

It was determined that the availability of certain green components impacted the Conditional Core Damage Probability numbers for Zone 98-J. The cables for these components (CV2645 and CV2647) are located in the west end of corridor 98-J and are routed through ER202 and EJ2012. There were no fixed ignition sources capable of damaging ER202. However, EJ2012 was routed above non-safety related motor control center (MCC) B41. Fire modeling predicted that cable damage would not be incurred for those MCC cubicles that constituted a 'ceiling jet' ignition source, whereas a plume scenario projected damage. 20 cubicles of B41 and 6 cubicles of D25 (a DC MCC) were considered in the plume. Although, 10 of these cubicles are spare and thus are not considered credible ignition sources, the total number of electrical cabinets that could lead to fire damage of the cables in EJ2012 was set to 26. A scenario was developed that included these 26 cabinets and neglected the remainder of the fixed ignition sources in the room.

A number of other green train components have related circuits routed through trays EC232/EC233 and EC209/EC208/EC207 in the west end of the corridor. EC207 is essentially in the plume of the various MCC cubicles associated with B31, B41 and D25. The third fire scenario considered the remainder of the MCC cubicles that do not affect EJ2012, noted above.

Although, there were several cabinets in Zone 98-J that are totally enclosed and are not realistic ignition sources, these cabinets were included in the total number of cabinets in the zone (i.e. included in the fire frequency number).

The ignition source frequency was subsequently recalculated as follows :

98-J (East)	Generic	WFL	WFI	SF	Total
Electrical Cabinets	1.9E-02	1	2.34E-02	0.75	3.34E-04
Battery Charger	4.0E-03	2	9.52E-02	0.75	5.71E-04
Ventilation subsystems	9.5E-03	2	1.12E-02	0.08	1.70E-05
Fire Protection panels	2.4E-03	2	2.33E-02	0	0.00E+00
Welding – Cables	5.1E-03	2	1.75E-02	0.05	8.95E-06
Welding – Transients	3.1E-02	2	1.75E-02	0.05	5.44E-05
Transients	1.3E-03	2	1.75E-02	0.75	3.42E-05
Total					**1.02E-03**

98-J (West -- EJ2012)

Electrical Cabinets	1.9E-02	1	1.79E-02	0.25	8.51E-05
Battery Charger	4.0E-03	2	9.52E-02	0	0.00E+00
Ventilation subsystems	9.5E-03	2	1.12E-02	0	0.00E+00
Fire Protection panels	2.4E-03	2	2.33E-02	0	0.00E+00
Welding – Cables	5.1E-03	2	1.75E-02	0.05	8.95E-06
Welding – Transients	3.1E-02	2	1.75E-02	0.05	5.44E-05
Transients	1.3E-03	2	1.75E-02	0.75	3.42E-05
Total					**1.83E-04**

98-J (West -- Remainder)

Electrical Cabinets	1.9E-02	1	5.85E-02	0.25	2.78E-04
Battery Charger	4.0E-03	2	9.52E-02	0	0.00E+00
Ventilation subsystems	9.5E-03	2	1.12E-02	0	0.00E+00
Fire Protection panels	2.4E-03	2	2.33E-02	0	0.00E+00
Welding – Cables	5.1E-03	2	1.75E-02	0.05	8.95E-06
Welding – Transients	3.1E-02	2	1.75E-02	0.05	5.44E-05
Transients	1.3E-03	2	1.75E-02	0.75	3.42E-05
Total					**3.76E-04**

As shown on Figure 3, a number of electrical cabinets are in the 'green' DC equipment room that is located to the north of the main corridor. Access to this room is an open doorway. Due to the physical construction of the room, the ignition sources in the DC equipment room will not impact raceways/circuits located in the corridor until the hot gas layer descends to the open doorway, then spreads into the corridor. The FIVE fire modeling program does not handle such scenarios efficiently. Consequently, with one exception, fire models involving the cabinets located in the DC equipment room were conservatively developed assuming that the cabinet was located in the corridor in the approximate position of the doorway (i.e. assumed to be against the wall, with a Fire Location Factor set to 2).

The one exception involves EC207. This tray runs adjacent to the open doorway. A fire model placing D04A in the corridor would be overly conservative in that EC207 would be in the plume. Therefore, EC207 was conservatively modeled assuming that it was located within the DC equipment room.

To estimate the combustible loading associated with each cabinet, actual cable data was extracted from the Plant Data Management System. The BTU/Ft values were specified for each cable routed to the cabinet and estimate of how much cable was installed within. The total value was conservatively increased by 10% to account for unknown factors.

Several targets (cables in conduits/cable trays) that would be located in the hot gas layer were "moved" to a higher elevation to create a ceiling jet fire models for conservatism. From the 'modified' target list, the targets that bound other hot gas layer targets are ER201, EJ1004 and EC207.

The FIVE program predicts shorter failure times when the target is at the lower threshold of the ceiling jet. Therefore, the target height of ceiling jet models was adjusted to produce a ratio of target height to ceiling height of approximately 0.85.

EPRI SU-105928 describes the resolution of 15 generic issues associated with EPRI's Fire PRA Implementation guide. RAI Question # 2 addressed the value to be utilized for the Heat Loss Factor. SU-105928 notes that a compromise position between the staff and the industry was to utilize a HLF of 0.7 with the virtual surface of the fire (for electrical cabinets) at the floor (versus the top of the cabinet). Consistent with the RAI resolution, all fire models utilize a HFL of 0.7 and electrical cabinet fires are modeled as a point source at the floor.

Some scenarios were limited to one target if a particular fire model bound other targets. The following is a list of targets and associated bound targets:

SOURCE : VUC14A

Target	Bound Targets
EC1287	EC1179, EC1180 & all conduits further east
EC1203	EC1181, EC1204, EC1259, EC1260 & EB1029
ER201	DC179, EC233, EC234, EC224, EC225, EC242 and DC019
EC207	EC206

In reality, EC207 is the closest target to this source. The project time to failure is over 22 minutes. The ventilation unit (i.e. small motor) does not contain sufficient combustible material to support a fire of this duration. This source could be excluded from the fire frequency calculation.

SOURCE : VUC14C

Target	Bound Targets
EC234	DC179, EC233, EC224, EC225, EC242 & DC019
EC1180	EC1179 and all conduits further east
EC1287	All conduits further west
ER201	C4109, EC206, EC207 & EC2520

In reality, EC234 is the closest target to this source. The project time to failure is over 23 minutes. The ventilation unit (i.e. small motor) does not contain sufficient combustible material to support a fire of this duration. This source could be excluded from the fire frequency calculation.

SOURCE : VUC13B

Target	Bound Targets
EJ1004	All conduits further east
EC1179	EC1180 & all conduits further to the west
EC234	DC179, EC233, EC224, EC225, EC2227, EC242 & DC019
ER201	C4109, EC206, EC207 & EC2520

In reality, EC234 is the closest target to this source. The project time to failure is over 65 minutes. The ventilation unit (i.e. small motor) does not contain sufficient combustible material to support a fire of this duration. This source could be excluded from the fire frequency calculation.

SOURCE : D04A or B

Target	Bound Targets
EC1287	EC1179, EC1180 & all conduits further west
EJ1004	All conduits further east
EC224	DC179, EC233, EC234, EC225, EC2227, EC242 & DC019
EC2174	EC206, EC2025
EC207	C4109 & ER201

In reality, EC207 is the closest target to this source. The projected time to failure is well over 1 hour. Consequently, no red train raceways are affected by the ignition sources located in the DC equipment room.

SOURCE : C51

Target	Bound Targets
JB343	EC1153, EC1175, EC1179 &, EC1258
JB711	JB713, EC1504, EJ1004, EJ1027 & EJ3004
EC1287	All conduits further west
EC2017	C4109, EC2018, EC2019, EC2020, EC2021, EC2022, EC2806, EC206 & EC207
DC019	C4756, DC179, EC233, EC234, EC224, EC225, EC2227 & EC242
DJ001	J4066

SOURCE : C512

Target	Bound Targets
EC233	EC1260, EC2757, EJ2012, EC207 & ER201

For those raceways that fire modeling determined that more than 20 minutes were required to reach the critical temperature, credit was taken for the ability to provide manual suppression. The related cables were considered undamaged and the associated components were assigned the 'normal' failure probability.

The east portion of corridor 98-J is protected by a cross-zoned, pre-action deluge system. The deluge system is actuated when a smoke detector and a heat detector sense fire conditions. The heat detectors are line type detectors (trade named Protectowire) and are installed on the cable trays in the east portion of the corridor. These detectors actuate at 190°F. A periodic surveillance is performed on the cable tray detection system and the room smoke detection system to ensure that the suppression system remains operable.

The sprinkler heads in the corridor are open heads. Thus, water will be available as soon as the sprinkler valve opens. Manufacturer's information indicates the valve will open in approximately 5 seconds. The smoke detector response time for this area is under 10 seconds. A fire model was performed using 190°F as the target temperature with the target height assumed to be 8' 7" and the cable tray in the plume. The actuation time for the line type heat detection system to sense the damage temperature of 190°F was estimated to be less than 7 minutes.

Based on the suppression system response time (i.e. approximately 7 minutes), those raceways that required more than 10 minutes to sustain damage were credited as being protected by the suppression system. The unavailability of the deluge system was assigned a value (i.e. 0.05) consistent with the EPRI guidance. It should be noted that the EPRI guidance specifies that the system unavailability is based on general industry data, whereas the nuclear industry typically provides better control. Therefore, the unavailability number is considered conservative. For those components considered protected by the suppression system, the unavailability value was factored into the normal failure probability.