Volume 3

WATTS BAR NUCLEAR PLANT UNIT 1 PROBABILISTIC RISK ASSESSMENT INDIVIDUAL PLANT EXAMINATION

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PLG

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4. BACK-END ANALYSIS

4.1 PLANT DATA AND DESCRIPTION

This section compares the important design features of the Watts Bar Nuclear Plant (Watts Bar) evaluated here with those evaluated for TVA's Sequoyah Nuclear Plant in NUREG-1150 (Reference 4.1-1), describes pertinent observations made during the containment walk-through, describes containment safeguard systems pertinent to the back-end analysis, and discusses the survivability of containment equipment during a severe accident. It should be noted that the Level 2 aspects of the Watts Bar Units 1 and 2 are nearly identical. Unless otherwise noted, the information provided below is applicable to both units.

4.1.1 COMPARISON OF WATTS BAR NUCLEAR PLANT AND SEQUOYAH NUCLEAR PLANT

As noted earlier, Watts Bar is nearly identical to Sequoyah. Sequoyah is the ice condenser containment reference plant for the NUREG-1150 analyses.

The more obvious similarities between Watts Bar and Sequoyah with regard to severe accident progression and containment performance are as follows:

- Both plants employ Westinghouse 4-loop nuclear steam supply systems with nearly identical thermal power ratings.
- Both plants employ ice condenser containments with nearly identical containment free volumes.
- Both plants employ safety-related air return fans and safety-related containment spray systems.
- The reactor cavities of each plant will be flooded prior to vessel breach if the refueling water storage tank (RWST) is injected into the containment **and** at least about one-quarter of the ice in the ice condenser is melted. The reactor cavity floor areas and geometries are comparable.

The more significant containment design difference between Watts Bar and Sequoyah is in the design pressure. The Watts Bar plant is designed for 15 psig, compared with the 10.8 psig design pressure for Sequoyah.

Table 4.1-1 provides a comparison of Watts Bar design parameters important to a Level 2 analysis with those for Sequoyah. Given the design similarities and the available analytical work based on the Sequoyah design, including that generated for the Sequoyah probabilistic risk assessment (PRA), it is appropriate to make use of Sequoyah work wherever it is available and applicable; e.g., Reference 4.1-2.

No tabulation of differences in the structures contiguous to the containment (i.e., the auxiliary building) is given. These structures are nearly identical, and differ only to

accommodate differences in the routing of some conduit and lines. Any significant differences in these structures were evaluated specifically for Watts Bar.

4.1.2 CONTAINMENT AND AUXILIARY BUILDING WALK-THROUGH

A walk-through of the Watts Bar Unit 1 reactor containment and auxiliary building was conducted on June 3, 1992.

The purpose of this walk-through was to acquaint members of the Level 2 individual plant examination (IPE) team with features of the containment and auxiliary building that are important to severe accident analysis. The following personnel participated in the walk-through:

- TVA
  - William Mims, Risk Assessment Staff, Level 2 Specialist
  - Mark Luksic, WBN, Assistant Shift Operations Supervisor
  - Mark Teeple, WBN, Mechanical Engineer, Nuclear Engineering
- PLG
  - R. Kenneth Deremer
- GKA
  - Marc Kenton
  - Mike Murray
- Independent Consultant
  - Ian B. Wall

4.1.2.1 Containment Building Walk-Through

The inspection of the containment concentrated on the following features:

- Reactor Cavity
- Seal Table
- Ice Condenser
- Hydrogen Ignitors
- Air Return Fans

Figures 4.1-1 and 4.1-2 depict the overall arrangement of the ice condenser containments.

- **Reactor Cavity.** Access to the reactor cavity is from a manway accessed from the elevation of the lower compartment floor. Figure 4.1-3 contains a sketch of this cavity. As indicated by the sketch, the instrument tubes pass through a very large volume before they enter the sloped region of the cavity. The cavity region

contains little but the instrument tubes and their supports. The ceiling is 20-feet high, with the instrument tunnel beginning 5 feet from the floor. The opening into the tunnel is roughly 8 feet × 5 feet.

Small seals fit around the instrument tubes to inhibit gas flow through the insulation gaps into the vessel region. This would probably also prevent cooling of debris in the lower head by water in the reactor cavity. The instrument lines emanating from the reactor cavity terminate at the seal table, which lies outside the crane wall and approximately 4 feet from the steel containment.

- **Seal Table.** The seal table is located in the instrument room, which can be reached from the containment personnel hatch on Elevation 713'. The instrument room is located outside the crane wall in containment. The seal table is 96-inches long, 30-inches wide, and 24-inches high. It is capped by a ½-inch stainless steel plate, which is flanged and bolted. Roughly 30 bolts penetrate the upper rim of the seal table and fasten through the flange to hold the seal table in place.

  As noted in NUREG/CR-4551 for Sequoyah (Reference 4.1-2), there is some concern regarding seal table failure during high pressure melt ejection and subsequent impingement of the debris expelled from the cavity directly on the steel containment wall. The possible point of attack cannot be flooded with water.

- **Ice Condenser.** There was no ice in the Watts Bar ice condenser at the time of the walk-through, which permitted ready access for the walk-through team. Lower doors of the ice condensers open inward to the lower plenum. In this region, turning vanes are provided to direct the flow vertically through the ice baskets. There are 24-sets of paired lower doors. These doors moved easily at the touch of a finger. The intermediate doors are located above the ice baskets and open upwards towards the containment dome into the upper plenum of the ice condenser, which contains cooling units. Hydrogen ignitors are clearly visible in this compartment. The upper doors of the ice condenser are located in the "roof" of the upper plenum and open vertically towards the containment dome. The ice condenser floor drains are 12-inch diameter pipe, and are capped with a spring-loaded door (flapper valve). Intermediate deck doors are roughly 20 to 30 pounds with dimensions of 7 feet × 2 feet. The ice baskets are 48-feet tall and 1 foot in diameter, and have very little structure in their cross section. The sheet steel sides are punched with many 1 inch × 1 inch square holes to increase the heat transfer area between the gas and the ice.

- **Hydrogen Ignitors.** Hydrogen ignitors were observed in the lower compartment of the containment, the upper plenum of the ice condenser, and in the upper compartment of the containment.

- **Air Return Fans.** The location of the air return fans was also noted, although one of the locations was covered with protective material and the fans themselves were not installed. The fan housing, however, clearly depicts the pathway of circulation from the upper compartment area to the lower compartments. Suction for the air return fans comes partially from the floor of the upper compartment and partially from pipes that draw air from the top of containment and steam generator/pressurizer enclosure.

4.1.2.2 Auxiliary Building Walk-Through

The specific purposes of the auxiliary building walk-through were to: (1) identify potential fission product release paths for interfacing systems loss of coolant accident (LOCA) scenarios and containment failures that "leak" into the annulus and subsequently into the auxiliary building, and (2) determine if any potential leak locations related to interfacing systems LOCAs would become immersed in water.

Two important observations resulted from the walk-through of the auxiliary building:

1. There appear to be no compartments that would flood as a result of an interfacing systems LOCA. See descriptions below for further details on the reasons for this conclusion.

2. There are significant elevation-to-elevation pathways (stairways and an equipment hatch) that would tend to pressurize the building uniformly, should steam be exhausted in the building. Therefore, the most likely release point from the auxiliary building appears to be the 16 roof blowout panels.

Figure 4.1-4 depicts the overall arrangement of the auxiliary building.

The auxiliary building is common to Units 1 and 2 and is kept at a quarter-inch water negative pressure. Communication between floors is good due to an open equipment hatch and an open stairwell, which both run the height of the building and connect the floors except for the uppermost (refuel floor), as noted below. Gross flooding is unlikely due to these open junctions and a large passive sump located below Elevation 676'.

Entry to the auxiliary building was through an airlock located at Elevation 713' (approximately the midlevel of the building). The airlock has two sets of doors, which are closed during normal operation. The pipe chase is isolated from this floor by a set of regular steel doors. Equipment density is heavy in the general areas, and fire spray coverage is good. Spray header height varies from roughly 7 feet to 15 feet. The containment personnel hatch is on this floor but is isolated by a 3-inch heavy steel door. Four stairwells and the main equipment hatch connect this floor to its neighbors, as well as to the elevator shaft. The motor-driven auxiliary feedwater pumps are located at this elevation in a generally open area. Access to the residual heat removal (RHR) and containment spray heat exchanger is provided at this elevation. Each heat exchanger room contains one RHR heat exchanger and one containment spray heat exchanger. Reactor coolant pump seal return heat exchanger rooms are also accessed in this area. Relief valves for the seal return lines were observed in the top region of the room. Manual isolation valves were readily accessible (from a location point of view).

Access to Elevation 692' is gained via the central stairway or the main elevator shaft. The CCPs and SIPs are located on this elevation. The turbine-driven AFW pump is located in a separate room on this elevation. Direct communication via the central equipment shaft is also possible. Many of the smaller compartments are isolated by closed doors during normal operation. Equipment density on this floor is moderate, and good spray coverage was noted. Spray headers were located near the ceiling and distributed throughout the open area. The vertical pipe chase was isolated from this elevation by a regular door opening into the chase. The pipe chase is heavily grated at this elevation. There are three

other stairways leading up to Elevations 713′ and 737′: two in the general area, and one in the cask decon collector tank room adjacent to the spent fuel pit.

RHR isolation (sump suctions) valves are located in a "vault" accessed at Elevation 692′.

Access to Elevation 676′ is gained from Elevation 692′ via an open, grated stairwell or the central elevator shaft. A large, passive sump lies below this volume. Also, an equipment hatch (roughly 15 feet × 15 feet) allows communication to Elevation 692′ and higher. Eight small rooms having equipment such as RHR pumps or containment spray pumps are isolated by regular steel doors during normal operation and a 1-foot-high curb. Each room has a dropout panel roughly 4.5 feet × 4.5 feet that fails into the passive sump below, preventing flooding of the containment spray pump and RHR pump rooms. The two pipe chases are isolated from this floor by a regular door opening into Elevation 676′ general area. No spray coverage was noted on this floor, and the equipment density was low.

The RHR and containment spray pump rooms are separated from the remainder of the auxiliary building by a 1-foot-high steel curb and a fire door. Before water could flow over the curb, it would drain via a "drop-out panel" (steel grating mounted on an approximately 2-inch-high concrete curb) to the "passive sump" located at the lowest elevation of the auxiliary building (Elevation 666′). Thus, water would rise only several inches in these rooms and would not cover the pump seals. Although the pump rooms have fire detection sensors, there are no sprinklers in these rooms.

Three stairwells and an elevator shaft lead up to Elevation 737′ from Elevation 713′. Equipment density is heavy, and fire spray coverage is similar to that seen on Elevation 713′. The pipe chase is isolated from this floor except for an 8 inch × 8-inch damper into each of the letdown heat exchanger rooms. This room is itself isolated from the rest of the floor by a regular door opening into the room. The air intake for the heating, ventilation, and air conditioning (HVAC) system is at this elevation, but these rooms are isolated by a set of airlock doors opening into the general area.

The refueling floor (Elevation 757′) can be accessed by the main elevator shaft or the main stairwell. Each, however, is sealed with a heavy steel door. Stairs by the elevator shaft lead to the roof, but this is also sealed by two doors (in series) opening out to the environment. The equipment hatch was open at the time of the walk-through, but it has a roll-out metal cover. If pressurization of the lower elevations occurs, it is expected that this hatch cover will fail prior to the stairwell doors. Four sets of four 5 foot × 5 foot blowout panels exist on the roof. These quarter-inch-thick panels are not secured in any fashion, except by a length of chain that prevents each from leaving the roof once they are displaced. The walk-through team felt that these blowout panels would be the primary path from the auxiliary building to the environment if pressurization were to occur.

4.1.3 CONTAINMENT SYSTEMS ANALYSES

The active containment systems (e.g., containment sprays, air return fans, containment heat removal, and containment isolation) are included in the front-end (i.e., Level 1) analysis described in Section 3. This approach is taken to ensure proper treatment of system dependencies between the front-end safety systems that are needed for preventing core damage, the containment systems that mitigate accident consequences, and the support systems that tie both types together. For example, electric power, instrument air,

service water, component cooling water, and safeguards actuation systems mutually support both the core damage prevention and containment safeguards systems. Placing active containment systems in a containment event tree (CET) that is not directly linked to the frontline trees is generally not advisable because it exacerbates the job of tracking dependencies.

Another reason for placing the active containment systems in the Level 1 model is that the resulting CET then examines primarily phenomenological issues. This is important because the probabilities assigned to the CET phenomena have a meaning that is fundamentally different from the probabilities assigned to the Level 1 model; i.e., random hardware failure data. Thus, the containment systems analyses were done in the Level 1 portion of the analysis. Information on the status of these systems is passed into the Level 2 model in the definitions of the plant damage states, as explained in Section 4.3.1. The survivability of otherwise operating containment systems in a severe accident environment is addressed in the next section.

4.1.4 EQUIPMENT SURVIVABILITY IN A SEVERE ACCIDENT ENVIRONMENT

Nuclear equipment and instrumentation are typically designed to operate in environmental conditions associated with design basis accidents, such as a loss of coolant accident or a main steam line break. In a severe accident involving core melt and vessel breach, the conditions inside containment can be more demanding than the design basis to the extent that equipment operability could be in question.

With the exception of air return fans, hydrogen ignitors, and containment sprays, no credit for equipment located inside containment is given in Level 2 mitigation following vessel breach.

An evaluation of the available means to monitor an accident and to arrest or mitigate its progression should include a review of equipment survivability; that is, the capability of equipment exposed to severe accident conditions to remain functional. The following qualitative analysis is intended to assess the survivability of equipment for Watts Bar under severe accident conditions. It is, therefore, limited to the evaluation of possible mitigation of the accident once core damage and vessel breach have occurred, as well as monitoring containment conditions (e.g., pressure, temperature, hydrogen concentration, etc.) as a severe accident progresses, which could affect possible accident management actions. The potential for arresting the accident before the core is damaged is addressed in the Level 1 analysis.

The mitigation of a severe accident can be achieved by suppressing containment pressure, cooling the damaged core debris, and removing energy and radioactive material from the containment atmosphere. For Watts Bar, this can be achieved in part by the passive ice condenser and is enhanced by activating the containment spray system, air return fans, and hydrogen mitigation system.

4.1.4.1 Containment Conditions

The containment spray, air return fan, and hydrogen mitigation systems are designed for LOCA containment conditions.

4.1.4.2 Monitoring and Actuation

The monitoring capabilities required to enable operators to take the correct emergency response actions have been identified in Regulatory Guide 1.97. The hardware that provides the parameter readings has been designed at Watts Bar to the environmental requirements appropriate for their purpose and location. Systems that provide long-term mitigation functions operate from controls outside the containment.

For the situation where the accident progresses to severe core damage or melt, and possibly beyond reactor vessel bottom head failure, the useful parameters reduce to those that are associated with understanding the condition of the containment and the performance and control of the remaining systems for core debris and containment cooling.

The parameters that provide important information to the operators in the aftermath of core damage and that rely on hardware located in the containment are as follows:

- Reactor Coolant System Pressure
- Reactor Vessel Water Level
- Core Exit Temperature
- Pressurizer Water Level
- Containment Sump Water Level
- Containment Pressure
- Containment Area Radiation
- Containment Hydrogen Concentration
- Containment Atmosphere Temperature
- Steam Generator Secondary-Side Water Level

The hardware that is located inside the containment to monitor these parameters is designed for LOCA containment conditions.

Except for the air return fans, no credit has been taken in this IPE for any operator actions or equipment operation after vessel breach that would require information or actuation using hardware located inside the containment. In addition, for scenarios in which electric power is unavailable, no credit has been taken for the operation of sensors or actuators that require the unavailable power source.

The ice condenser is the primary defense against containment breach, whereas the systems that could provide additional defense against containment breach are the containment spray system, the air return fans, and the hydrogen ignitors. The auxiliary feedwater (AFW) system is important for cooling the reactor coolant system (RCS) to allow depressurization and for preventing steam generator tube failure leading to containment boundary bypass. Depressurizing the RCS tends to mitigate the containment loads at vessel breach and may arrest core damage in-vessel if low pressure injection can be actuated before core damage progresses to the point where the debris cannot be cooled.

4.1.4.3 Ice Condenser

The ice condenser system (ICS) is designed to passively absorb thermal energy released in the event of a LOCA or high energy line break (HELB), thus limiting the peak pressure in the containment. In addition to condensing steam, the ice beds can trap radioactive aerosols and condense vapors during severe accidents. The ice in the ice condenser melts as it absorbs thermal energy. Thus, its effectiveness to remove fission products from the containment atmosphere diminishes with time in a severe accident. However, when the contents of the RWST have been injected into the containment and at least one quarter of the ice melts, the water on the containment floor overflows into the reactor cavity and contributes to cooling any debris that might be found there after a vessel breach, or scrubbing any radionuclide release that might result from core-concrete interaction (CCI).

4.1.4.4 Containment Spray

The containment spray system is made up of two independent and fully redundant trains of equipment. Each is capable of injecting 4,000 gpm of RWST water through one of two spray ring headers located near the top of the containment and takes suction from the RWST. If both containment spray trains deliver rated flow with no high pressure injection, the RWST would be depleted after about 45 minutes. However, if all of the high pressure injection pumps taking suction from the RWST also operate, which they can do when the RWST contains at least 29% capacity, the RWST would be depleted after about 35 minutes. Once the RWST is injected, the containment spray system must be manually realigned to take suction from the containment sump in the recirculation mode. The containment spray pumps are located in the auxiliary building and stainless steel spray nozzles are employed in the spray ring headers located inside containment, so that spray injection should not be impaired by ambient containment conditions.

The potential for continued containment spray following containment failure is expected to affect the radionuclide release to the environment. Containment failure considerations concerning spray operability include the availability of sump water for recirculation as well as any failures to the spray piping or headers caused by the containment failure mode. Failure of the containment sprays in the recirculation mode could result from plugging of sump screens or refueling cavity drain lines by accident debris. Failure of the sprays at recirculation is explicitly represented in the representative sequences addressed for each key plant damage state (KPDS) discussed in Section 4.9. Section 4.4 addresses several containment failure modes, most of which result in large containment failure. It is judged that such containment failure modes will result in consequential failure of the spray headers or loss of water, so no credit will be given for spray operation following containment failure.

4.1.4.5 Air Return Fans

The air return fans, including the fan drive motors, backdraft dampers, and power cabling, are contained inside containment between the upper and lower compartments. Two redundant AC-powered fans are provided, each of which is capable of circulating sufficient air to satisfy the purpose of the air return fans.

4.1.4.6 Hydrogen Ignitors

The AC-powered hydrogen ignitors are located inside containment and are designed to survive the temperature conditions that would result from controlled hydrogen burns. For this IPE, their availability is assumed to depend on the availability of AC power and on the probability that the operators have activated the ignitors per emergency procedures.

4.1.4.7 Auxiliary Feedwater

The status of auxiliary feedwater flow to the steam generators is an important part of the severe accident progression. Heat transfer from the primary side to the secondary side can significantly affect core degradation as well as containment integrity and radionuclide behavior. For that reason, the question of AFW availability is an important issue. The AFW system is independent of the containment behavior except for piping penetrations and actuation and control. Neither containment expansion nor anticipated temperatures are expected to cause damage to the penetrations.

4.1.5 REFERENCES

4.1-1. U.S. Nuclear Regulatory Commission, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, December 1990.

4.1-2. Sandia National Laboratories, "Evaluation of Severe Accident Risks: Sequoyah, Unit 1," prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-4551, SAND86-1390, Vol. 5, Rev. 1, Part 2, December 1990.

Table 4.1-1 (Page 1 of 2). Basic RCS and Containment Comparison Table

Item	Sequoyah* (NUREG-1150)	Watts Bar
Type of Reactor	PWR	PWR
Manufacturer	Westinghouse	Westinghouse
Date of Commercial Operation	1981	N/A
Reactor Core		
Nominal Power	1,217 E7 Btu/hr	1,164 E7 Btu/hr
Number of Fuel Assemblies	193	193
Fuel Rods per Assembly	264	264
Number of Fuel Rods	50,952	50,952
Core Weight (total)	292,810 lb	273,413 lb
Uranium Dioxide	222,740 lb	222,645 lb
Zircaloy	50,910 lb	46,993 lb
Miscellaneous	19,160 lb	3,775 lb
Reactor Vessel		
Inside Diameter	173 in	173 in
Overall Height	43.8 ft	43.6 ft
Thickness at Beltline	8.5 in	8.5 in
Head Thickness	5.5 in	6.5 in
Reactor Coolant System		
Volume (nominal)	13,200 ft^3	12,145 ft^3
Water in System (nominal)	547,400 lb	510,000 lb
Operating Temperature (nominal)	580°F	588.2°F
Operating Pressure (nominal)	2,235 psig	2,235 psia
PORV Setpoint (nominal)	2,500 psia	2,500 psia
Number of Reactor Coolant Pumps	4	4
Number of Steam Generators	4	4
Containment		
Inside Diameter	115 ft	115 ft
Cylinder Height	114 ft	116.85 ft
Free Volume	1,215,000 ft^3	1,191,500 ft^3
Free Volume Upper Containment	651,000 ft^3	651,000 ft^3
Free Volume Lower Containment	383,000 ft^3	303,800 ft^3
Free Volume Ice Condenser	81,000 ft^3	176,200 ft^3
Design Leak Rate	0.25%/day	0.25%/day
Design Pressure	10.8 psig	15 psig
Operating Temperature	120°F	100°F

*Taken from Table A.3 of Reference 4.1-1.

Table 4.1-1 (Page 2 of 2). Basic RCS and Containment Comparison Table

Item	Sequoyah* (NUREG-1150)	Watts Bar
Containment (continued)		
Construction	Steel	Steel
Bottom Liner Plate Thickness	0.25 in	0.25 in
Cylinder Thickness	1.4 to 0.5 in	1.5 to 1.4 in
Dome Thickness	0.44 to 0.94 in	0.81 to 1.4 in
Basemat Thickness	9.0 ft	9.28 ft
Floor Thickness above Liner	2.0 ft	--
Reactor Cavity		
Annular Cavity Diameter	17 ft	13 ft
Floor Area	650 ft^2	649 ft^2
Water Capacity (including instrumentation tunnel)	18,000 ft^3	14,800 ft^3
Shield Building		
Inside Diameter	125 ft	125 ft
Cylinder Height	150 ft	149.3 ft
Wall Thickness	3 ft	3 ft
Construction	Reinforced Concrete	Reinforced Concrete
Ice Condenser		
Weight of Ice	2.4 E6 lb	2.2 E6 lb
Ice Temperature	20°F	27°F
RWST	46,800 ft^3	46,800 ft^3
Containment Spray Pumps		
Number	2	2
Design Flow (each)	4,750 gpm	4,000 gpm
Containment Spray Heat Exchangers		
Number	2	2
Design Capacity (each)	95 E6 Btu/h	129 E6 Btu/hr
Accumulators		
Number	4	4
Pressure	660 psig	642 psig
Water Capacity (total)	5,400 ft^3	5,400 ft^3

*Taken from Table A.3 of Reference 4.1-2.

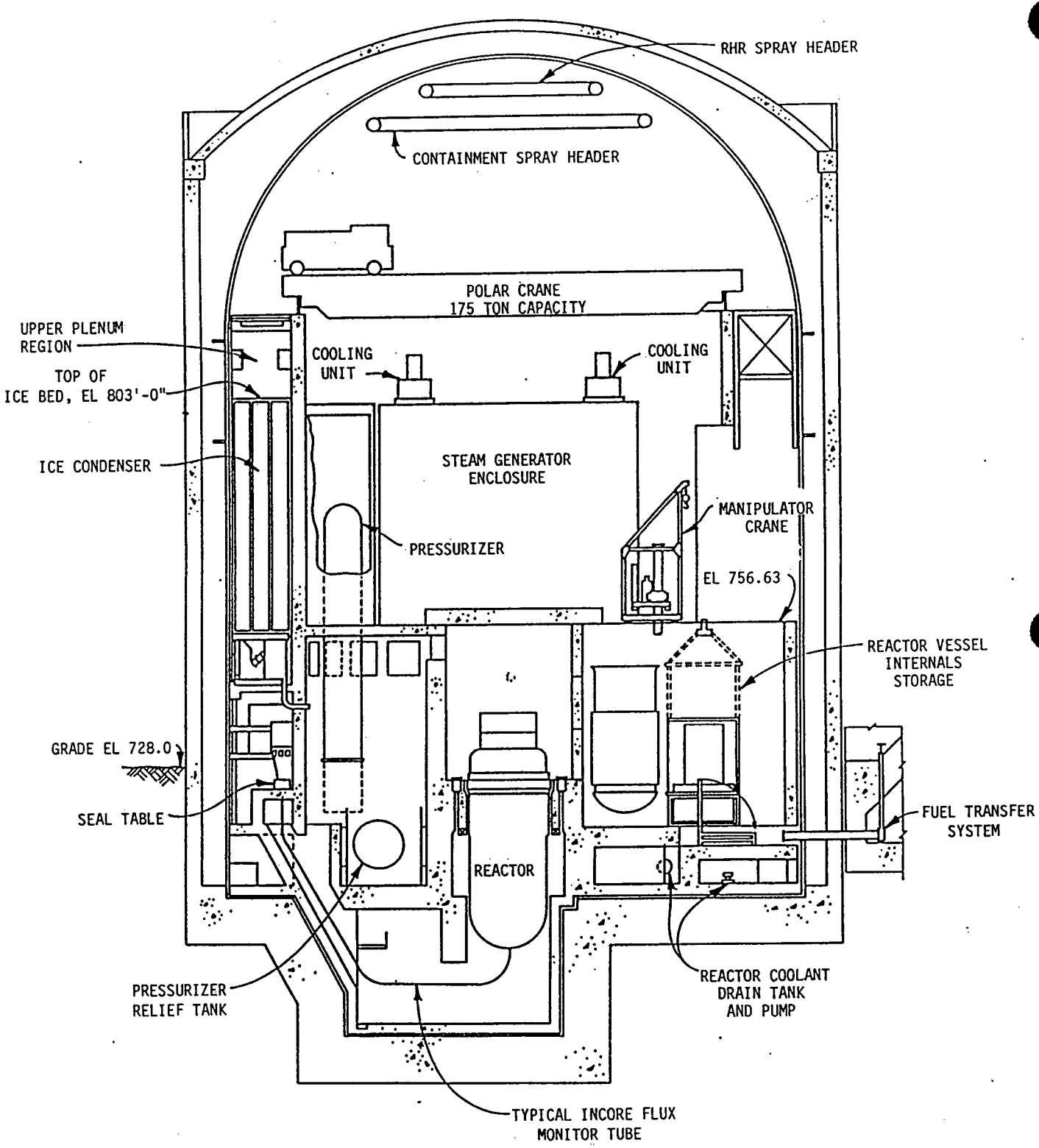

Figure 4.1-1. Watts Bar Containment (showing instrument tunnel)

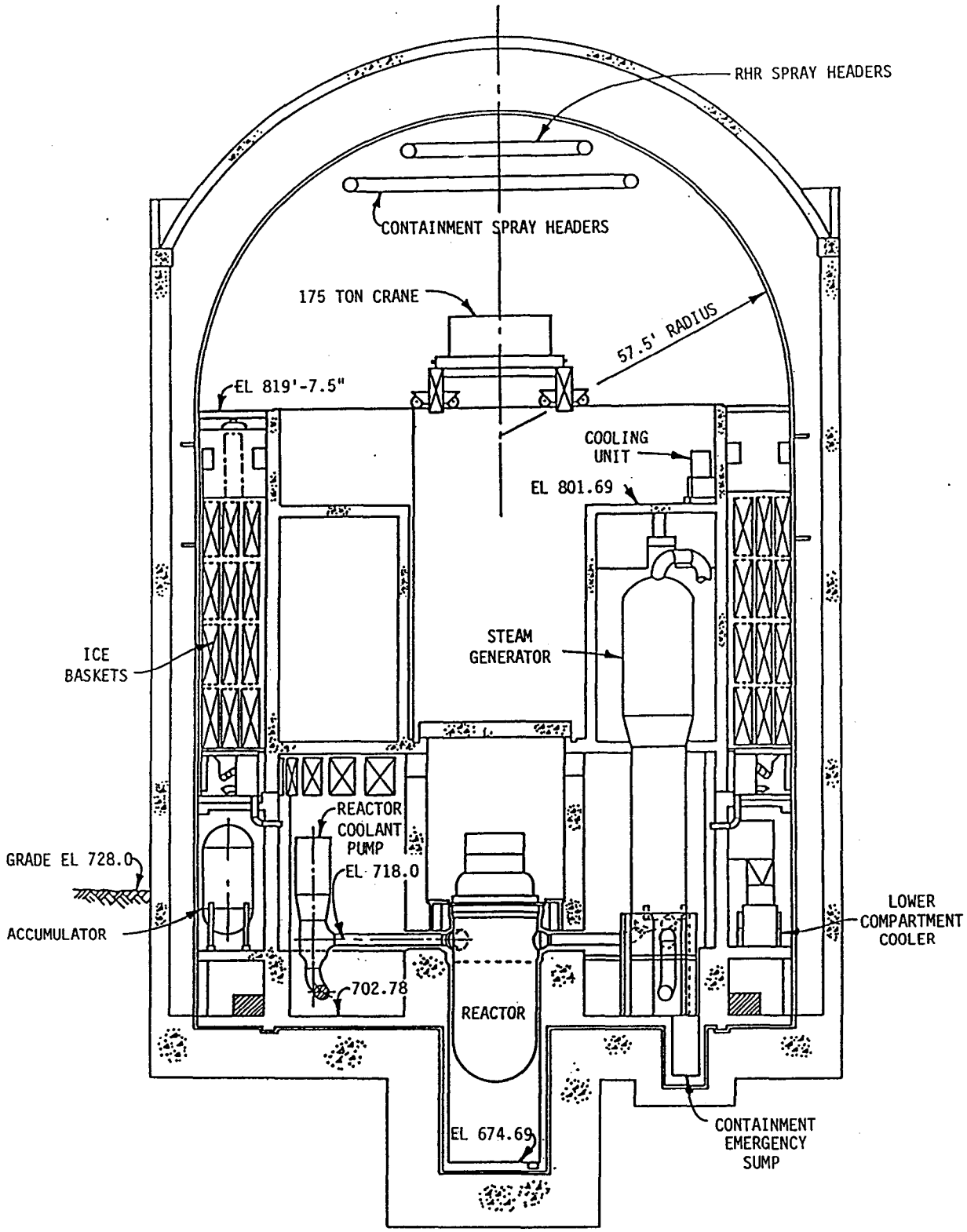

Figure 4.1-2. Watts Bar Containment (showing RCP and steam generator compartments)

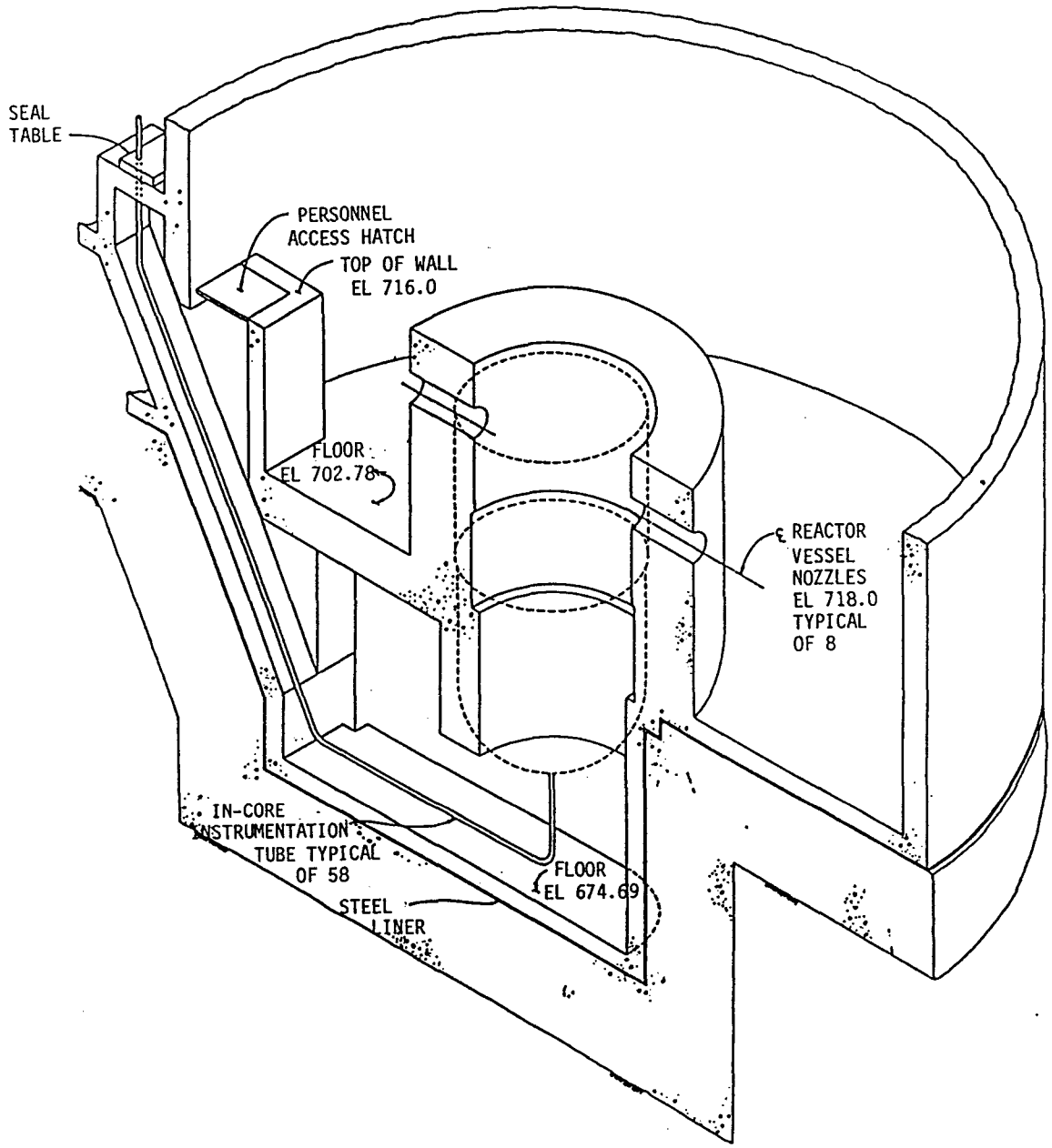

Figure 4.1-3. Watts Bar Reactor Cavity

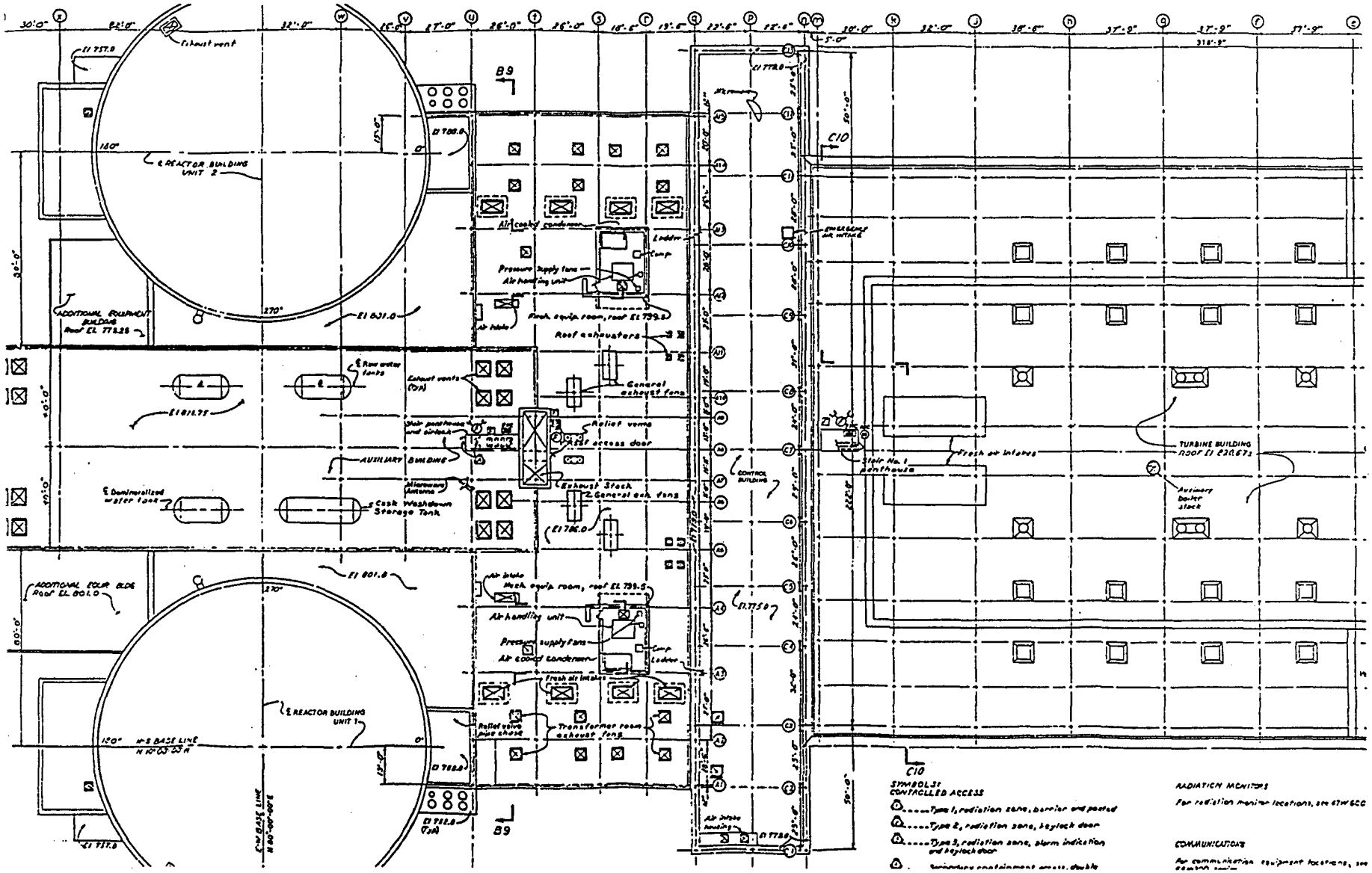

Figure 4.1-4. Watts Bar Auxiliary Building

4.2 PLANT MODELS AND METHODS FOR PHENOMENOLOGICAL EVALUATIONS

To quantify the Watts Bar Nuclear Plant containment event tree (CET) and to determine the radionuclide release into the environment that would accompany each CET end state (i.e., "source term," see Section 4.9.3), it is necessary to be able to describe quantitatively the response of the plant for selected accident sequences. In this study, two approaches have been used: (1) plant-unique analysis for Watts Bar, and (2) analogy to previous analyses done for Sequoyah; e.g., in NUREG-1150 (Reference 4.2-1).

4.2.1 ANALOGY TO NUREG-1150 REFERENCE PLANT

The Sequoyah plant is the reference ice condenser plant in NUREG-1150. Since Watts Bar is nearly identical to Sequoyah, selected plant response information can therefore be taken directly from analyses supporting NUREG-1150. This is especially true for phenomena that have been quantified largely by expert opinion rather than by deterministic modeling, including:

- Likelihood of in-vessel steam explosion-generated missile failing containment (alpha containment failure mode).
- Likelihood of "rocket mode" containment failures.
- Induced primary system failure (hot leg, surge line, steam generator tubes) before vessel breach.

4.2.2 WATTS BAR UNIQUE PHENOMENOLOGICAL ISSUES AND ANALYSES

4.2.2.1 Unique Design Features

The Watts Bar ice condenser containment has a number of unique design features. Such design features include the following:

- **Ice Condenser.** The ice condenser system is designed to absorb thermal energy released in the event of a loss of coolant accident (LOCA) or high energy line break (HELB), thus limiting the peak pressure in the containment. The ice condenser is essentially a cold storage room approximately 50 feet in height that contains approximately 2 million lbm of borated ice. It is bounded on one side by the steel containment wall and is designed to provide a flow passage between the lower compartment, which holds the reactor coolant system (RCS), and the upper compartment of the containment during accident conditions. Normally the ice condenser flow passage is isolated from the containment environment by doors located at the top and bottom of the ice condenser structure, to preclude the sublimation of large quantities of ice during operation.
- **Containment Sprays.** The containment spray system is provided in the upper compartment to condense steam that bypasses the ice condenser and for use after the ice has melted. This system provides containment pressure-suppression while the containment sprays operate in the injection mode following a LOCA, and subsequently provides containment heat removal when the sprays operate in the

recirculation mode. Two spray ring headers are located near the top of the containment.

- **Air Return Fans.** The primary purpose of the air return fans (ARF) is to enhance the ice condenser and containment spray heat removal operation by circulating air from the upper compartment to the lower compartment, through the ice condenser, and then back to the upper compartment. The secondary purpose of the ARF is to limit hydrogen concentrations in potentially stagnant regions. Any steam that is produced during the blowdown to the lower compartment following an accident will mix with the air and flow through the lower inlet doors of the ice condenser. The steam portion of the mixture will condense as long as ice remains in the ice condenser and the air will continue to flow into the upper compartment through doors at the top of the ice condenser. The ARF also provides a continuous mixing of the containment compartment atmospheres for the long-term post-blowdown environment. This mixing brings fission products in contact with the ice bed, ice condenser structure and/or the upper compartment spray for removal from the containment atmosphere.

- **Hydrogen Mitigation.** The purpose of the hydrogen mitigation system (HMS) is to increase the containment capability to accommodate hydrogen that could be released during a degraded core accident. The HMS is based on the concept of controlled hydrogen ignition using thermal ignitors to induce periodic burns to moderate energy addition rates. To assure adequate spatial coverage, a total of 68 ignitors are distributed throughout various regions of the containment in which hydrogen could be released or to which it could flow in significant quantities. The primary release of hydrogen occurs from the reactor coolant system which is located in the lower compartment. The lower compartment ignitors prevent flammable mixtures from entering the ice condenser. Any hydrogen not burned in the lower compartment is carried up through the ice condenser and into the upper plenum of the ice condenser. Since steam is removed from the mixture as it is passed through the ice bed, mixtures that were nonflammable in the lower compartment due to steam inerting or insufficient hydrogen/oxygen concentration tend to be potentially flammable in the ice condenser upper plenum. Therefore, ignitors are located in the upper plenum. In the case that incomplete combustion occurs in the upper plenum region, the upper compartment also is equipped with ignitors to ensure burning of flammable mixtures in this region.

4.2.2.2 Phenomenological Issues

Because of the unique design features of the Watts Bar plant discussed above, some phenomenological issues that are not of particular concern for other plants become of particular concern for the Watts Bar Level 2 analyses. Such issues include the following:

- **Potential for High Concentrations of Hydrogen in Containment.** The use of the ice condenser system for pressure suppression allows a relatively small containment volume. This leads to relatively higher concentrations of hydrogen for severe accidents in plants of similar power levels with alternate type containments. One consequence of these higher concentrations is that the potential must be considered for combustion of hydrogen in the containment prior to vessel breach.

A second consequence of higher concentrations of hydrogen is that the potential must be considered for detonation.

- **Implications of Low Containment Ultimate Strength.** The use of the ice condenser system for pressure suppression allows the containment design pressure to be relatively low. Since design margin is typically a prescribed factor, the ultimate strength of the containment is also somewhat low. The low design pressure has been accommodated at Watts Bar using a free-standing steel containment structure. Thus, the potential for catastrophic containment failure modes must be considered at Watts Bar. Furthermore, some event sequences, such as small LOCAs, have the potential to cause a significant portion of the ice to melt prior to vessel breach, so that the pressure suppression capacity of the ice condenser could be greatly diminished at the time of vessel breach, and the resulting blowdown of the RCS could significantly challenge the low pressure design of the containment.

- **Potential for Core Debris to Directly Attack Containment Wall.** The in-core instrumentation tunnel provides a passage that could allow core debris, ejected when RCS pressure is high at the time of vessel breach, to pass from the reactor cavity to the in-core instrumentation room. Under such a scenario, core debris could melt through the instrumentation seal table and deposit against the inner wall of the steel containment. The potential must be considered for direct thermal attack of the steel containment by this debris.

4.2.2.3 MAAP Analyses

The Modular Accident Analysis Program (MAAP) code (Reference 4.2-2) has been used extensively to analyze accident scenarios specifically for the Watts Bar plant. MAAP 3.0B Version 17, as modified, was used for the analyses described in this report. MAAP is made plant-specific through the creation of a so-called "parameter file" that contains plant-specific data on plant volumes, elevations, metal masses, pump curves, etc. The Watts Bar parameter file was created and verified by Gabor, Kenton and Associates, Inc. (GKA). It was based on the Sequoyah parameter file that was originally created by TVA, then updated and verified by GKA.

MAAP was used extensively by GKA for the following purposes:

- **Confirm Plant Damage State (PDS) Binning.** MAAP simulations of transients and LOCAs of various sizes were assessed to confirm that various core damage sequences were binned to appropriate plant damage states.

- **Confirm Level 1 Success Criteria.** MAAP simulations were performed to confirm selected Level 1 success criteria.

- **Simulate Representative Sequences for Each of the Key Plant Damage States.** The transition from the front-end analysis to the back-end analysis is accomplished by binning each Level 1 core damage sequence into one of many PDSs discussed in Section 3.1.5. PDSs were subsequently rebinned into key plant damage states (KPDS) as described in Section 4.3. For each of the KPDSs, one or more representative sequences in that KPDS were simulated using MAAP. This simulation had two purposes: (1) to gain a qualitative and quantitative

understanding of how the Watts Bar-specific severe accident sequences progress and (2) to compare the Watts Bar-specific accident progressions with comparable analyses elsewhere for Watts Bar, or for similar plants such as Sequoyah. Key features of the accident progressions were noted and some of these key features included:

- Time of uncovering the top of the active core and time of vessel failure.
- RCS pressure at time of vessel failure and dispersal of core debris in containment.
- In-vessel and ex-vessel hydrogen production.
- Containment temperatures and pressures throughout the transient.
- Timing and effect of hydrogen burns.
- The effect of sprays and air return fans when these containment safety systems were available.
- Reactor building parameters where appropriate; e.g., for interfacing system LOCAs.

Section 4.7 describes the accident progression of representative KPDSs as modeled by MAAP.

- **Provide Information To Help Quantify CET Split Fractions.** MAAP was used to support the quantification of CET top event split fractions. Details of the split fraction quantification process are presented in Section 4.8.

- **Compute Source Terms.** MAAP was used to compute source terms. Section 4.9.3 presents the source term results.

- **Perform Sensitivity Studies.** Sensitivity studies were performed based on recommendations provided in the Electric Power Research Institute report, "Recommended Sensitivity Analyses for an Individual Plant Examination Using MAAP 3.0B" (Reference 4.2-3). MAAP's treatment of uncertain severe accident phenomena is controlled by the model parameters. Model parameters are used both as inputs to a given physical model and to select between alternate descriptions of a phenomenon.

  Sensitivity studies were also performed by varying the key model parameters that can control such phenomena as: hydrogen production in-vessel, the in-vessel fission product and inert aerosol release, fission product revaporization, direct containment heating and debris coolability. The sensitivity studies are discussed in Section 4.8.1.2.

4.2.2.4 RISKMAN Analyses

The RISKMAN software package was used in the Level 2 analysis to evaluate and quantify the CET for Watts Bar. Specifically, the event tree analysis module of RISKMAN was used to define, quantify and tabulate the event sequences leading from the plant damage states defined in Section 4.3 to the final end states (containment failure mode and associated release of radioactive fission products to the environment).

The RISKMAN methodology and techniques are presented in detail in Section 2.3.

4.2.2.5 STADIC Analyses

The STADIC computer code (Reference 4.2-4) was used to evaluate the probability of containment failure due to rapid pressurization. The STADIC program determines the probability of containment failure and the conditional probability that the containment failure is large or small. The probability of containment failure is assessed using the probability distributions for containment strength and imposed loading prescribed as input and then sampled many times using Monte Carlo techniques to determine the interference between the two distributions. This interference represents the probability that the imposed loading exceeds the containment strength. Further details of this application and results are presented in Section 4.8.

The STADIC program was also used to establish the uncertainties associated with release group frequencies.

4.2.2.6 Containment Ultimate Strength Analysis

Information on the containment ultimate strength analysis is presented in Section 4.4.

4.2.3 REFERENCES

4.2-1. U.S. Nuclear Regulatory Commission, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, December 1990.

4.2-2. Henry, R. E., and M. G. Plys, "MAAP-3.0B — Modular Accident Analysis Program for LWR Power Plants," Electric Power Research Institute, EPRI NP-7071-CCML, Volumes 1-3, November 1990.

4.2-3. Gabor, Kenton and Associates, Inc., "Recommended Sensitivity Analyses for an Individual Plant Examination Using MAAP 3.0B," prepared for Electric Power Research Institute Report TR-100167, November 1992.

4.2-4. PLG, Inc., "STADIC Computer Code User Manual," PLG-0689, Revision 0/PC, October 1990.

4.3 PLANT DAMAGE STATES

Each end state of the plant model ("front-end" or Level 1) event trees defines an accident sequence that results from an "initiating event," followed by the failure or success of various plant systems and/or the success or failure of operators to respond to procedures or otherwise intervene to mitigate the accident. Each accident sequence has a unique "signature" due to the particular combination of top event successes and failures. Ideally, each accident sequence that results in core damage should be evaluated explicitly in terms of accident progression and the release of radioactive materials, if any, into the environment. However, as there can be millions of such sequences, it is impractical to perform such analyses for each accident sequence. Therefore, the sequences must be grouped into plant damage state (PDS) (or accident class) bins, each of which collects sequences for which the progression of core damage, the release of fission products from the fuel, the status of the containment and its systems, and the potential for mitigating source terms are similar. Detailed analysis is then focused on specific sequences selected to represent each of these bins.

The PDS bins become the entry states (similar to initiating events for the plant model event trees) to the containment event trees (CET) and are characterized by the thermodynamic conditions in the reactor coolant system and in the containment at the time of severe core damage, and the availability or unavailability of both passive and active plant features that can terminate the accident or mitigate the release of radioactive materials into the environment.

As noted earlier, a representative accident sequence is selected for each PDS. These representative sequences are analyzed in detail with appropriate thermal-hydraulic and fission product transport codes such as the Modular Accident Analysis Program (MAAP) (Reference 4.3-1) sponsored by the industry to characterize the timing of important events (such as the onset of severe core damage and reactor vessel melt-through) as well as the nature of the core damage and fission product release.

4.3.1 SELECTION OF PLANT DAMAGE STATE PARAMETERS

As noted above, PDSs are the discrete end states of the Level 1 model for sequences resulting in core damage and the initiating events for Level 2 (containment performance) analyses. The plant damage states must be defined in such a manner that, within a plant damage state, the sequence-to-sequence variability in the containment response is small in comparison with the uncertainties in the outcomes of the CET top events. In this manner, the issue of sequence variability can be separated from the issue of containment response uncertainty, and the evaluation of split fractions for the CET top events can be limited to the assessment of containment response uncertainty.

Before PDSs are defined, the analyst must identify plant conditions, systems, and features that can have a significant impact on the potential course of an accident. Once these are identified, a table is constructed to display the potential combinations of the PDS characteristics that are physically possible, and to assign an identifier to each of these combinations. The table that results from this process is referred to as a PDS "matrix." The matrix is then reviewed by Level 1 analysts to ensure compatibility with the plant model and that appropriate dependencies are taken into account. The matrix is revised as necessary until it satisfies the requirements of Level 1 and Level 2 analysts.

In principle, the CET should be quantified separately for each PDS since the values of the CET top event split fractions are dependent on the PDS being analyzed. In practice, however, PDSs can be grouped (or binned) together to minimize the amount of CET quantification. In most cases, PDSs of lower frequency are binned with similar PDSs of higher frequency and potentially greater consequences (referred to as "conservative condensation").

The binning of sequences to plant damage states was accomplished using the special event trees discussed in Section 3.1.3.

The definition of plant damage states must incorporate:

- Information that is determined by what happens in the plant modeling phase of the analysis and therefore is input to the containment analysis.

- Information that is important to the determination of containment response during the period of time beginning with core damage through the release of radioactive materials into the environment.

The plant model information on the operability status of active systems that is important to the timing and magnitude of the release of radioactive materials must be passed into the CET via the definition of the PDS. This requires that, in addition to representing the systems and functions that are important to keeping the core cooled, the plant model event trees must also address active systems and functions important to containment isolation, containment heat removal, and the removal of radioactivity from the containment atmosphere. The containment spray system is an example of such a system.

The boundary between the plant model event trees and the containment event tree (i.e., the PDS vector) was selected for the following reasons:

- Active systems,* including the containment engineered safeguards, are included in the plant model event tree because their dependencies on support systems, such as electrical power and service water, can be determined more easily in the plant model event trees.

- The prescribed boundary separates the phenomenological CET from the plant model event trees that deal with active systems and operator actions with a well-defined interface.

- The prescribed boundary facilitates a separation between analyses of likelihood (as measured by frequency) and uncertainty (as measured by probability).

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*In some probabilistic risk assessments (PRA), such as the Reactor Safety Study (WASH-1400) (Reference 4.3-2), certain active containment systems were incorporated into the containment event trees. However, such a practice makes it difficult (if not impossible) to track system dependencies correctly. To avoid this problem, the approach used in this study places these systems in the plant model (Level 1) event trees.

This separation between plant model and containment event trees, combined with the PDS concept, allows an optimization of both the plant analysis and the containment analysis while, at the same time, providing needed flexibility in the modeling process. For example, the level of detail in the plant analysis could be significantly increased, if desired, without increasing the containment response analysis effort, if the same PDSs are maintained. The detailed information for individual sequences leading to severe core damage is, of course, available from the plant model event trees.

The CET considers the influence of physical and chemical processes on the integrity of the containment and on the release of fission products once core damage has occurred. The considerations that influence the progression of core damage, the time and mode of containment failure, and the release of radioactive materials into the environment fall into two categories:

1. The physical conditions in the reactor coolant system (RCS) and containment at the time of vessel melt-through.

2. The status and availability of containment systems.

The considerations of physical conditions in the RCS and containment that are included in the PDS matrix are as follows:

- The pressure inside the reactor vessel at the onset of core damage.
- The availability of cooling on the secondary side of the steam generators.
- Whether the refueling water storage tank (RWST) has been injected into the containment prior to the time of vessel melt-through.*

In many of the previous probabilistic risk assessments that have been performed, no distinction was made between the RCS pressure at the onset of core damage and the RCS pressure at the time of vessel breach. This distinction was not made since it was believed that the period of time between the beginning of uncovering the core and breaching the vessel was too short for either operator action or natural phenomena to occur that would alter the pressure in the RCS. However, the U.S. Nuclear Regulatory Commission analysis of Surry and Zion (NUREG-1150) (Reference 4.3-3) takes substantial credit for depressurization of the RCS after uncovering the core and prior to breaching the vessel. For example, results reported in NUREG-1150 indicate that for fast station blackout events where the RCS pressure was at the power-operated relief valve (PORV) setpoint at the time that the top of the active fuel was uncovered (UTAF), 66% of these cases had RCS pressure less than 200 psia at the time of vessel breach. For these events, depressurization prior to vessel breach results primarily from thermally induced failures of the hot leg or surge line, reactor coolant pump seal loss of coolant accidents (LOCA), and thermally induced failure of the PORVs in the open position. The RCS pressure at the time of vessel melt-through is an important parameter because of the potential for pressurized ejection of molten debris through the breach when RCS pressure is greater than 200 psia.

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*This parameter, along with the quantity of ice melted, indicates whether the cavity will be flooded prior to vessel breach or at some later time during the accident.

The higher the pressure, the more important are the effects of melt ejection. In some cases, a reduction in RCS pressure may prevent vessel breach altogether.

In this study, the pressure identified in the definition of PDSs is that which occurs at the onset of core damage; i.e., UTAF.* Events that could influence the change in pressure after the onset of core damage but prior to vessel breach are addressed in the CET.

In past PRA studies, the classification of pressurized water reactor (PWR) accident sequences into RCS pressure ranges at the onset of core damage has been correlated to initiating event type, as shown below:

Event Type	RCS Pressure
Transients (no vessel breach)	System Setpoint Pressure
Small LOCAs	High Pressure
Transients with Pressurizer PORVs Open	High Pressure
Medium LOCAs	Low Pressure
Large LOCAs	Low Pressure

The availability of steam generator secondary side cooling will determine whether the steam generator tubes will be subject to high temperatures and potential failure, if combined with high RCS pressure.

The presence of water in the reactor cavity at the time of reactor vessel melt-through is important to containment response because the interaction of this water with hot core debris can:

- Fragment and disperse the core debris from the reactor cavity into other regions of the containment.
- Cause the containment pressure to increase by vaporization of the water; i.e., steam spikes.
- Influence the phenomena associated with high pressure melt ejection.
- Influence the release of fission products from the core debris of the particulates.

The containment systems availability considerations included in the PDS matrix are as follows:

- The state of the containment (intact or failed) at the time when core damage starts; i.e., when the containment event tree is entered. This distinction includes containment isolation failure and interfacing system LOCA considerations.
- The availability of containment engineered safety features such as containment sprays, the ice condenser, and heat removal for cooling the containment

*This is a conservative definition of core damage.

atmosphere and fission product removal before and after failure of the reactor vessel.

- The availability of hydrogen control systems.

4.3.2 PLANT DAMAGE STATE MATRIX

Based on a preliminary review of the Watts Bar design, the following specific items are considered for PDS definition:

- **RCS Pressure.** The following four ranges of RCS pressure (P) at the inception of core damage have been defined:

  - P < 200 psia
  - 200 psia < P < 600 psia
  - 600 psia < P < 2,000 psia
  - P > 2,000 psia; i.e., "pegged" at the system setpoint

- **Steam Generator Cooling.** This parameter addresses whether steam generator secondary-side cooling is available.

- **RWST Injection into the Containment.** This parameter addresses whether the contents of the refueling water storage tank have been injected into the containment.

- **Containment Isolation and Bypass Status.** The following five situations are considered:

  1. Containment isolated and not bypassed.

  2. Containment not isolated or failed prior to core damage; leak area less than the equivalent of approximately 3 inches in diameter.

  3. Containment not isolated or failed prior to core damage; leak area greater than the equivalent of 3 inches in diameter.

  4. Small containment bypass; e.g., an unisolated steam generator tube rupture.

  5. Large containment bypass; i.e., a WASH-1400-type interfacing systems LOCA (V-sequence).

- **Containment Spray Operation.** Six combinations of containment spray (injection and recirculation) and residual heat removal (RHR) spray have been considered:*

  1. Containment spray injection (CSI), containment spray recirculation (CSR), and RHR sprays are available.

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*It is assumed that CSR is unavailable if CSI is unavailable.

2. Only CSI and CSR are available.

3. Only CSI and RHR spray are available.

4. Only CSI is available.

5. Only RHR spray is available.

6. No sprays are available.

- **Containment Heat Removal (CHR).** Whether heat is removed from the containment via containment spray or vessel injection and the associated heat exchangers.*

- **Ice Condenser.** The availability of the ice condenser, as a passive means for removing energy and airborne radioactive material from the containment atmosphere, is an important factor in severe accident progression and mitigation.

- **Hydrogen Control.** Operation of the containment air return fans is an important factor in assessing the distribution of energy and hydrogen throughout the containment. Operation of these fans tends to distribute hydrogen uniformly throughout the upper and lower compartments of the containment. The availability of the ignitors during severe accidents impacts the concentration at which hydrogen is burned, thereby minimizing potential challenges to the containment due to the energy released during the hydrogen combustion process. Hydrogen combustion at low concentrations spreads the heat of combustion over longer periods of time, thereby minimizing peak temperatures and associated pressures in the containment atmosphere. The recombiners are not considered, as they are sized for design basis loss of coolant accidents in which small amounts of hydrogen are produced, primarily from radiolysis over extended periods of time. Four combinations of air return fan and ignitor availability are addressed.

The coding shown in Figure 4.3-1 results in a seven-character identifier for each PDS; e.g., SXYBSYN. In this scheme, the first character (L, I, H, or S) denotes the RCS pressure at the onset of core damage. The second character (Y, X, or N) denotes the status of steam generator cooling. The third character (Y or N) denotes the status of water in the reactor cavity prior to vessel breach. The fourth character (A, B, C, D, E, F, G, H, I, J, K, or N) denotes the status of containment spray and containment heat removal systems. The fifth character (I, S, L, B, or V) in the PDS identifier denotes the status of the containment boundary at the time of vessel melt-through. The sixth character (Y or N) in the identifier addresses the availability of the ice condenser, and, finally, the last character (A, B, C, or N) in the identifier addresses the status of the hydrogen mitigation system.

The matrix shown in Figure 4.3-1 includes 12 rows representing unique combinations of RCS pressure, status of steam generator cooling, and status of reactor cavity flooding, and 48 columns denoting the status of the containment and the availability of containment

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*The Watts Bar containment fan coolers (containment atmosphere recirculation system) are automatically tripped on a safety signal. Therefore, the coolers are given no credit in severe accident analysis.

spray and heat removal systems. Figure 4.3-1 does not explicitly show that each cell in the matrix represents eight combinations of ice condenser availability and hydrogen control status.

As indicated above, the "raw PDS matrix" shown in Figure 4.3-1 contains a total of 576 cells representing 4,608 plant damage states. However, the number of PDSs analyzed could be reduced substantially because they are precluded by Watts Bar design features, the type of initiating event, a modeling assumption, or any combination of these reasons. This reduction could be performed apriori; however, through the use of appropriate rules in the RISKMAN software files, it is accomplished automatically during the Level 1 quantification process. For example, successful CHR requires:

1. Successful CSI, successful sump switchover, and essential raw cooling water to at least one containment spray heat exchanger.

2. Successful RHR spray that requires RHR in recirculation and RHR heat exchanger cooling, and both trains (by procedure). RHR spray is only initiated if containment pressure is greater than 9.5 psig and sprays have operated for more than 1 hour.

These plant features imply that CSI and CSR guarantee CHR, and therefore, RHR spray is not asked in the Level 1 model. Thus, PDSs with CSI, CSR, and RHR are precluded by plant design features or procedures and by plant modeling assumption. In addition, since successful CSI and CSR guarantee CHR, plant damage states with CSI and CSR successful and no CHR are also precluded.

4.3.3 REFERENCES

4.3-1. Henry, R. E., and M. G. Plys, "MAAP-3.0B — Modular Accident Analysis Program for LWR Power Plants," Electric Power Research Institute, EPRI NP-7071-CCML, Volumes 1-3, November 1990.

4.3-2. U.S. Nuclear Regulatory Commission, "Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," WASH-1400 (NUREG/75-014), October 1975.

4.3-3. U.S. Nuclear Regulatory Commission, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, December 1990.

RCS CONDITIONS				CONTAINMENT ISOLATION AND BYPASS STATUS																																											
				CONTAINMENT ISOLATED AND NOT BYPASSED (I)												CONTAINMENT NOT ISOLATED OR FAILED																		CONTAINMENT BYPASSED											
																LEAK < 3-INCH DIAMETER (S)												LEAK > 3-INCH DIAMETER (L)						SMALL BYPASS (B)												LARGE BYPASS (V)					
EXPECTED RCS PRESSURE AT UTAF (PSIA)	STEAM GENERATOR COOLING	RWST INJECTED INTO CONTAINMENT	CONTAINMENT SPRAY AND CHR	CSI, CSR, AND RHR		CSI AND CSR ONLY		CSI AND RHR ONLY		CSI ONLY		RHR ONLY		NONE		CSI, CSR, AND RHR		CSI AND CSR ONLY		CSI AND RHR ONLY		CSI ONLY		RHR ONLY		NONE		CSI, CSR, AND RHR	CSI AND CSR	CSI AND RHR	CSI ONLY	RHR ONLY	NONE	CSI, CSR, AND RHR		CSI AND CSR ONLY		CSI AND RHR ONLY		CSI ONLY		RHR ONLY		NONE		CSI, CSR, AND RHR	CSI AND CSR	CSI AND RHR	CSI ONLY	RHR ONLY	NONE
			SPRAYS OPERATE																																														
			CHR	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	—	—	—	—	—	—	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	—	—	—	—	—	—
				(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(N)	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
< 200 (L)	(N)	NO (N)	A = LNN																																														
		YES (Y)	B = LNY																																														
200 TO 600 (I)	(N)	NO (N)	C = INN																																														
		YES (Y)	D = INY																																														
600 TO 2,000 (H)	YES (Y)	NO (N)	E = HAN																																														
		YES (Y)	F = HAY																																														
	NO (X)	NO (N)	G = HXN																																														
		YES (Y)	H = HXY																																														
> 2,000 (S)	YES (Y)	NO (N)	I = SAN																																														
		YES (Y)	J = SAY																																														
	NO (X)	NO (N)	K = SXN																																														
		YES (Y)	L = SXY																																														

LEGEND:

CSI = CONTAINMENT SPRAY INJECTION
CSR = CONTAINMENT SPRAY RECIRCULATION
RHR = RESIDUAL HEAT REMOVAL SPRAY

PDS CODE = S X Y B S _ _

- HYDROGEN CONTROL (SEE INSERT)
- ICE CONDENSER AVAILABILITY
  - Y = AVAILABLE
  - N = NOT AVAILABLE
- CONTAINMENT NOT ISOLATED OR FAILED PRIOR TO VESSEL BREACH (EQUIVALENT DIAMETER < 3 INCHES)
- ALL SPRAYS AVAILABLE BUT NO CONTAINMENT HEAT REMOVAL
- WATER IN REACTOR CAVITY PRIOR TO VESSEL BREACH
- NO STEAM GENERATOR COOLING
- RCS PRESSURE > 2,000 PSIA

HYDROGEN CONTROL		
AIR RETURN FANS	IGNITERS	
	YES	NO
AVAILABLE	A	B
NOT AVAILABLE	C	N

SI APERTUR. CARD

Also Available On Aperture Card

Figure 4.3-1. Comprehensive Watts Bar Plant Damage State Matrix

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4.4 CONTAINMENT STRUCTURAL EVALUATION AND FAILURE CHARACTERIZATION

4.4.1 PROBABILISTIC CHARACTERIZATION OF PRESSURE CAPACITY

A plant-specific containment strength analysis was performed to determine the probability of failure as a function of internal pressure and temperature for critical failure modes of the containment. The variability in the probability of failure and the sizes of the leak areas were also estimated. Details of the overpressure capacity analysis of the Watts Bar containment structure can be found in Reference 4.4-1. The capacities are reported as probabilistic quantities in terms of median failure pressures and their associated variabilities.

A number of potential containment failure modes were investigated. The controlling failure modes were identified by ranking all of the investigated modes according to their estimated median pressure capacities. For the critical failure modes, the variabilities in the pressure capacities were estimated, which allowed for the probability of failure to be described as a function of pressure. In addition, failure modes were evaluated for high temperature conditions.

The Watts Bar pressure capacity was evaluated using limit state analyses for the various modes considered. The pressure capacities for the individual failure modes are dependent on several factors, including material properties, modeling assumptions, and postulated failure criteria. A major source of uncertainty is the expected strain resulting in failure.

Since many of the base parameters are random and the methods used to evaluate capacities are subject to some uncertainty, the pressure capacity for any failure mode is also considered to be a random variable. It is assumed that the pressure capacities have a lognormal distribution. With the pressure capacity assumed to be a lognormal random variable, and denoting it as P, the probability of failure occurring at a pressure less than a specific value, p, can be described by the following expression:

$$P_f = \text{Prob}\,(P \leq p) = \Phi\left[\frac{\ell n(p/\hat{P})}{\beta_C}\right]$$

where

P_f = the probability that failure occurs at pressure $P \leq p$.

P = the random pressure capacity.

β_C = the logarithmic standard deviation of P.

$\Phi(\bullet)$ = the cumulative distribution function for a standard normal random variable.

$\hat{P}$ = the median pressure capacity.

In the above expression, the pressure capacity for a given failure mode is probabilistically described by the following expression:

$$P = \hat{P} \bullet M \bullet S$$

in which $\hat{P}$ is the median pressure capacity, M is a lognormally distributed random variable having a unit median and a logarithmic standard deviation β_M representing the uncertainty in modeling, and β_S is also a lognormally distributed random variable with a unit median and a logarithmic standard deviation S representing the uncertainty in the material properties. The overall uncertainty in the median capacity is obtained by taking the square root of the sum of the squares of β_M and β_S.

The median pressure capacity represents the internal pressure level for which there is a 50% probability of failure (leakage) for a given failure mode. The median values are evaluated from limit state analyses for the different failure modes. The uncertainties, β_M and β_S, are associated with variability due to a lack of knowledge related to differences between the analytical model and the real structure. Modeling uncertainties are associated with the assumptions used to develop analytical models and their ability to represent the failure condition properly. The strength uncertainties are associated with variabilities related to the material resistance. Examples of the sources of such uncertainties include variability in concrete strength, steel yield strength, steel-strain relationships, and the influence of elevated temperatures on material strength.

4.4.2 WATTS BAR PRESSURE CAPACITY ANALYSIS

The capacity of the Watts Bar containment was estimated based on incipient leakage as the failure criterion. The controlling failure modes were investigated for containment metal temperatures ranging from room temperature to 800°F. The potential failure modes examined included the following:

1. Cylinder hoop failure.
2. Dome membrane failure.
3. Equipment hatch buckling.
4. Containment anchor bolt failure.
5. Personnel hatch bulkhead flexure.
6. Baseslab failure.
7. Pipe penetration failure.

In all cases, the failure modes were considered to be the result of a quasi-static pressure loading. The pressure rise times were assumed to be sufficiently long such that the dynamic transient response of the containment structure could be neglected. Also, the material temperatures were assumed to have reached a steady state, particularly after some period of time at accident temperatures.

The capacities of the various failure modes over the range of temperatures considered are shown in Table 4.4-1.

The failure mode identified as having the potential for the lowest median pressure capacity was found to be baseslab failure. Other important failure modes include equipment hatch buckling and dome membrane failure. Cylinder hoop failure and the failure of bellows at pipe penetrations were both found to be correlated with dome membrane failure.* Thus, only the most limiting of these correlated failure modes (i.e., dome membrane failure) must be addressed in the containment event tree (CET) quantification. Containment anchor bolt failure, personnel hatch bulkhead flexure, and personnel hatch door flexure were all found to have significantly higher median pressure capacities and smaller logarithmic standard deviations, such that it would be unlikely that any of these modes would fail before the first three failure modes mentioned above, so they were not addressed in the CET quantification.

Thus, three failure modes must be addressed in the CET quantification and are as follows:

- Dome membrane failure.
- Equipment hatch buckling.
- Baseslab failure.

One of these failure modes (baseslab failure) produces a large subsoil failure. The other two failure modes (dome membrane failure and equipment hatch buckling) produce catastrophic aboveground failures. No small containment failure modes were identified as being important for Watts Bar.

Evaluations of the failure pressures for these three important failure modes are discussed below.

- **Dome Membrane Failure.** An axisymmetric finite element analysis of the containment dome has previously been conducted (Reference 4.4-2). Failure of the containment is not considered likely at the yield strength of the dome material.

  Using estimated stress-strain curves for the temperatures being considered, the expected range of stress and thus, pressure capacity for a given temperature and strain range could be calculated. Table 4.4-1 shows the resulting median pressures, variabilities, and 95% confidence of nonexceedance for failure initiating in the dome. The temperatures shown in Table 4.4-1 correspond to metal temperatures. Figure 4.4-1 shows the temperature dependence of the median pressure capacity for the dome membrane failure mode.

- **Equipment Hatch Buckling.** The equipment hatch is a spherical cap, 3/4-inch thick with a 20'-0" spherical radius, fabricated from SA 516 Grade 70 plate. The hatch is inward opening (pressure seating), and sealing is provided by a double gumdrop seal ring configuration with silicone rubber rings. Figure 4.4-2 shows the hatch configuration.

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*Correlation between two failure modes implies that the uncertainties associated with predicting the failure mode arise from similar considerations; e.g., they both use the same model or they are dependent on the same material strength data. Therefore, if one failure mode has a capacity greater than the expected mean, the other failure mode will also exhibit this tendency.

A finite element analysis of the Watts Bar equipment hatch (Reference 4.4-2) resulted in a buckling pressure capacity of 137 psig. This analysis was based on an elastic-plastic analysis using a geometrically perfect cap and SA 516 Grade 70 material properties.

Results of spherical cap buckling tests indicate substantial variability (Reference 4.4-3), which is often attributed to minor geometrical imperfections. Based on the experimental results in Reference 4.4-3, a median buckling capacity of about 120 psig and a lognormal standard deviation of 0.23 are expected for the Watts Bar equipment hatch. Table 4.4-1 shows the median buckling capacity, lognormal standard deviation, and 95% confidence of nonexceedance pressures for the temperature range to 800°F. Figure 4.4-1 shows the temperature dependence of the median pressure capacity for the equipment hatch buckling mode of failure.

Buckling of the spherical cap does not necessarily lead to the formation of a crack in the cap. However, sufficient distortion of the tensile ring is expected to occur such that a "large" leak area in terms of the PRA is likely.

- **Baseslab Failure.** The Watts Bar baseslab is a 9.28-foot-thick reinforced concrete slab that supports the shield building, the containment shell, and the concrete internal structures. The slab is circular, with a keyhole sump enclosing the reactor vessel. Number 11 Grade 60 reinforcing bars are used on both faces. The concrete design strength is 4,000 psi. The capacity of the baseslab was apparently not considered in the Reference 4.4-2 evaluation of Watts Bar.

  Based on a simple, uniform axisymmetric flat plate analysis that included the weights of the slab, concrete internals, and shield building and that assumed that the plate was built at the core cavity outer radius, shear and flexure capacities were developed based on expected median strengths for both steel and concrete. A median flexural capacity of 95 psig with a lognormal standard deviation of 0.22 was calculated. The shear capacity was found to be higher.

  The above results were developed based on room temperature material properties. A thermal analysis was beyond the scope of this investigation, but it is expected that the above pressure capacity will be representative of the baseslab capacity for most accident conditions for a considerable time period into the transient.

  Flexure of the baseslab initially places the 1/4-inch liner in compression, which is initially unlikely to result in a breach of the pressure boundary. However, once a flexural hinge is formed in the slab, large deformations result from very minor increases in pressure, such that fracture of the liner must be assumed to occur shortly after hinge formation. The leak path is down through the baseslab at the outer diameter of the reactor cavity, radially outward between the slab and bedrock, and up to the top of the slab around the outer periphery.

4.4.3 REFERENCES

4.4-1. Wesley, D. A., and Hadidi-Tamjed, "Containment Overpressure Capacity for the Watts Bar Nuclear Power Plant," prepared for PLG, Inc., by EQE Engineering Consultants, August 1992.

4.4-2. Jung, J., "Ultimate Strength Analysis of the Watts Bar, Main Yankee and Bellefonte Containments," NUREG/CR-1 3724, July 1984.

4.4-3. Kaplan, A., "Buckling of Spherical Shells," from *Thin-Shell Structures*, Y. C. Fung and E. E. Sechler, Editors, Prentice-Hall, Inc., New Jersey, 1974.

Table 4.4-1. Summary of Watts Bar Containment Failure Modes

MODE	COR-RELATED WITH MODES	ASSOCIATED LEAK AREA (1)	ROOM TEMP			200 deg F			400 deg F			600 deg F			800 deg F		
			P50 (2)	Bc(3)	P05(4)	P50	Bc	P05	P50	Bc	P05	P50	Bc	P05	P50	Bc	P05
1)CYLINDER HOOP	2,7	L	165	0.11	137.7	157	0.14	124.7	140	0.15	109.4	126	0.15	98.4	122	0.16	93.8
2)DOME MEMBRANE	1,7	L	130	0.12	112.1	124	0.12	101.8	112	0.12	91.9	110	0.15	85.9	104	0.16	79.9
3)EQUIP HATCH BUCKLING		L	120	0.23	82.2	117	0.24	78.8	113	0.26	73.7	109	0.28	68.8	98	0.3	59.8
4)CONTAINMENT ANCHORAGE(5)		L	185	0.14	146.9												
5)PERSONNEL HATCH BULKHEAD	6	C	177	0.14	140.6	163	0.21	115.4	152	0.22	105.8						
6)BASESLAB FLEXURE(5)		L	95	0.22	66.1												
7)PENETRATION BELLOWS (6)	1,2	C	124	0.1	105.2	115	0.1	97.6	110	0.13	88.8	98	0.16	75.3	89	0.19	65.1

(1) L = CATASTROPHIC FAILURE; C = CONTROLLED LEAKAGE
(2) MEDIAN FAILURE PRESSURE (PSIG)
(3) COMPOSITE LOGNORMAL STANDARD DEVIATION
(4) 5th PERCENTILE OF THE LOGNORMAL DISTRIBUTION (PSIG)
(5) FAILURE LOCATION NOT SUBJECT TO CONTAINMENT ATMOSPHERE TEMPERATURE
(6) LIMITING PARAMETERS FOR FIVE TYPES OF BELLOWS
(7) NOT REQUIRED

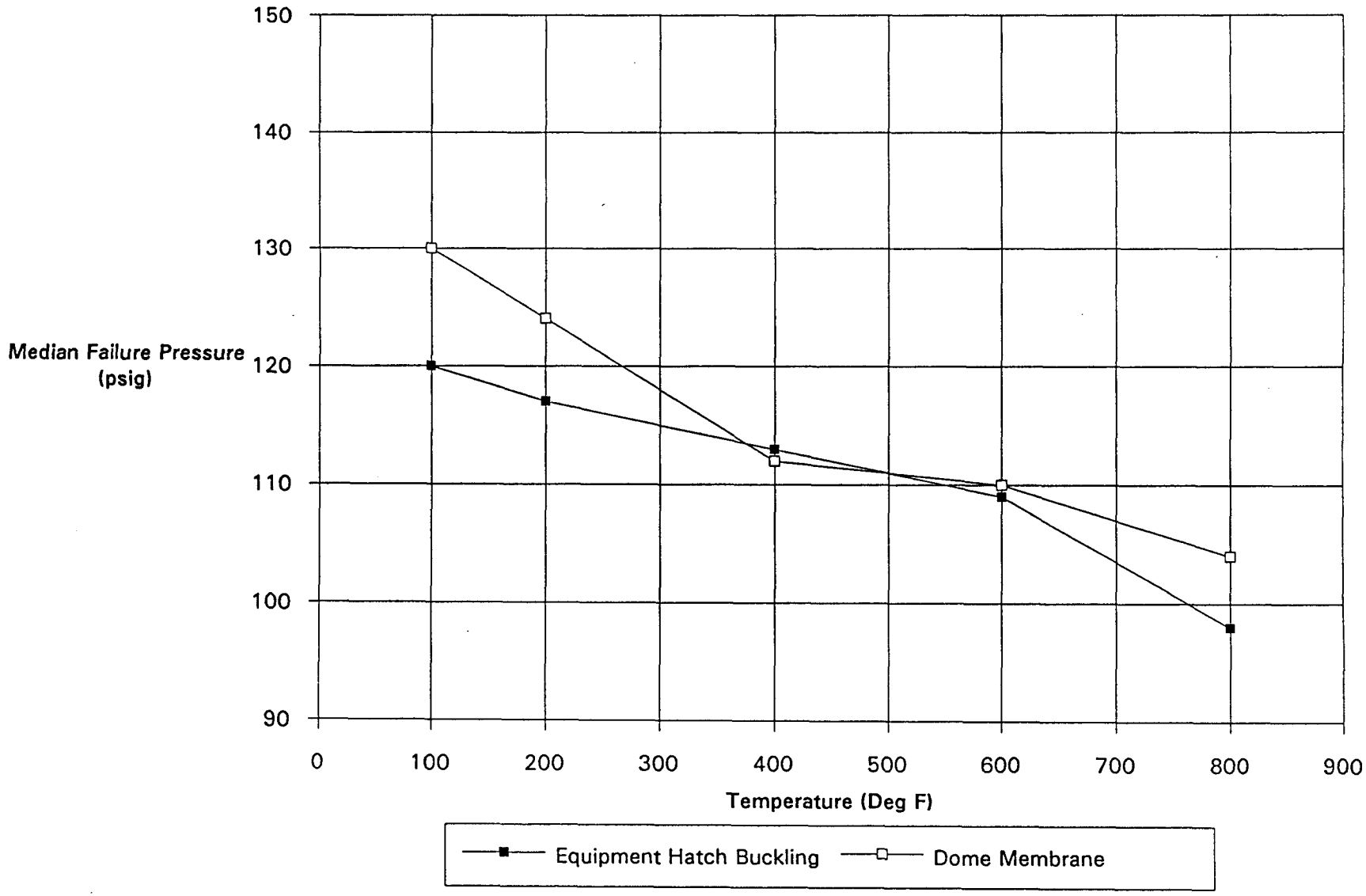

Figure 4.4-1. Temperature Dependence of Dominant Watts Bar Containment Failure Modes

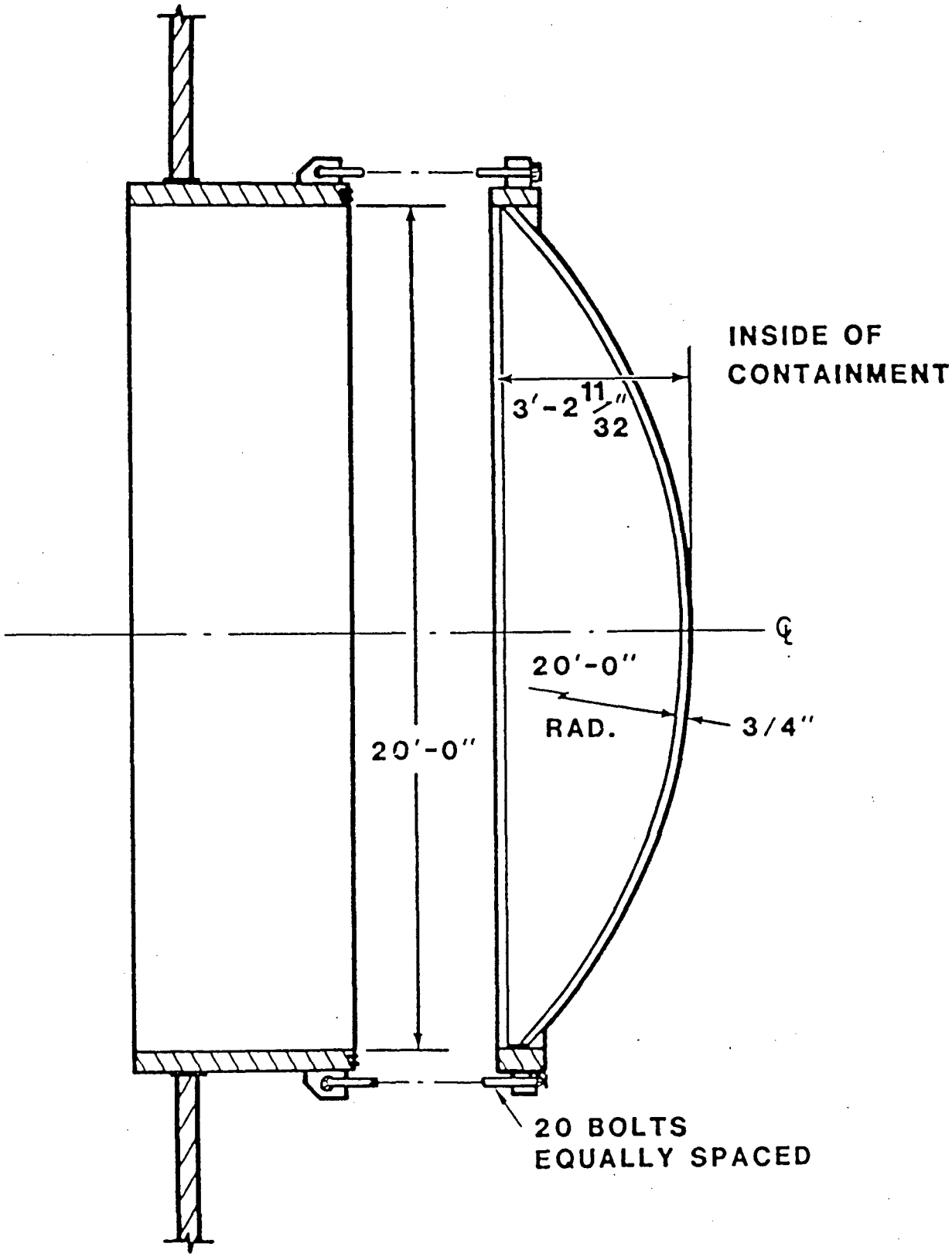

Figure 4.4-2. Equipment Hatch Configuration (from Reference 4.4-2)

4.5 CONTAINMENT EVENT TREE

The Watts Bar Nuclear Plant containment event tree (CET) considers the progression of severe accidents beginning with the onset of core damage [defined as the uncovering of the top of the active fuel (UTAF)] and addresses the events and physical processes that are important in determining the time, cause, and mode of containment failure, and the resultant release (via release categories) of radioactive fission products into the environment. The entry conditions for CET analyses are the plant damage states (PDS) discussed in Section 4.3.

The Watts Bar CET addresses events occurring prior to vessel breach (including the potential for in-vessel recovery of the damaged core), the phenomena associated with both in-vessel and ex-vessel progression of the accident, containment integrity challenges, and the potential for containment failure. If containment failure does occur, the timing and mode (i.e., a small, controlled leak or a large break and the location of such failures) of failure are also addressed.

It would be extremely impractical to develop source terms for each CET sequence. Therefore, individual CET sequences are binned into a limited number of release categories in a manner that is analogous to the binning of Level 1 core damage sequences into plant damage states. Release category assignments are governed by the release category definitions described in Section 4.9.

The Watts Bar CET has been developed with the objective to use data from the containment response analyses performed for Sequoyah in support of NUREG-1150 (Reference 4.5-1) wherever possible.

Each of the 111 top events identified in Volume 5 of NUREG/CR-4551 (Reference 4.5-2) for the Sequoyah accident progression event tree (APET) was reviewed for its applicability to the CET described here. The outcome of this review is summarized in Table 4.5-1. Many of the Sequoyah APET top events involve information already contained in the definition of the Watts Bar plant damage states. To include such events in the Watts Bar CET would be repetitious and require additional calculation time. In addition, a number of the Sequoyah APET top events have been combined into single events in the present Watts Bar CET. For other reasons (see Table 4.5-1), certain Sequoyah APET top events are also not included in the present CET. The end product of this review of Sequoyah APET top events is the selection of 30 top events (including the PDS entry condition) for the CET used to quantify Level 2 results in this study.

4.5.1 CONTAINMENT EVENT TREE LOGIC

Analysis of the Watts Bar behavior for internal initiating events resulted in a large number of accident sequences, most of which have an initially isolated containment structure for which an analysis of potential containment failure causes during the core melt scenarios is required. Nonisolated cases require an analysis of phenomena that are important for source term definition. The containment event tree provides a logic structure and systematic framework for analyzing in-plant consequences of each plant state. The logic encompasses major phenomena between plant state and release category definition. Based on insight from previous Sequoyah probabilistic risk assessment (PRA) results (primarily NUREG-1150) and NUREG/CR-5602 (Reference 4.5-3), a set of 30 top events,

including the entry state, shown in Table 4.5-2 and described in Section 4.5.2, is used in the event tree. The number of top events was balanced to provide necessary detail and, at the same time, maintain visibility and tractability. Greater detail for the top events was avoided to preserve the containment event tree as a meaningful tool to communicate key containment response considerations at a practical level of complexity. Phenomenological questions were admitted as CET top events, if they addressed one of the following issues:

1. Definition of a safe, stable state for the debris configuration either in-vessel or in the containment.

2. Dependencies for later top events in the CET, such as reactor coolant system (RCS) pressure at vessel breach, high pressure melt ejection, hydrogen burns, basemat melt-through, etc.

3. Containment failure events and failure modes.

The Watts Bar CET, encompassing approximately 116,000 accident sequences, is shown in Figure 4.5-1. Not all sequences are explicitly displayed. Instead, subtrees are defined and individually designated; e.g., X2. Then, dashed lines on the CET indicate that a transfer is made to a subtree, and the subtree is not redisplayed.

Each CET sequence terminates in an appropriate release category. Release categories are defined in Section 4.9. Each release category represents a unique containment failure mode or mechanism. The Watts Bar release category descriptions are consistent with the NUREG-1150 release category (containment failure bins) designations and nomenclature.

The first three CET sequences involve degraded core recovery; i.e., sequences in which cooling to the core is recovered with the core degraded or severely damaged, but the accident sequence is terminated before reactor vessel failure, such as in the Three Mile Island Unit 2 accident. Degraded core recovery is limited primarily to the core damage phase before debris relocation to the bottom of the reactor vessel can occur. Therefore, in general, a degraded core can only be recovered if a relatively small fraction of the core has melted. For the remaining sequences, core cooling is not restored, and core damage is assumed to progress to vessel failure.

The Event Tree Analysis module of RISKMAN is used to: (1) implement the detailed logic of the CET, (2) propagate the assigned branch probabilities for each CET sequence, and (3) combine the probabilities of all CET sequences belonging to each release category. The CET can be quantified separately for each plant damage state or it can be appended (linked) to the Level 1 trees for each initiating event. If different plant damage states have the same CET branching probabilities, these plant damage states can be grouped, and RISKMAN exercised only once for the group. The software has the capability of allowing for conditional branch probabilities. For example, the probability of a late hydrogen burn depends on whether hydrogen burns prior to or at vessel breach. Similarly, ultimate containment failure depends on the coolability of the core debris in the reactor cavity or containment.

4.5.2 DESCRIPTION OF CONTAINMENT EVENT TREE TOP EVENTS

In general, top events on the CET are time sequenced and consider major phenomenological events that could occur during the formation and relocation of core debris. Specifically, these phenomena are grouped into these phases:

1. Phenomena that occur while the damaged core is contained within the vessel.

2. Phenomena that occur during vessel breach and shortly thereafter as the core debris is dispersed to the reactor cavity and other regions of the containment.

3. Phenomena involving long-term cooling of the core debris, the containment, and the possibility of basemat penetration.

Top Events 1 through 12 address the first set of phenomena and include the possibility that the core can be recovered prior to vessel failure. Top Events 13 through 22, and 29, address the phenomenological behavior exhibited immediately after reactor vessel failure and follow it through until either debris quenching or dryout occurs. Top Events 23 through 28 address the phenomena occurring during the long term following the quenching or dryout of the debris. A description of each top event is as follows:

- **Top Event 0 — Plant Damage State (IE).** This top event simply identifies the plant damage state for which the containment event tree is to be evaluated. The containment event tree can be evaluated separately for each important plant damage state (or group of PDSs); i.e., for each plant damage state with a significant frequency of occurrence. The plant damage state at the beginning of core damage has an impact not only on the split fractions (i.e., the likelihood of success or failure) of certain top events on the CET but also on the release category assignment.

- **Top Event 1 — Containment Not Bypassed Prior to Core Damage (BY).** This top event asks whether the containment is bypassed prior to core damage; e.g., the scenario involves a faulted steam generator tube rupture (SGTR) or interfacing systems loss of coolant accident (LOCA) outside the containment. The answer to this question is passed to the CET from Level 1. Success for this path implies that there is no bypass of the containment at the time of core damage.

- **Top Event 2 — No Large Bypass Prior to Core Damage (LB).** This top event is asked for failure branches of the previous top event. The success branch for this top event indicates that the failure is small; e.g., a single steam generator tube rupture that is also faulted outside containment. The failure branch for this top event would represent a large containment bypass; e.g., a V-sequence large break in an interfacing system.

- **Top Event 3 — Core Damage Arrested Prior to Vessel Breach (CV).** This top event addresses the possibility that the damaged core can be cooled inside the vessel, thereby preventing vessel breach. Core damage arrest could be accomplished by the operator successfully activating a means of adequate core cooling after the core has started degrading but before loss of a coolable geometry occurs and before a significant amount of corium relocates to below the lower grid plate. Once the core

relocates to the region below the lower grid plate, the design of the reactor vessel lower head with all of the instrument tube penetrations will be conducive to rapid vessel head failure.* Thus, recovery after core debris relocates to the bottom of the reactor vessel is not likely.

The likelihood of successful operator action to reestablish core cooling during the time period between the commencement of core degradation and core relocation is very dependent on the sequences being analyzed.

- For a number of important transient and small LOCA sequences, the time to the beginning of core damage is relatively long (due to the large inventory of water in the steam generators) compared to the time to vessel breach once core damage occurs. Therefore, if recovery is feasible, it is much more likely to occur before core damage starts. A successful recovery would shift an accident sequence from a potentially risk-significant release category to one with minimal release.

- Once severe core damage begins the progression of core damage is rapid, partly driven by the exothermic metal-water reaction allowing only a short time for recovery of a degraded core.

- For many sequences, sustained cooldown or 5-hour delays between the initiation of the event and loss of inventory increases the time between UTAF and vessel breach (VB) significantly. These sequences are strong candidates for recovery.

Top Event CV can also be used to redirect Level 1 scenarios that were originally assumed to result in core damage but that, by virtue of detailed thermal-hydraulic analysis performed in support of Level 2, are shown to not result in core damage.

Two issues must be addressed to quantify the in-place debris cooling event. First, the conditional probability of recovering core cooling before core damage has progressed too far must be determined, given that recovery of cooling was unsuccessful in the time period from accident initiation to the beginning of core damage. The recovery phase to the start of core damage is addressed in the plant event trees and is not part of the containment analysis. The second issue involves determining the limits of core damage at which the debris is recoverable in place if core cooling is reactivated. The reactor safety community is addressing those technical issues that are associated with fragmentation, quenching, and cooling of a degraded core in place. However, substantial uncertainties still remain about the extent of core damage that is recoverable in place as well as about the size and shape of solid blockages that may develop in the lower region of the core that may inhibit in-place recovery.

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*It should be noted, however, that even if debris relocates to the bottom head region, recent research (see Reference 4.5-4) has indicated the possibility that vessel breach can be prevented if the reactor cavity is flooded to a level above the bottom of the reactor vessel lower head. Credit for this possibility is not being taken in this study.

It should be noted that substantial credit was given in the NUREG-1150 and NUREG/CR-5602 analyses for pressurized water reactors for recovery prior to vessel breach (and after the initiation of core damage). Much of this credit was associated with recovery of AC power during this time interval or with depressurization that permitted injection from low pressure makeup systems. However, it also appears as though some of the "recovery" resulted from relaxation of conservative success criteria that were used in the Level 1 analysis.

- **Top Event 4 — No Induced Pressurizer Power-Operated Relief Valve (PORV) or Safety Relief Valve (SRV) Failure (LS).** This top event is included in the Watts Bar CET to address the potential for thermal-induced failure of a pressurizer PORV or SRV in the open position due to frequent cycling at elevated temperatures. Such failures will tend to depressurize the RCS, perhaps to a level at which the effects of high pressure melt ejection can be neglected. Given that a PORV or SRV does indeed stick open after the onset of core damage, there is considerable uncertainty about whether the valve fails fully open or partially open. This uncertainty is addressed in the assignment to various ranges in Top Event 12 (RP).

- **Top Event 5 — Reactor Coolant Pump (RCP) Seal Cooling Available (SP).** When conditions (no seal injection or thermal barrier cooling) for an RCP seal LOCA exist as determined in Level 1, the failure branch of this top event is assigned a value of 1.0. When no such conditions exist, the failure branch is assigned a value of 0.0. The size of the RCP seal LOCA is addressed in Top Event 12 (RP), given that the failure path for this top event is taken.

- **Top Event 6 — No Induced Steam Generator Tube Rupture (IS).** The induced steam generator tube rupture (ISGTR) issue stems from the concern that, during postulated core melt accidents involving both high reactor coolant system pressure (in particular, when RCS pressure is at or near the pressurizer PORV setpoint) and a loss of cooling on the secondary side of the steam generator, the steam generator tubes could fail due to overheating. If such an event were to occur, the high primary system pressure would likely result in the opening of the secondary-side safety valves, thus creating a containment bypass (i.e., a ruptured and faulted steam generator) route during the time of core overheating and fission product release from the fuel.

  For an ISGTR to challenge containment integrity, it is necessary that:

  - Natural convection flows from the core and reactor vessel to the steam generator tubes are sufficient to heat the tubes to high temperatures.

  - Creep rupture of the steam generator tubes occurs at the predicted temperatures generated by the natural convection flow.

  - The steam generator tubes fail before any other breach in the primary system, such as the reactor vessel bottom, hot leg piping, or surge line.

  Note that "success" for this top event is defined as no ISGTR.

- **Top Event 7 — No Induced RCS Hot Leg or Surge Line Failure (IP).** The possibility of depressurizing the RCS by natural convection-induced heating of the RCS boundary (other than induced steam generator tube ruptures) prior to vessel failure is addressed in this top event question. Deliberate depressurization of the RCS by the operator after core damage could also be addressed in this top event. Such actions would convert otherwise high pressure core melt sequences into low pressure core melt sequences, thereby ensuring that conditions that are necessary for direct containment heating (DCH) or ISGTR have a negligible probability of occurrence. Note that "success" for this top event is defined as no induced RCS failure.

- **Top Event 8 — No Hydrogen Burn Prior to Vessel Breach (H0).** This top event questions if the containment fails prior to vessel breach because of a hydrogen deflagration or detonation. The success branch for this top event indicates that no hydrogen burn occurs prior to vessel breach.

- **Top Event 9 — No Loss of Ice Condenser Function Prior to Vessel Breach (ICE).** This top event questions whether the ice condenser function is retained up to the time of vessel breach. The ice condenser is important for its pressure suppression capability and for removing fission products from the containment atmosphere. The success of this top event implies that the ice condenser functions (pressure suppression and fission product removal) are intact at the time of vessel breach.

- **Top Event 10 — No Containment Failure Prior to Vessel Breach (C1).** This top event considers the possibility that the containment is failed or unisolated prior to vessel melt-through. As shown in Figure 4.5-2, Top Event 10 (C1) is one of four top events that address early containment failure. The possible sources of containment overpressurization at this point in the accident progression include:

  — RCS blowdown prior to reactor vessel failure.
  — Hydrogen combustion/detonation.

  The likelihood of containment failure, given a certain pressure increase, depends on the pressure capacity of the containment.

  This top event also addresses the possibility of preexisting leaks. Failure to isolate the containment will also lead to an "open containment" at the time of vessel breach. The success branch for this top event implies that the containment function is intact prior to vessel breach.

- **Top Event 11 — No Large Containment Failure Prior to Vessel Breach (L1).** This top event is asked only if Top Event 10 (C1) fails, and it addresses the size of any containment breach that exists or occurs prior to vessel breach. The success path for this top event implies a benign (small) breach in the containment, whereas the failure path addresses a large or catastrophic breach of the containment. If the containment breach is large, only two subsequent top events are evaluated to determine conditions in the containment: Top Events 18 (DBC) and 29 (SO). However, if the success path (i.e., small breach) is taken, the sequence is propagated through the remainder of the CET to determine if large, early containment failures could occur at Top Events 14 (C2) and 20 (CE).

- **Top Event 12 — RCS Pressure at Vessel Breach (RP).** This CET top event addresses the RCS pressure immediately prior to vessel breach. This top event has four branches, each of which corresponds to one of the pressure ranges defined for plant damage states. The branch that is taken for this top event is dependent on the RCS pressure at the onset of core damage and the success or failure of Top Events 4 (LS) through 7 (IP), all of which precede this top event.

- **Top Event 13 — No High Pressure Melt Ejection (ME).** This top event addresses whether the mode of vessel breach results in a pressurized ejection of core debris from the vessel. The quantification of the split fractions for this top event is strongly dependent on the RCS pressure at the time of vessel breach [Top Event 12 (RP)], the mode of vessel failure, and the amount of debris expelled from the vessel. Whether a high pressure melt ejection has occurred influences the amount of debris dispersion and the magnitude of any direct containment heating effects. These, in turn, influence the outcomes of Top Events 14 (C2), 16 (DI), and 18 (DBC). The success branch for this top event implies no high pressure melt ejection (HPME).

- **Top Event 14 — No Containment Failure at Vessel Breach (C2).** This top event addresses the threat to containment integrity resulting from (1) the pressure spike resulting from the combined effects of blowdown of the primary system, ex-vessel steam explosions, and the loads created by the phenomena associated with HPME; (2) alpha-mode failures; and (3) rocket mode failures. The failure branch for this top event represents an early containment failure.

  One mechanism for containment failure is termed the rocket mode of failure. This is postulated to occur as a result of a sudden depressurization of the reactor coolant system via the bottom of the vessel. The effluent is postulated to lift the reactor vessel upward, out of the reactor cavity, impinging on the missile shield above the vessel and into the containment. The likelihood of this failure mode is limited by the reactor vessel connections to the RCS piping.

  The phenomena associated with HPME include the thermal interaction of the dispersed core debris with the containment atmosphere, the exothermic energy added by the oxidation of metal in the dispersed debris, and the energy associated with combustion of available hydrogen. As discussed earlier, the question of HPME [Top Event 13 (ME)] strongly influences the likelihood of this top event.

  The key uncertainties that are associated with the issue of high pressure melt ejection that would determine its significance to a specific plant are as follows:

  — The fraction of the core mass that is initially ejected from the vessel.

  — The amount of aerosol that is generated and the fraction of that aerosol that is transported to various regions of the containment.

  — The amount of concurrent metal oxidation and resultant hydrogen generation and combustion.

— The rate and quantity of heat transfer to the containment atmosphere.

— The resultant pressure and temperature transient in the Watts Bar containment.

— The probability of failure of the Watts Bar containment, given the containment pressure and temperature transient.

While this top event addresses potential containment failures due to in-vessel steam explosions (alpha-mode failures) and rocket mode failures, the probability of such events is believed to be extremely low.

The success branch for this top event implies no containment failure.

- **Top Event 15 — No Large Containment Failure at Vessel Breach (L2).** This top event question is not asked unless Top Event 14 (C2) is failed. Given that containment failure occurs at vessel breach, this top event asks whether the containment failure is large or small, similar to Top Event 11 (L1). Failure at this top event implies a large, early containment failure. Once it is determined whether sprays operate after such failures and whether the ex-vessel debris can be cooled, sequences with large, early containment failures are mapped to a release category. Success relative to this top event implies a small, early containment failure, but subsequent large, early containment failures due to hydrogen burns within several hours of vessel breach might be possible so that successes at this top event continue to propagate through the CET. Alpha-mode and rocket-mode events are assumed to cause large containment failures.

- **Top Event 16 — No Direct Impingement of Debris on Seal Table Wall (DI).** This top event questions if the containment function fails due to direct contact of the ejected debris with the containment wall. The success branch of this top event denotes no loss of containment integrity due to thermal attack of the containment wall in the seal table room. As indicated in Figure 4.5-2, this mode of failure is considered to be an early containment failure.

- **Top Event 17 — Heat Removal Available Immediately after Vessel Breach (X2).** Given that containment heat removal was available prior to core damage (as determined in the Level 1 study), and thus prior to vessel breach, this top event addresses whether the containment heat removal function survives the environmental effects resulting from vessel breach. These effects include the pressure and temperature transient in the containment, the steam environment, and airborne aerosols. Failure of the top event indicates that the function of containment heat removal is failed after vessel breach. Continued operation of air return fans and containment sprays will influence steam concentrations and containment heat and radionuclides removal.

- **Top Event 18 — Debris Cooled (DBC).** Following vessel breach, core debris will be released into the reactor cavity and, depending on the pre-breach RCS pressure and whether water is in the reactor cavity, the debris can be dispersed to other regions of the containment. This top event questions whether debris released from the vessel can be cooled to inhibit concrete thermal attack (i.e., concrete ablation)

and/or the release of fission products from the debris. For scenarios involving low RCS pressure prior to vessel breach, the corium is expected to enter the cavity in the form of a so-called "gravity pour." This debris will be retained within the cavity. For cases in which the RCS pressure is high prior to vessel breach, a large fraction of the ejected core debris may be entrained by the blowdown gases and dispersed to other regions of the containment. If the debris is spread over a sufficiently large area, it might be possible that upward convection and radiation cooling of the debris alone are sufficient to prevent concrete ablation, even in the absence of an overlying layer of water. This situation is not likely in the reactor cavity but is very likely if the debris is dispersed from the cavity and not "trapped" in a confined region of the containment. It is also possible that, although an overlying layer of water is present, the debris bed is too deep to prevent thermal attack of the concrete.

Success of this top event implies that no appreciable concrete attack is occurring, thereby preventing the generation of noncondensible gases, additional hydrogen (and carbon monoxide), and the release of fission products from the debris.

- **Top Event 19 — No Early Hydrogen Burn (HE).** As depicted in Figure 4.5-2, containment failures that did not occur at vessel breach but did occur shortly after vessel breach are treated as early failures in this study. Hydrogen burns/detonations are a possible mechanism for causing containment failure within this time frame. This concern is greatest for events in which there is little or no burning prior to or at vessel breach and the containment is not inerted by steam; i.e., spray pumps and/or ice condenser are in operation.

- **Top Event 20 — No Containment Failure due to Early Burn (CE).** Success for this top event question implies that no containment failure occurs due to hydrogen burns within several hours of vessel breach. Containment failure at vessel breach, including hydrogen burn contributions, is addressed in Top Event 14 (C2). The failure path for this top event implies that the containment has failed.

- **Top Event 21 — No Large Containment Failure due to Early Burn (LE).** This top event is similar to Top Event 15 (L2) and is asked only if Top Event 20 (CE) fails. This event applies only to hydrogen burns within several hours of vessel breach. The failure branch for this top event implies a large containment failure.

- **Top Event 22 — Containment Heat Removal Available after Early Burn (XE).** This top event is similar to Top Event 17 (X2), except that it addresses the survivability of the containment sprays function following a hydrogen burn that occurs within several hours of vessel breach. This top event is accessed only for the failure branch of Top Event 19 (HE).

- **Top Event 23 — No Containment Failure due to Late Burn (CL).** Long-term containment shell integrity due to deflagrations/detonations of combustible gases is considered in this top event. This top event accounts for the possibility that flammable gas combustion could occur late in the accident progression due to the generation of hydrogen and carbon monoxide from long-term core-concrete interaction. The likelihood of this top event depends on any previous hydrogen combustion and whether the debris is cooled. If the debris is cooled, the added

source of hydrogen would be smaller. The success branch for this top event implies that the containment does not fail due to late deflagrations/detonations, if they occur.

- **Top Event 24 — No Large Containment Failure due to Late Burn (LL).** This top event is similar to Top Events 11 (L1), 15 (L2), and 21 (LE), except that it addresses containment failure due to late hydrogen burn at times greater than several hours after vessel breach. The failure branch for this top event implies that a large containment failure occurs.

- **Top Event 25 — Long-Term Containment Heat Removal Available (XLT).** Maintaining long-term containment integrity requires sustained heat removal by the containment spray system and/or operation of low pressure injection in the recirculation mode with heat removal. Failure of this top event implies that long-term containment cooling cannot be provided.

- **Top Event 26 — No Long-Term Overpressurization Containment Failure (CLT).** This top event addresses long-term overpressurization of the containment due to increased temperature and the accumulation of steam and noncondensible gases in the containment. The failure branch of this top event implies containment failure. The availability of containment heat removal in the long term will prevent containment overpressurization but will not necessarily prevent debris-concrete interaction and eventual basemat melt-through.

- **Top Event 27 — No Large Long-Term Containment Failure (LLT).** This top event addresses the size of the containment failure following any long-term overpressurization of the containment. The failure path for this top event implies a large containment failure.

- **Top Event 28 — No Basemat Penetration (BI).** Long-term basemat integrity is always considered to be maintained for sequences in which the debris is cooled because only very limited concrete attack is predicted to occur during debris quenching. If the debris is not cooled, it is conceivable that the basemat concrete penetration could be self-limiting if the debris pool becomes large. The debris can also be self-cooled if a substantial fraction of the core debris is dispersed out of the reactor cavity. The result of basemat melt-through is a release of fission products below the containment basemat. The success branch of this top event implies that there is no basemat penetration and if no other containment failure has occurred, these successes are binned to a "containment intact" release category.

- **Top Event 29 — Sprays Operate after Large, Early Failure (SO).** This top event is asked only if a large, early containment failure occurs, as denoted by the failure branch of Top Event 11 (L1), 15 (L2), or 21 (LE). If the sprays are initially available (as determined in the Level 1 analysis) and operate after containment failure, they will have a significant impact on the source term. The failure branch for this top event implies that sprays are not available or that containment failure results in failure of the sprays.

4.5.3 REFERENCES

4.5-1. U.S. Nuclear Regulatory Commission, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, December 1990.

4.5-2. Sandia National Laboratories, "Evaluation of Severe Accident Risks: Sequoyah, Unit 1," prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-4551, SAND86-1390, Vol. 5, Rev. 1, Part 2, December 1990.

4.5-3. Galyean, W. J., J. A. Schroeder, and D. J. Pafford, "Simplified Containment Event Tree Analysis for the Sequoyah Ice Condenser Containment," EG&G Idaho, Inc., prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-5602, December 1990.

4.5-4. Henry R. E., et al., "Cooling of Core Debris Within The Reactor Vessel Lower Head, *ANS Transactions,* Vol. 63, pp. 260, June 1991 (to be published in Nuclear Safety).

Table 4.5-1 (Page 1 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
1	Size and location of RCS break when the core uncovers?	To a degree, this information is implicit in the accident sequences defined by the Level 1 model; e.g., RCP seal LOCA. This APET top event is not included in the Watts Bar CET.
2	Has the reaction been brought under control?	The status of reactor shutdown is implicit in the sequences selected to represent PDSs and is not repeated in the Watts Bar CET.
3	For SGTR, are the secondary system SRVs stuck open?	Random failure of the steam generator relief valves prior to core damage has been addressed in the Level 1 model and is not included in the Watts Bar CET.
4	Status of ECCS?	The availability of the ECCS is defined in the Watts Bar Level 1 model.
5	Is the RCS depressurized by the operators?	Operator depressurization prior to uncovering the core is addressed in the Level 1 model and is not repeated in the Watts Bar CET.
6	Status of sprays?	The status of spray injection and recirculation spray systems prior to core damage is developed in the Level 1 model and is not explicitly treated as a top event in the Watts Bar CET. Failures due to severe accident conditions are accounted for in Watts Bar CET Top Event 17 (X2), which addresses the survivability of containment heat removal at vessel breach.
7	Status of AC power?	The status of AC power at the onset of core damage is contained in the Level 1 information passed to the Watts Bar CET and in the description of dominant sequences. This APET top event is not explicitly included in the Watts Bar CET.

Table 4.5-1 (Page 2 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
8	Are the RWST contents injected into the containment?	The response to this question is implicit in the Level 1 accident sequences; therefore, this APET top event is not included in the Watts Bar CET.
9	Heat removal from the steam generators?	This question is addressed in the Level 1 model (availability of steam generator cooling) and is not explicitly treated as a top event in the Watts Bar CET.
10	Is the secondary depressurized before the core uncovers?	Operator depressurization before core uncovery is addressed in the Watts Bar Level 1 model and is not specifically included in the Watts Bar CET.
11	Cooling for RCP seals?	Cooling for RCP seals is addressed in the Watts Bar Level 1 model but is also included in Watts Bar CET Top Event 5 (SP) to facilitate the determination of RCS pressure at the time of vessel breach.
12	Initial containment leak or isolation failure?	This information is developed in the Level 1 model and is not explicitly treated as a top event in the Watts Bar CET.
13	Do the operators turn on the hydrogen ignitors?	The availability of the hydrogen ignitors and operator reliability is addressed in the Level 1 model. Operability of the hydrogen ignitors after core damage is addressed in Watts Bar CET Top Event 8 (HO).
14	Status of air return fans (ARF)?	The availability of the ARFs is addressed in the Level 1 model. Watts Bar CET Top Event 8 (HO) implicitly addresses the availability of ARFs after core damage.
15	Event V—break location scrubbed by sprays?	Event V is addressed by the Watts Bar CET in Top Events 1 (BY) and 2 (LB). Failures of Top Events 1 (BY) and 2 (LB) are mapped directly to release categories. The potential for fission product scrubbing can be addressed by conservative and best estimate source terms for the corresponding release categories.

Table 4.5-1 (Page 3 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
16	RCS pressure at the start of core degradation?	This question is implicit in the Level 1 accident sequences.
17	Do the PORVs or SRVs stick open?	Random failures of the pressurizer PORVs or SRVs prior to core damage have been addressed in the Watts Bar Level 1 model. Failures due to frequent cycling at elevated temperatures after core damage has commenced are addressed as Top Event 4 (LS) in the Watts Bar CET. Such failures convert high pressure states to lower pressure states at the time of vessel breach, thus minimizing the pressure loads at vessel breach and the potential for early containment failures. Thus, given that damage has occurred, the sticking open of the PORVs may be beneficial.
18	Temperature-induced RCP seal failure?	The status of RCP seal cooling is addressed in Level 1 but is repeated in the Watts Bar CET as Top Event 5 (SP).
19	Is the RCS depressurized before breach by opening the pressurizer PORVs?	RCS depressurization that is defined in existing emergency procedures (i.e., before core degradation) has been addressed in the Level 1 model. Operator depressurization that is beyond the scope of existing procedures has not been specifically addressed in either the Level 1 or Level 2 models. Operator depressurization after the onset of core damage can be included in the CET when accident management concerns are addressed.
20	Temperature-induced SGTR?	Induced SGTR is specifically addressed in the Watts Bar CET as Top Event 6 (IS). For ISGTR, fission products are released directly into the environment, essentially independent of containment phenomena, and therefore a unique release category has been established for these events.

Table 4.5-1 (Page 4 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
21	Temperature-induced hot leg or surge line break?	RCS hot leg failures are specifically addressed in Watts Bar CET Top Event 7 (IP).
22	Is AC power recovered early?	The status of AC power prior to uncovering the core is implicit in the PDSs and sequences representing the PDSs. AC power recovery after uncovering the core is considered to be an accident management issue and is not addressed in this IPE submittal.
23	After power recovery, is core cooling reestablished promptly?	See response to APET Top Event 22.
24	Rate of blowdown to the containment?	This information is a component in the assessment of containment loading and is not specifically included in the Watts Bar CET.
25	Vessel pressure just before vessel breach?	This APET top event is included in the Watts Bar CET as Top Event RP. This top event has four branches to account for different pressure ranges.
26	Is core damage arrested? No vessel breach?	The NUREG-1150 analysis for Sequoyah takes substantial "credit" for core damage arrest prior to vessel breach, although time windows for operator actions are generally short. In some cases, this "recovery" is based on realistic (versus FSAR) success criteria. This top event has been included in the Watts Bar CET and will be quantified where appropriate.
27	Early sprays?	This information is implicit in the PDS definition and will not be repeated in the CET.
28	Early air return fans?	See response to APET Top Event 27.

Table 4.5-1 (Page 5 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
29	Has the ice melted out of the ice condenser before VB?	Effectiveness of the ice condenser up to the time of vessel breach is addressed specifically in Watts Bar CET Top Event 9 (ICE).
30	Have bypass paths developed in the IC before VB?	See response to APET Top Event 29.
31	Are the air return fans effective before Hydrogen Ignition?	This information is implicit in Watts Bar Top Event 8 (HO).
32	Is the bulk of the blowdown flow diverted from the lower compartment to the upper compartment via the floor drains?	This APET top event is not included explicitly in the Watts Bar CET, but it is assessed implicitly in Watts Bar CET Top Event 9 (ICE).
33	What is the steam concentration in the lower compartment and the oxygen distribution in containment during core degradation?	This APET top event is not included explicitly in the Watts Bar CET, but it is assessed implicitly in Watts Bar CET Top Event 8 (HO).
34	What is the steam concentration in the IC during core degradation?	See response to APET Top Event 33.
35	What is the steam concentration in the upper compartment during core degradation?	See response to APET Top Event 33.

Table 4.5-1 (Page 6 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
36	Early baseline pressure?	This APET top event is not included explicitly in the Watts Bar CET; however, the baseline pressure is addressed in Watts Bar CET Top Event 10 (C1), when the containment is pressurized significantly prior to vessel breach; e.g., if a hydrogen burn occurs at Watts Bar CET Top Event 8 (H0).
37	Time of accumulator discharge?	See response to APET Top Event 36.
38	Amount of hydrogen release in-vessel during core degradation?	This top event is not included explicitly in the Watts Bar CET but is implicit in Watts Bar CET Top Event 8 (H0) addressing hydrogen burn before vessel breach question.
39	Amount of zirconium oxidized in-vessel during core degradation?	See response to APET Top Event 38.
40	Fraction of in-vessel hydrogen released from the RCS during core degradation?	See response to APET Top Event 38.
41	To what degree is the hydrogen mixed in the upper compartment?	See response to APET Top Event 38.
42	Distribution of hydrogen in containment during core degradation?	See response to APET Top Event 38.
43	What is the hydrogen concentration in the lower compartment, and the burn completeness if ignited?	See response to APET Top Event 38.

Table 4.5-1 (Page 7 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
44	What is the hydrogen concentration in the IC, and the burn completeness if ignited?	See response to APET Top Event 38.
45	What is the hydrogen concentration in the upper plenum of the IC, and the burn completeness if ignited?	See response to APET Top Event 38.
46	What is the hydrogen concentration in the upper compartment, and the burn completeness if ignited?	See response to APET Top Event 38.
47	Are the hydrogen ignitors operating during core degradation?	The operability of hydrogen ignitors is passed onto the CET from the Watts Bar Level 1 model. This APET top event is also implicit in Watts Bar CET Top Event 8 (H0).
48	Does hydrogen ignition occur in the lower compartment during core degradation?	This APET top event is modeled as Top Event 8 (H0) in the Watts Bar CET. Questions related to containment failures prior to vessel breach are addressed in Top Events 10 (C1) and 11 (L1).
49	Does hydrogen ignition occur in the IC during core degradation?	See response to APET Top Event 48.
50	Does hydrogen ignition occur in the upper plenum during core degradation?	See response to APET Top Event 48.
51	Does hydrogen ignition occur in the upper compartment during core degradation?	See response to APET Top Event 48.

Table 4.5-1 (Page 8 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
52	Is there a transition to detonation (DDT) in the IC during core degradation?	See response to APET Top Event 48.
53	Is there a DDT in the upper plenum of the IC during core degradation?	See response to APET Top Event 48.
54	Pressure rise in containment due to early deflagration?	See response to APET Top Event 48.
55	Impulse from detonation in IC during core degradation?	See response to APET Top Event 48.
56	Impulse from detonation in upper plenum of IC during core degradation?	See response to APET Top Event 48.
57	Containment failure criteria for pressure and impulse loading?	See response to APET Top Event 48.
58	Early containment failure and mode of failure?	See response to APET Top Event 48.
59	Status of IC before VB?	This APET top event is modeled implicitly in Watts Bar CET as Top Event 9 (ICE), which addresses functionality of the ice condenser up to the time of vessel breach.
60	Are ARFs or ducting impaired due to early burns?	This APET top event is not explicitly modeled in Watts Bar CET. Early containment heat removal capability, however, is addressed in Watts Bar CET Top Event 22 (XE).

Table 4.5-1 (Page 9 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
61	Are sprays impaired due to early containment failure or environment?	See the response to APET Top Event 60.
62	What fraction of hydrogen released in-vessel is in containment at VB?	This APET top event is not explicitly modeled in the Watts Bar CET. The amount of hydrogen that is releasad into the containment depends primarily on PDS description and the release paths from the RCS to the containment that exist following UTAF. The amount of hydrogen released is modeled implicitly in Watts Bar CET Top Event 19 (HE), which addresses early hydrogen burns.
63	Level of cavity flood at VB?	This APET top event is not explicitly modeled in the Watts Bar CET. The degree of cavity flooding prior to vessel breach can be determined from sequences representing the PDSs of interest.
64	Does an alpha mode event fail both the vessel and the containment?	This APET top event is implicitly modeled in Watts Bar CET Top Event 14 (C2).
65	Type of VB?	This APET top event is implicit in Watts Bar CET Top Event 12 (RP).
66	Fraction of core released from the vessel at breach?	This APET top event is addressed in Watts Bar CET Top Events 13 (ME) and 14 (C2).
67	Level of core released from the vessel at breach?	See response to APET Top Event 66.
68	Fraction of the core released at VB that is diverted to the in-core instrumentation room?	This APET top event is implicitly modeled in Watts Bar CET Top Event 16 (DI).

Table 4.5-1 (Page 10 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
69	Level of the core ejected to the in-core instrumentation room at VB?	See response to APET Top Event 68.
70	Does the vessel become a "rocket" and fail the containment or bypass the IC?	Failure of the containment due to the so-called rocket effect is addressed in Watts Bar CET Top Events 14 (C2) and 15 (L2).
71	Ex-vessel steam explosion at VB?	The effect of an ex-vessel steam explosion is included in the quantification of Watts Bar CET Top Event 14 (C2) for high pressure melt ejection. For low pressure and pour-type melts, the ex-vessel steam explosion affects the coolability of debris and the amount of core involved in CCI. The effect of ex-vessel steam explosion for pour-type melts is addressed in the quantification of Watts Bar CET Top Event 18 (DBC).
72	Size of hole in vessel (after ablation)?	The size of the hole is implicit in the loads analyzed for Watts Bar CET Top Events 14 (C2) and 15 (L2).
73	Maximum peak pressure rise at VB? (For cases that do not involve HPME with subsequent dispersal from the reactor cavity.)	The containment pressure loads at vessel breach are a component of the quantification of split fractions for Watts Bar CET Top Event 14 (C2).
74	Maximum peak pressure rise at VB? (For cases that involve HPME with the RCS at intermediate pressure and significant hydrogen present at VB.)	See response to APET Top Event 73.

Table 4.5-1 (Page 11 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
75	Maximum peak pressure rise at VB? (For cases that involve HPME with the RCS at intermediate pressure and significant hydrogen burned before VB, or HPME occurs with the RCS at high pressure.)	See response to APET Top Event 73.
76	Level of IC bypass at VB?	This APET top event is modeled in the Watts Bar CET as Top Event 9 (ICE).
77	Peak pressure rise at VB? (Correction for times of IC bypass.)	See response to APET Top Event 73.
78	Containment failure by direct core contact with the containment wall?	This APET top event is modeled in Watts Bar CET as Top Event 16 (DI).
79	What fraction of potentially oxidizable metal in the ejected core is oxidized at VB?	This APET top event is not explicitly modeled but is addressed in Watts Bar Top Events 19 (HE), 20 (CE), and 21 (LE).
80	What amount of the hydrogen is released to containment at VB?	This APET top event is implicitly modeled in Watts Bar CET Top Event 19 (HE), which addresses early hydrogen burns.
81	What fraction of hydrogen in containment is consumed at VB?	See response to APET Top Event 80.
82	Containment failure at VB and mode of containment failure?	This APET top event is implicitly modeled in Watts Bar CET Top Events 14 (C2) and 15 (L2).

Table 4.5-1 (Page 12 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
83	Status of the IC immediately after VB?	This APET top event is not modeled in the Watts Bar CET. It is assumed that the ice condenser functions are lost shortly after vessel breach.
84	Are ARFs or ducting impaired due to burns at VB?	This APET top event is not explicitly modeled. However, Watts Bar CET Top Event 17 (X2) addresses the availability of containment heat removal after vessel breach.
85	Are sprays impaired due to containment failure or environment at VB?	The only spray system components located inside the containment are the spray nozzles and associated piping and the containment sump. Clogging of the pump suction with debris is the only failure mechanism with a significant probability of occurrence. This top event is included in the Watts Bar CET as Top Event 17 (X2).
86	Fraction of core not participating in HPME that is available for CCI?	This APET top event is modeled implicitly in Watts Bar CET Top Events 13 (ME), 16 (DI), and 18 (DBC).
87	Level of core not participating in HPME that is available for CCI?	See response to APET Top Event 86.
88	Is the debris bed in a coolable configuration?	Debris bed coolability is addressed in Watts Bar CET Top Event 18 (DBC).
89	What is the nature of the prompt CCI?	This APET top event is modeled implicitly in Watts Bar CET Top Event 18 (DBC).
90	Is AC power recovered late?	Recovery actions after the onset of core damage are not currently included in the Watts Bar CET.

Table 4.5-1 (Page 13 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
91	Late sprays?	This APET top event is modeled implicitly in Watts Bar CET Top Event 25 (XLT).
92	Late ARFs?	See response to APET Top Event 91.
93	Is the IC melted or bypassed within the first hour of prompt CCI?	This APET top event is not addressed in Watts Bar CET. See the response to APET Top Event 83.
94	Late containment pressure?	This information is implicit in Watts Bar CET Top Events 23 (CL) and 26 (CLT).
95	Amount of hydrogen (plus hydrogen-equivalent of carbon monoxide and carbon dioxide) generated during prompt CCI?	The amount of combustible gases produced during CCI is addressed in the quantification of Watts Bar CET Top Events 19 (HE) and 23 (CL).
96	What amount of oxygen remains in the containment late?	The amount of hydrogen that burns and the oxygen that is consumed is addressed in Watts Bar CET Top Events 14 (C2), 20 (CE), and 23 (CL). The amount of oxygen that leaks from the containment is not addressed.
97	Amount of hydrogen in the containment after prompt CCI?	The amount of hydrogen produced by CCI is addressed by Watts Bar CET Top Events 19 (HE), 20 (CE), and 21 (LE).
98	How much steam is in containment late?	The amount of steam in the containment is addressed in Watts Bar CET Top Event 23 (CL).

Table 4.5-1 (Page 14 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
99	What is the inert level in the containment, and is there sufficient hydrogen or oxygen for burns?	The potential for late hydrogen (all combustible gases) burns is addressed in Watts Bar CET Top Event 23 (CL).
100	Late hydrogen ignitors?	This APET top event is implicit in Watts Bar CET Top Event 23 (CL), which addresses the late ignition of combustible gases.
101	Is there a late deflagration in the containment?	Early hydrogen burns are addressed in Watts Bar CET Top Event 19 (HE). Late hydrogen burns are addressed in Watts Bar CET Top Event 23 (CL).
102	Pressure rise due to late deflagration?	The pressure rise due to a late hydrogen burn is implicitly addressed in Watts Bar CET Top Event 23 (CL).
103	Late containment failure and mode of failure?	The probability of containment failure and size of failure due to late burns are addressed in Watts Bar CET Top Events 23 (CL) and 24 (LL), respectively.
104	Are sprays impaired due to late containment failure or environment?	The effects of spray and containment heat removal failures due to containment failure can be addressed in the source terms defined for the release categories. Long term containment heat removal is addressed in Watts Bar CET Top Event 25 (XLT).
105	Is AC power recovered very late?	Recovery actions after the onset of core damage are not included in the Watts Bar CET.
106	Very late sprays?	See response to APET Top Event 104.

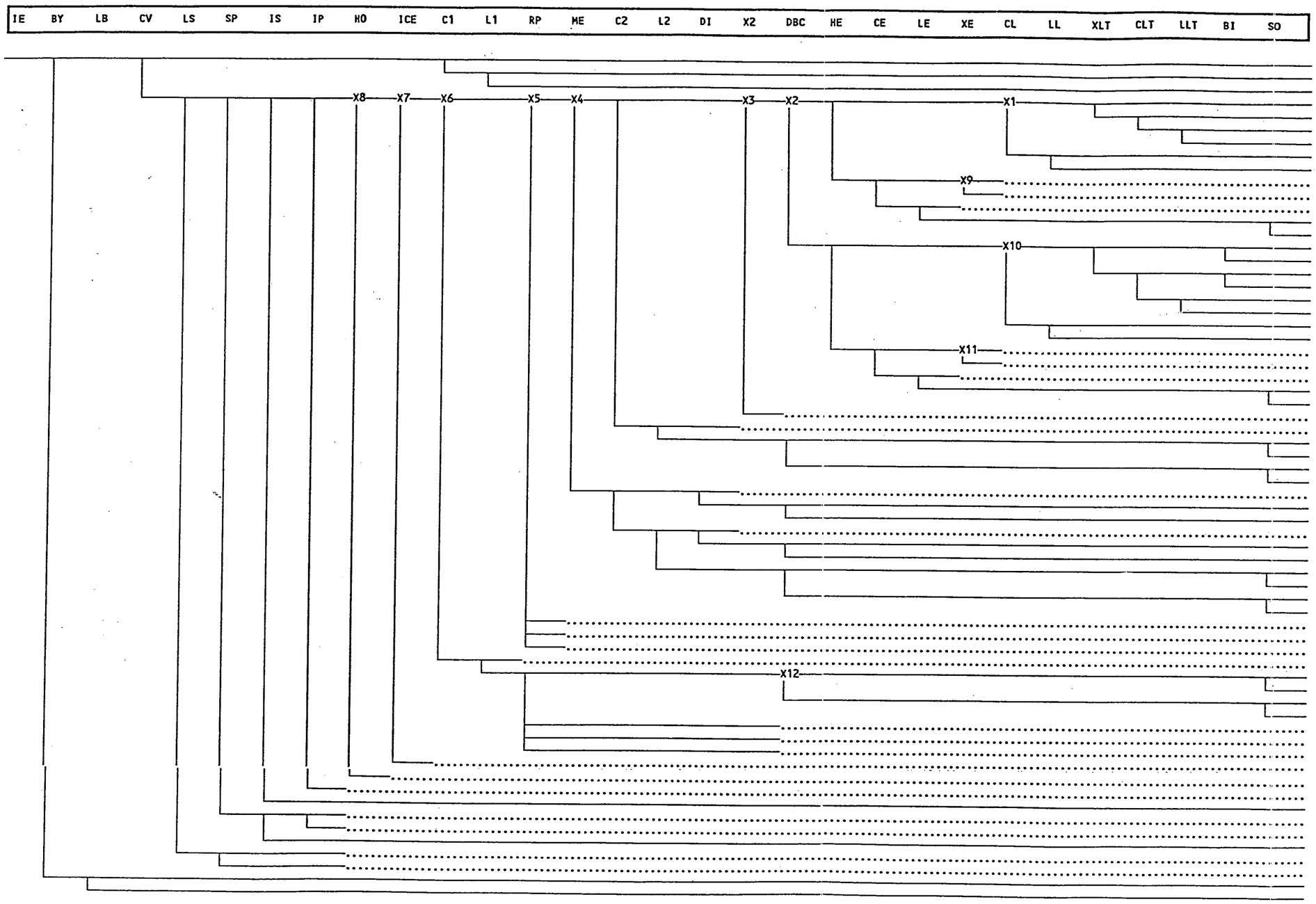
Table 4.5-1 (Page 15 of 15). Applicability of NUREG-1150 Sequoyah APET Top Events to Watts Bar CET		
NUREG-1150 APET Top Event		Applicability to Watts Bar CET
Number	Description	
107	Eventual basement melt-through (BMT)?	This top event is included in the Watts Bar CET Top Event 28 (BI).
108	What is the very late pressure in the containment?	This APET top event is implicitly addressed in Watts Bar CET Top Event 26 (CLT).
109	Very late containment failure and mode of failure?	This APET top event is addressed in Watts Bar CET Top Events 26 (CLT) and 27 (LLT).
110	Sprays after very late containment failure?	See response to APET Top Event 104.
111	Does core concrete attack occur after late boil-off and very late containment failure?	This APET top event is not considered in the Watts Bar CET.

Table 4.5-2. Containment Event Tree Top Event Descriptions

Top Event	Description
0. IE	Plant Damage State
1. BY	Containment Not Bypassed Prior to Core Damage
2. LB	No Large Bypass Prior to Core Damage
3. CV	Core Damage Arrested Prior to Vessel Breach
4. LS	No Induced Pressurizer PORV or SRV Failure
5. SP	Reactor Coolant Pump Seal Cooling Available
6. IS	No Induced Steam Generator Tube Rupture
7. IP	No Induced RCS Hot Leg or Surge Line Failure
8. HO	No Hydrogen Burn Prior to Vessel Breach
9. ICE	No Loss of Ice Condenser Function Prior to Vessel Breach
10. HC1	No Loss of Containment Failure Prior to Vessel Breach
11. L1	No Large Containment Failure Prior to Vessel Breach
12. RP	RCS Pressure at Vessel Breach
13. ME	No High Pressure Melt Ejection
14. C2	No Containment Failure at Vessel Breach
15. L2	No Large Containment Failure at Vessel Breach
16. DI	No Direct Impingement of Debris on Seal Table Wall
17. X2	Heat Removal Available Immediately after Vessel Breach
18. DBC	Debris Cooled
19. HE	No Early Hydrogen Burn
20. CE	No Containment Failure due to Early Burn
21. LE	No Large Containment Failure due to Early Burn
22. XE	Containment Heat Removal Available after Early Burn
23. CL	No Containment Failure due to Late Burn
24. LL	No Large Containment Failure due to Late Burn
25. XLT	Long-Term Containment Heat Removal Available
26. CLT	No Long-Term Overpressurization Containment Failure
27. LLT	No Large Long-Term Containment Failure
28. BI	No Basemat Penetration
29. SO	Sprays Operate after Large, Early Failure

MODEL Name: WATTSBAR
Event Tree: CET

11:07:44 31 JUL 1992



1		1
2		2
3		3
4		4
5		5
6		6
7		7
8		8
9		9
10	X1	10-15
11	X1	16-21
12	X9	22-33
13		34
14		35
15		36
16		37
17		38
18		39
19		40
20		41
21		42
22		43
23	X10	44-51
24	X10	52-59
25	X11	60-75
26		76
27		77
28	X2	78-151
29	X3	152-299
30		300
31		301
32		302
33		303
34	X3	304-451
35		452
36		453
37	X3	454-601
38		602
39		603
40		604
41		605
42		606
43		607
44	X4	608-1211
45	X4	1212-1815
46	X4	1816-2419
47	X5	2420-4835
48		4836
49		4837
50		4838
51		4839
52	X12	4840-4843
53	X12	4844-4847
54	X12	4848-4851
55	X6	4852-9699
56	X7	9700-19395
57	X8	19396-38787
58		38788
59	X8	38789-58180
60	X8	58181-77572
61		77573
62	X8	77574-96965
63	X8	96966-116357
64		116358
65		116359

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Figure 4.5-1. Watts Bar Containment Event Tree

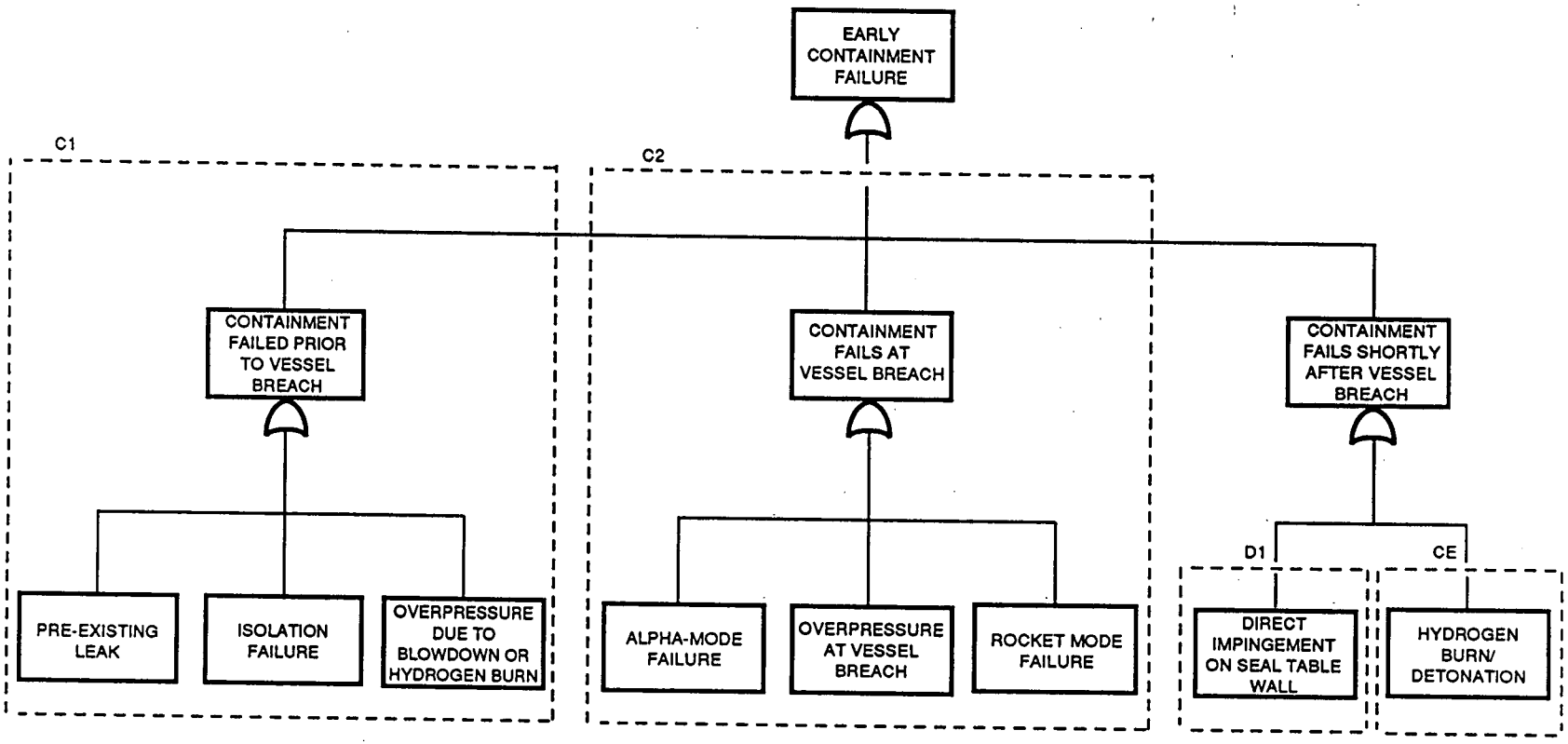

Figure 4.5-2. Contributors to Early Containment Failure

4.6 KEY PLANT DAMAGE STATES AND REPRESENTATIVE SEQUENCES

4.6.1 SELECTION OF KEY PLANT DAMAGE STATES FROM LEVEL 1 RESULTS

As shown in Table 4.6-1, the Level 1 model identified 26 plant damage states (PDS) with a frequency of 1×10^{-7} or greater per reactor-year. For Level 2 analysis, these PDSs are condensed into a reduced set of key plant damage states (KPDS). This condensation process is described in this section and is based on the individual plant examination (IPE) reporting criteria established by the U.S. Nuclear Regulatory Commission (NRC) in Appendix 2 of Generic Letter No. 88-20 (Reference 4.6-1). The process takes advantage of the known frequency and the relative severity or consequence potential for each PDS. In Section 2.2.2.5 of NUREG-1335 (Reference 4.6-2), it is stated that "all accident sequences (represented now by plant damage states or bins) that meet the screening criteria should be represented by containment event trees (CET) according to standard practice." Thus, the approach used in this submittal is believed to be in full compliance with the IPE intent.

Because the PDSs represent "functional accident sequences," the KPDSs (each of which requires a detailed Level 2 analysis) are selected on the basis of the PDS frequencies in comparison to the IPE reporting criteria. Table 4.6-2 lists the IPE criteria for selecting important accident sequences and the interpretation of these criteria for the Level 2 portion of the Watts Bar IPE. On the basis of the Level 2 functional sequence selection criteria summarized in Table 4.6-2, the following 17 KPDSs (for guidance on how to interpret KPDS see Figure 4.3-1 in Section 4.3) were identified for Watts Bar:

KPDS	PDS Frequency per Reactor-Year	KPDS Frequency per Reactor-Year	Subsumed PDSs
ENI (HANNI)	1.4×10^{-4}	1.4×10^{-5}	
FCI (HAYCI)	9.0×10^{-5}	9.0×10^{-5}	
FNI (HAYNI)	4.4×10^{-5}	4.4×10^{-5}	
LCI (SXYCI)	1.5×10^{-5}	1.5×10^{-5}	
GNI (HXNNI)	8.3×10^{-6}	8.3×10^{-6}	
BCI (LNYCI)	5.7×10^{-6}	5.7×10^{-6}	
ENS (HANNS)	4.8×10^{-6}	4.8×10^{-6}	
EIB (HANIB)	3.7×10^{-6}	3.7×10^{-6}	
HGI (HXYGI)	3.1×10^{-6}	3.1×10^{-6}	GNS,FCB,FCS,KTL,ETL,FNS
ENB (HANNB)	2.7×10^{-6}	2.7×10^{-6}	
EGI (HANGI)	2.3×10^{-6}	2.3×10^{-6}	
KNS (SXNNS)	2.2×10^{-6}	2.2×10^{-6}	
KNI (SXNNI)	2.2×10^{-6}	2.2×10^{-6}	
FGI (HAYGI)	2.1×10^{-6}	2.1×10^{-6}	
HNI (HXYNI)	2.0×10^{-6}	2.0×10^{-6}	
HCI (HXYCI)	1.6×10^{-6}	1.6×10^{-6}	
LNI (SXYNI)	1.4×10^{-6}	1.4×10^{-6}	

In addition to these 17 KPDSs, the V-sequence PDS [ATV (LNNTV)] is also given visibility in the Level 2 analysis, but its frequency (4.1×10^{-8} per reactor year) is extremely low and will not be a significant contributor to risk. The KPDSs, as well as other PDSs whose frequency was subsumed into the KPDS frequency, are identified in Table 4.6-1 as being "analyzed" in Level 2. As indicated in Table 4.6-1, more than 99% of the core damage frequency (CDF) has been addressed in Level 2, although some PDSs (i.e., functional sequences) with frequencies less than 1.0×10^{-6} per reactor-year were addressed by subsuming the PDS frequency into KPDS EIB (HANIB). Preliminary Modular Accident Analysis Program (MAAP) analysis of the representative sequence [steam generator tube rupture (SGTR) with a stuck-open steam generator relief valve faulted outside of containment] for EIB indicated a very significant source term. PDS FCB (HAYCB) was rebinned to EIB since it also represented an SGTR bypass, and its frequency was much lower than that of EIB. No specific guidance is given in Generic Letter No. 88-20 regarding screening criteria for sequences involving containment isolation failures. There are two Watts Bar PDSs (KTL and ETL) involving large (e.g., purge lines) containment isolation failures with frequencies greater than the screening criterion (1×10^{-7} per reactor-year) for functional sequences involving containment bypass. The combined frequency of these two PDSs (4.1×10^{-7} per reactor-year) was subsumed into KPDS EIB. There are three PDSs (GNS, FCS, and FNS) involving small isolation failures with frequencies between 1×10^{-7} and 1×10^{-6} per reactor-year. The combined frequency of these three PDSs is 9.8×10^{-7} per reactor year and was also rebinned to EIB. The net effect of subsuming all of these PDSs into EIB was to increase its frequency by approximately 55% to 5.5×10^{-6} per reactor-year.

A second level of "screening" is required to address the availability of hydrogen control systems (air return fans and ignitors). As shown in Table 4.6-3, one PDS (ENS) has four combinations of hydrogen system control availability with frequencies greater than 1×10^{-7} per reactor-year. The dominant sequences in this PDS are containment bypasses [reactor coolant pump (RCP) seal return lines] caused by failure to isolate the containment. Thus, each combination was separately represented in the Level 2 quantification. Key plant damage state ENI had three combinations of hydrogen control system availabilities that exceeded the screening criteria of 1×10^{-6} per reactor-year for function sequences not involving bypass. Each combination was separately addressed in the Level 2 analysis. Key plant damage states KNS and KNI each had two combinations of hydrogen control system availabilities. These combinations were also separately addressed in the Level 2 quantification process.

4.6.2 SELECTION OF REPRESENTATIVE ACCIDENT SEQUENCES FOR SEVERE ACCIDENT ANALYSIS

This section defines the accident sequences that were selected to represent the KPDSs.

4.6.2.1 Key Plant Damage State ENI (HANNI)

The highest frequency sequence to plant damage state ENI is initiated by a total loss of all essential raw cooling water (ERCW). Since ERCW provides the ultimate heat sink for many safety systems, numerous systems are unavailable in this sequence. In particular, component cooling system (CCS) and the charging pumps are unavailable. The operators trip the RCPs in response to the loss of CCS. However, the loss of all seal cooling leads to an eventual seal loss of coolant accident (LOCA). Auxiliary feedwater operates

successfully, and the operators depressurize the steam generators to cool down the reactor coolant system (RCS) shortly after the seal LOCA develops. Core damage occurs due to the loss of all high pressure injection. The residual heat removal (RHR) and containment spray pumps are assumed to operate in the injection mode while taking suction from the refueling water storage tank (RWST) inventory. However, the RHR and containment spray pumps are unavailable during recirculation due to the loss of ERCW and CCS cooling.

The air return fans operate successfully, and the hydrogen ignitors are energized. The containment isolates automatically.

A second sequence is initiated by a loss of train A of 6.9-kV shutdown power. An independent failure of a specific train B 480V shutdown board also occurs. The loss of these two support system trains leads to the loss of CCS train A and of both CCPs for RCP seal injection. A seal LOCA eventually develops. The safety injection pumps are also unavailable. Core damage results from the loss of all high pressure injection. The RHR and containment spray pump trains are also unavailable due to the loss of these two support trains.

The B train air return fan operates successfully, but the hydrogen ignitors in this sequence cannot be energized due to the power failures. The containment isolates automatically.

A third sequence assigned to plant damage state ENI is initiated by a loss of offsite power that is not recovered within the first hour. The onsite diesel generators also fail to provide shutdown power as a backup. The loss of all seal cooling leads to an eventual seal LOCA without high pressure injection. Electric power is not restored prior to core damage. Turbine-driven auxiliary feedwater is available, and the operators initiate steam generator depressurization to limit the rate of seal leakage.

In this sequence, both the air return fans and the hydrogen ignitors are unavailable due to the loss of all AC power. The containment isolates automatically.

4.6.2.2 Key Plant Damage State FCI (HAYCI)

The highest ranked sequence to plant damage state FCI is initiated by a small LOCA, which is assumed to occur at the RCP seals of one pump. The plant trips, and a safety injection signal is generated. Both the charging pumps and the safety injection pumps actuate to provide RCS inventory control at high pressure. Containment spray pumps come on in response to a Phase B condition. Later, automatic swapover of RHR suction to the containment sump is successful, but the operators fail to align for high pressure recirculation; i.e., the discharge of the RHR pumps is not aligned to the suction of the charging or safety injection pumps.

Auxiliary feedwater is successful, and the operators are assumed to depressurize the steam generator in accordance with procedures at about 15 minutes after plant trip. Both RHR pumps and both spray pumps are assumed to be available for recirculation from the sump.

The air return fans operate, and the hydrogen ignitors are energized. The containment isolates successfully.

A second sequence was evaluated for this plant damage state. It is also initiated by a small LOCA, which is assumed to occur at the RCP seals of one pump. The plant trips, and a safety injection signal is generated. Both the charging pumps and the safety injection pumps actuate to provide RCS inventory control at high pressure.

Containment spray pumps actuate in response to a Phase B condition. However, the RHR pumps both fail to operate. In addition, the operators fail to provide makeup to the RWST via the containment spray system.

Auxiliary feedwater is successful, and the operators are assumed to depressurize the steam generator in accordance with procedures at about 15 minutes after plant trip. Both spray pumps are available for recirculation from the sump.

4.6.2.3 Key Plant Damage State FNI (HAYNI)

The highest frequency sequence assigned to plant damage state FNI begins with a loss of both trains of CCS on Unit 1. This system failure results in a loss of cooling to the RCP thermal barrier heat exchangers, and to the upper and lower RCP motor bearings of all four pumps. The loss of motor bearing cooling means that after a period of time with continued pump operation, loss of effective lubrication leads to pump vibration and eventual failure of the bearings. The vibration of the motor and shaft would be transmitted to the RCP seals, which are assumed to fail. In this sequence, the operators then fail to trip the RCPs prior to seal damage resulting in a small LOCA. Auxiliary feedwater operates.

The loss of all CCS cooling means that oil cooling for the safety injection pumps is also lost. Charging pump B, cooled by CCS, is unavailable, but the operators successfully align for ERCW to CCP A. CCP A actuates on the safety injection signal caused by the LOCA and provides high pressure injection to make up for the loss of inventory through the damaged RCP seals.

The RHR heat exchangers, however, are unavailable for recirculation from the sump due to the loss of CCS cooling, and the RHR pumps would also be stopped by the operators by the time of recirculation from the sump.

The containment spray pumps are also unavailable for recirculation from the containment sump in this sequence due to the loss of lube oil cooling. The spray pumps are assumed to run for a period of time in the injection mode, while taking suction from the cool RWST inventory.

The air return fans operate successfully, and the hydrogen ignitors are energized. The containment isolates automatically.

4.6.2.4 Key Plant Damage State LCI (SXYCI)

The highest frequency sequence to plant damage state LCI is initiated by a loss of 125V battery board I. This makes unavailable the train A motor-driven auxiliary feedwater (AFW) pump. The other two AFW pumps fail independently. Main feedwater (MFW) is assumed to be unavailable due to the loss of one train of DC power. Both CCPs (i.e.,

train A CCP is already running) and one safety injection pump are available for feed and bleed cooling, but only one pressurizer PORV has control power.

Train B of both RHR and containment spray are available for recirculation from the containment sump.

The air return fans are available, and the hydrogen ignitors are energized. The containment isolates automatically.

4.6.2.5 Key Plant Damage State GNI (HXNNI)

The highest frequency sequence to plant damage state GNI is initiated by a loss of offsite power, which is not recovered within the first hour. The backup diesel generator for train A shutdown power also fails. Train B of the ERCW pumps then also fails independently to provide adequate flow. As a result of these support train failures, all high pressure pumps are unavailable. However, the operators successfully cross-tie the train A ERCW to the 1B-B diesel generator. The turbine-driven AFW pump also fails, which shortens the time available for recovery of electric power. The loss of all seal cooling leads to a small LOCA. Electric power is not recovered prior to core damage.

RHR and containment spray are unavailable for both injection and recirculation. In this sequence, power is still available for the air return fans and for the hydrogen ignitors. The containment successfully isolates.

A second sequence assigned to plant damage state GNI is initiated by a loss of offsite power, which is not recovered within the first hour. Both Unit 1 diesel generators also fail to provide shutdown power as a backup. The turbine-driven AFW pump fails independently, and attempts to start the pump locally also fail. The loss of all seal cooling leads to an eventual seal LOCA without high pressure injection. Electric power is not restored prior to core damage. Both MFW and auxiliary feedwater are unavailable, and the operators initiate steam generator depressurization to limit the rate of seal leakage.

In this sequence, both the air return fans and the hydrogen ignitors are unavailable due to the loss of all AC power. The containment isolates successfully; i.e., the operators locally isolate the seal return line.

4.6.2.6 Key Plant Damage State BCI (LNYCI)

The highest ranked sequence to plant damage state BCI is initiated by a medium LOCA; i.e., a LOCA big enough to depressurize the RCS without secondary heat removal, or greater than the equivalent of a 2-inch-diameter hole. The high-pressure injection pumps (i.e., charging pumps and safety injection pumps) provide RCS inventory control initially, and the containment spray pumps actuate to limit containment pressure. Auxiliary feedwater is available. In accordance with procedures, the operators depressurize the steam generators, beginning at about 15 minutes. The automatic swapover for sump recirculation operates successfully, but the operators fail to align for high pressure recirculation. Low pressure injection is not possible at the initial time of swapover to the containment sump.

Both RHR and containment spray pumps are available in the injection and recirculation modes.

The air return fans are available, and the hydrogen ignitors are energized. The containment isolates automatically.

4.6.2.7 Key Plant Damage State ENS (HANNS)

The highest frequency sequence assigned to plant damage state ENS is initiated by a loss of offsite power that is not recovered in the first hour. Both Unit 1 diesel generators also fail to provide shutdown power as a backup. The turbine-driven AFW pump operates to provide secondary heat removal. The operators initiate steam generator depressurization to limit the rate of seal leakage. The loss of all seal cooling leads to an eventual seal LOCA without high pressure injection. Electric power is not restored prior to core damage.

In this sequence, both the air return fans and the hydrogen ignitors are unavailable due to the loss of all AC power. The operators fail to locally isolate the containment by not closing the seal return line.

Other sequences with some shutdown power available assigned to this plant damage state are similar, but the status of the air return fans and hydrogen ignitors is different. Therefore, this same station blackout sequence was evaluated three more times to reflect the different possible states of these containment systems. Cases with both the air return fans and hydrogen ignitors operable, and with just one or the other of them operable were evaluated.

4.6.2.8 Key Plant Damage State EIB (HANIB)

The highest frequency sequence to plant damage state EIB is initiated by a steam generator tube rupture. A safety injection signal successfully actuates the CCPs and safety injection pumps for RCS inventory control. The ruptured steam generator is initially isolated, and auxiliary feedwater is available. However, the operators fail to initiate RCS cooldown by depressurizing the intact steam generators. As a consequence, the ruptured steam generator overfills due to the flow of RCS through the broken tube. The safety valves on the ruptured steam generator open and then fail to reclose after passing water (faulted steam generation outside containment). Leakage continues from the ruptured steam generator, with the RCS still at pressure.

Assuming that AFW to the ruptured steam generator is isolated automatically or by the operator per procedure, over a long period of time, the RWST is depleted by the CCPs. In this sequence, the operators then fail to make up borated water to the RWST for continued high pressure injection. Recirculation from the containment sump is unavailable because the lost inventory is outside containment.

The air return fans are available, and the hydrogen ignitors are energized. The containment isolates automatically.

4.6.2.9 Key Plant Damage State HGI (HXYGI)

The representative sequence assigned to plant damage state HGI is initiated by a loss of offsite power that is not recovered in the first hour. The onsite Unit 1 diesel generator for train B fails. An independent failure of the train A diesel generator on Unit 2 also occurs. These support system train failures together with an independent failure of the turbine-driven AFW pump results in the loss of all AFW on Unit 1. The operators successfully initiate feed and bleed cooling using the train A charging and safety injection pumps. However, since only one shutdown board is available on each train, there is insufficient ERCW flow on both trains for recirculation from the sump. Sump recirculation is therefore unavailable. Electric power is not restored prior to core damage.

In this sequence, the A train air return fan and the hydrogen ignitors are available. The containment is manually isolated.

4.6.2.10 Key Plant Damage State ENB (HANNB)

The highest frequency sequence to plant damage state ENB is initiated by a steam generator tube rupture. Vital Battery Board I of 125V DC control power fails independently. A safety injection signal successfully actuates the train B charging pump and the train B safety injection pump for RCS inventory control. The ruptured steam generator fails to isolate due to the loss of DC control power train A. Auxiliary feedwater is available, but the operators fail to initiate RCS cooldown by depressurizing the intact steam generators. Makeup to the RWST is also unavailable due to the same DC control power loss. Core damage results from the eventual loss of RCS inventory out the ruptured and faulted steam generator to the environment.

Containment spray and recirculation from the containment sump are unavailable due to the loss of inventory out the break.

The B train air return fan is available, and the hydrogen ignitors are energized. The containment is bypassed via the ruptured and faulted steam generator.

4.6.2.11 Key Plant Damage State EGI (HANGI)

The highest ranked sequence to plant damage state EGI is initiated by a small LOCA. All of the CCPs, safety injection, RHR, and containment spray pumps operate in the injection mode. The operators initiate an RCS cooldown in accordance with procedures. However, the refueling cavity drains are plugged. The operation of the containment spray pumps transfers the RWST and RCS inventories to the upper containment compartment. Therefore, recirculation from the containment sump is unavailable for both RHR and containment spray. The failure of recirculation leads to core damage.

The air return fans are available, and the hydrogen ignitors are energized. The containment isolates automatically.

4.6.2.12 Key Plant Damage State KNS (SXNNS)

The highest frequency sequence assigned to plant damage state KNS is initiated by a loss of 120V AC Vital Instrument Power Board 1-I. This support failure prevents the automatic

actuation of equipment normally initiated by train A of the solid state protection system (SSPS). SSPS train B fails independently, and the operators fail to initiate AFW, to restore main feedwater, or to initiate feed and bleed cooling. Basically, this sequence involves a plant trip without any automatic or manual actuation of standby equipment.

The air return fans are not actuated. The containment also fails to isolate. Eventually, however, the operators energize the hydrogen ignitors.

Other sequences assigned to this plant damage state involve the success of both the air return fans and the hydrogen ignitors. The above sequence was therefore evaluated; with both of these systems operable.

4.6.2.13 Key Plant Damage State KNI (SXNNI)

The highest frequency sequence assigned to plant damage state KNI is initiated by a loss of offsite power that is not recovered in the first hour. The onsite Unit 1 diesel generator for train A fails. An additional failure of the Unit 2 train B diesel generator also occurs. The loss of this power train disables train B of the CCS. These support system train failures result in the loss of the motor-driven AFW pumps on Unit 1. The turbine-driven AFW pump fails independently. Both charging pumps and safety injection pumps are also unavailable due to these support system train failures. Core damage occurs from the loss of all secondary heat removal without feed and bleed cooling. The containment spray pumps are also unavailable due to the support failures. Electric power is not restored prior to core damage.

In this sequence, the B train air return fan and the hydrogen ignitors are available. The containment isolates automatically.

One of the containment spray trains has lost its lube oil cooling from CCS train B. It is possible that the pump could operate in the injection mode while pumping cool RWST inventory. This possibility is evaluated as a sensitivity case. The B train RHR pump could also operate in the injection mode while pumping cool RWST inventory. However, for this sequence RCS pressure remains high. Therefore, no sensitivity case was postulated since the operability of RHR pump has no impact on the accident progression.

4.6.2.14 Key Plant Damage State FGI (HAYGI)

The highest ranking sequence to plant damage state FGI is initiated by a loss of train A of the CCS. This failure results in a loss of cooling to the RCP thermal barrier heat exchangers, and to the upper and lower RCP motor bearings of all four pumps. The loss of motor bearing cooling means that, after a period of time with continued pump operation, loss of effective lubrication leads to pump vibration and to eventual failure of the bearings. The vibration of the motor and shaft would be transmitted to the RCP seals, which are assumed to fail. In this sequence, the operators then fail to trip the RCPs prior to seal damage, resulting in a small LOCA. Auxiliary feedwater operates.

The operators successfully align ERCW to the train A CCP for lube oil cooling. Therefore, both charging pumps are available to provide high pressure injection. The operators initiate steam generator depressurization in response to the LOCA. When recirculation from the containment sump is required, the train B sump valve fails to open. This prevents sump

recirculation because train A of RHR and containment spray are both unavailable due to the dependence on train A of CCS. Train B of containment spray is available during the injection mode, but the alignment for spray recirculation fails independently.

The air return fans are available, and the hydrogen ignitors are energized. The containment isolates automatically.

4.6.2.15 Key Plant Damage State HNI (HXYNI)

The highest ranked sequence to plant damage state HNI is initiated by a loss of offsite power, which is not recovered within one hour. The Unit 2 train A diesel generator fails to start. In addition, train B of the ERCW pumps fails, resulting in a loss of ERCW flow to headers 1B and 2B. The general building ventilation system and the engineered safety features (ESF) coolers supplying room cooling to the area that contains the CCS and motor-driven AFW pumps are unavailable due to these support system train failures. The loss of area cooling to this location results in the eventual unavailability of the motor-driven pumps located within this area; i.e., the CCS and the AFW pumps. An additional independent failure of the turbine-driven AFW pump also occurs in this sequence. The operators are not able to locally restart it. Consequently, when the area heats up enough to fail the operating motor-driven pumps, all AFW is lost.

Feed and bleed cooling is initiated using train A centrifugal charging pump; i.e., whose lube oil cooling has been aligned to ERCW header 1A. At the time of switchover for sump recirculation, there is still no CCS cooling to the RHR heat exchangers or for the RHR pump seals. Therefore, recirculation from the sump fails. The containment spray pumps are also lost due to the unavailability of CCS for lube oil cooling. Makeup to the RWST via the spray system for continued high pressure injection is unavailable due to the loss of both spray pumps.

The air return fans are available, and the hydrogen ignitors are energized. The containment isolates automatically.

4.6.2.16 Key Plant Damage State HCI (HXYCI)

The highest ranked sequence to plant damage state HCI is initiated by a partial loss of main feedwater from greater than 40% power. The reactor fails to trip, both automatically and manually. Main feedwater is assumed to be isolated in response to the initiating event. The turbine-driven AFW pump fails independently. The motor-driven AFW pumps both operate, but at least one of the valves to the four steam generators fails to open. Therefore, there is insufficient secondary heat removal to avoid overpressure of the RCS. The reactor vessel fails, which is assumed to result in core damage.

Containment spray and recirculation from the containment sump are available after core damage.

The air return fans are available, and the hydrogen ignitors are energized. The containment isolates automatically.

4.6.2.17 Key Plant Damage State LNI (SXYNI)

The highest frequency sequence assigned to plant damage state LNI is initiated by a loss of 125V vital battery board I. An independent failure of power at vital battery board II also occurs. Additionally, the turbine-driven AFW pump also fails, and the operators are unable to restart it locally. This results in the loss of all AFW. Main feedwater is unavailable, and feed and bleed cooling is not possible without both trains of 125V DC. The normally running charging pump is available for high pressure injection, but is ineffective due to the unavailibility of the pressurizer PORVs. Core damage results from the loss of all heat removal.

The air return fans and both the RHR and containment spray pumps are also unavailable due to the loss of DC control power. However, the containment isolates automatically. The hydrogen ignitors are energized successfully since shutdown power is still available.

4.6.3 REFERENCES

4.6-1. U.S. Nuclear Regulatory Commission, "Individual Plant Examination for Severe Accident Vulnerabilities," 10CFR50.54(§), Generic Letter No. 88-20, November 23, 1988.

4.6-2. U.S. Nuclear Regulatory Commission, "Individual Plant Examination: Submittal Guidance," NUREG-1335, August 1989.

Table 4.6-1 (Page 1 of 2). Watts Bar Plant Damage State Frequencies (per reactor-year)

			Intact(I)		Isol. Failure (S)		Isol. Failure (L)		Small Bypass(B)		Large Bypass(V)	
			Analyzed	Not Anal.	Analyzed	Not Anal.	Analyzed	Not Anal.	Analyzed	Not Anal.	Analyzed	Not Anal.
ENI	HANNI	1.4E-04	1.4E-04									
FCI	HAYCI	9.0E-05	9.0E-05									
FNI	HAYNI	4.3E-05	4.3E-05									
LCI	SXYCI	1.5E-05	1.5E-05									
GNI	HXNNI	8.3E-06	8.3E-06									
BCI	LNYCI	5.7E-06	5.7E-06									
ENS	HANNS	4.8E-06			4.8E-06							
EIB	HANIB	3.7E-06							3.7E-06			
HGI	HXYGI	3.1E-06	3.1E-06									
ENB	HANNB	2.7E-06							2.7E-06			
EGI	HANGI	2.3E-06	2.3E-06									
KNS	SXNNS	2.2E-06			2.2E-06							
KNI	SXNNI	2.2E-06	2.2E-06									
FGI	HAYGI	2.1E-06	2.1E-06									
HNI	HXYNI	2.0E-06	2.0E-06									
HCI	HXYCI	1.6E-06	1.6E-06									
LNI	SXYNI	1.4E-06	1.4E-06									
DCI	INYCI	9.9E-07		9.9E-07								
GNS	HXNNS	5.1E-07			5.1E-07							
LGI	SXYGI	4.6E-07		4.6E-07								
FCB	HAYCB	4.3E-07							4.3E-07			
FCS	HAYCS	2.9E-07			2.9E-07							
KTL	SXNTL	2.5E-07					2.5E-07					
FNS	HAYNS	1.9E-07			1.9E-07							
ETL	HANTL	1.7E-07					1.7E-07					
AGI	LNNGI	1.5E-07		1.5E-07								
KGI	SXNGI	9.0E-08		9.0E-08								
FPL	HAYPL	7.2E-08						7.2E-08				
FTL	HAYTL	4.1E-08						4.1E-08				
ATV	LNNTV	4.1E-08									4.1E-08	
LCS	SXYCS	4.0E-08				4.0E-08						
CNI	INNNI	3.3E-08		3.3E-08								
BGI	LNYGI	3.1E-08		3.1E-08								
FEI	HAYEI	2.9E-08		2.9E-08								
BCS	LNYCS	2.1E-08				2.1E-08						
HGS	HXYGS	2.0E-08				2.0E-08						
FII	HAYII	1.9E-08		1.9E-08								
ANI	LNNI	1.4E-08		1.4E-08								
HCB	HXYCB	1.2E-08								1.2E-08		
DGI	INYGI	1.0E-08		1.0E-08								
GTL	HXNTL	9.8E-09						9.8E-09				
CNS	INNNS	9.5E-09				9.5E-09						
LPL	SXYPL	7.5E-09						7.5E-09				

Table 4.6-1 (Page 2 of 2). Watts Bar Plant Damage State Frequencies (per reactor-year)

			Intact(I)		Isol. Failure (S)		Isol. Failure (L)		Small Bypass(B)		Large Bypass(V)	
			Analyzed	Not Anal.	Analyzed	Not Anal.	Analyzed	Not Anal.	Analyzed	Not Anal.	Analyzed	Not Anal.
BNI	LNYNI	6.8E-09		6.8E-09								
EGS	HANGS	6.3E-09				6.3E-09						
BPL	LNYPL	5.8E-09						5.8E-09				
BEI	LNYEI	5.5E-09		5.5E-09								
HNS	HXYNS	5.2E-09				5.2E-09						
DCS	INYCS	4.5E-09				4.5E-09						
DNI	INYNI	4.2E-09		4.2E-09								
ANS	LNNNS	4.0E-09				4.0E-09						
LNS	SXYNS	3.7E-09				3.7E-09						
HRL	HXYRL	3.4E-09						3.4E-09				
FGS	HAYGS	2.6E-09				2.6E-09						
BII	LNYII	2.5E-09		2.5E-09								
GGI	HXNGI	2.2E-09		2.2E-09								
CTL	INNTL	1.1E-09						1.1E-09				
ERL	HANRL	1.1E-09						1.1E-09				
DPL	INYPL	1.1E-09						1.1E-09				
AGS	LNNGS	6.2E-10				6.2E-10						
ATL	LNNTL	4.8E-10						4.8E-10				
ARL	LNNRL	1.9E-10						1.9E-10				
CGI	INNGI	1.5E-10		1.5E-10								
BGS	LNYGS	7.0E-11				7.0E-11						
DGS	INYGS	2.2E-11				2.2E-11						
HTL	HXYTL	0.0E+00						0.0E+00				
Column Totals		3.3E-04	3.2E-04	1.9E-06	8.0E-06	1.2E-07	4.1E-07	1.4E-07	6.8E-06	1.2E-08	4.1E-08	0.0E+00
Total Frequency Analyzed		3.3E-04										
Fraction Analyzed		0.99	0.99		0.99		0.74		1.0		1.0	

Table 4.6-2. Sequence Selection Criteria and Interpretation for the Watts Bar IPE

Sequence Group (from Generic Letter No. 88-20, Appendix 2)	IPE Reporting Criteria	
	Generic Letter	Watts Bar IPE
1. Any functional sequence with core damage frequency greater than or equal to:	1×10^{-6} per reactor-year	1×10^{-6} per reactor-year
2. Any functional sequence that contributes more than "x" percent to core damage:	5%	0.3%
3. Any functional sequence with containment failure leading to a release > or = to PWR-4 in WASH-1400 at a frequency > or = to:	1×10^{-6} per reactor-year	1×10^{-7} per reactor-year
4. Any functional sequence leading to containment bypass at a frequency > or = to:	1×10^{-7} per reactor-year	1×10^{-7} per reactor-year
5. Any functional sequence judged to be an important contributor to core damage or poor containment performance:	(judgment)	(judgment)

Note: The functional sequence reporting criteria are used for the Level 2 analysis. The Level 1 systemic sequences are grouped into the functional sequences for comparison against the criteria. The plant damage states are used to group sequences by function.

Table 4.6-3. Watts Bar Key Plant Damage States — Hydrogen Control (per reactor-year)

PDS SUMS:			HYDROGEN CONTROL DESIGNATORS							
			A		B		C		N	
		TOTAL FREQ	FREQ	FRAC	FREQ	FRAC	FREQ	FRAC	FREQ	FRAC
ENI	HANNIY_	1.4E-04	1.1E-04	0.78	3.9E-06	0.03	7.5E-07	0.01	2.6E-05	0.19
FCI	HAYCIY_	9.0E-05	9.0E-05	1.0	1.6E-07	0.00	4.9E-07	0.01	0.0E+00	0.00
FNI	HAYNIY_	4.3E-05	4.3E-05	1.0	1.2E-07	0.00	7.7E-08	0.00	0.0E+00	0.00
LCI	SXYCIY_	1.5E-05	1.5E-05	1.0	0.0E+00	0.00	2.0E-07	0.01	0.0E+00	0.00
GNI	HXNNIY_	8.3E-06	5.4E-06	0.64	0.0E+00	0.00	0.0E+00	0.00	3.0E-06	0.36
BCI	LNYCIY_	5.7E-06	5.7E-06	1.0	0.0E+00	0.00	0.0E+00	0.00	0.0E+00	0.00
ENS	HANNSY_	4.8E-06	1.1E-06	0.23	3.5E-07	0.07	3.8E-07	0.08	2.9E-06	0.61
EIB	HANIBY_	5.5E-06	5.5E-06	1.0	0.0E+00	0.00	0.0E+00	0.00	0.0E+00	0.00
HGI	HXYGIY_	3.1E-06	3.1E-06	1.0	0.0E+00	0.00	0.0E+00	0.00	0.0E+00	0.00
ENB	HANNBY_	2.7E-06	2.6E-06	1.0	0.0E+00	0.00	5.5E-08	0.02	0.0E+00	0.00
EGI	HANGIY_	2.3E-06	2.3E-06	1.0	0.0E+00	0.00	0.0E+00	0.00	0.0E+00	0.00
KNS	SXNNSY_	2.2E-06	3.5E-07	0.16	0.0E+00	0.00	1.9E-06	0.84	0.0E+00	0.00
KNI	SXNNIY_	2.2E-06	2.0E-06	0.93	0.0E+00	0.00	1.4E-07	0.07	0.0E+00	0.00
FGI	HAYGIY_	2.1E-06	2.1E-06	1.0	0.0E+00	0.00	1.2E-08	0.01	0.0E+00	0.00
HNI	HXYNIY_	2.0E-06	2.0E-06	1.0	0.0E+00	0.00	0.0E+00	0.00	0.0E+00	0.00
HCI	HXYCIY_	1.6E-06	1.6E-06	1.0	0.0E+00	0.00	0.0E+00	0.00	0.0E+00	0.00
LNI	SXYNIY_	1.4E-06	5.3E-07	0.37	0.0E+00	0.00	9.0E-07	0.63	0.0E+00	0.00
TOTALS		3.3E-04	2.9E-04	0.87	4.6E-06	0.01	4.9E-06	0.01	3.2E-05	0.10

HYDROGEN CONTROL DESIGNATORS		
AIR RETURN FANS	IGNITORS	
	YES	NO
AVAILABLE	A	B
NOT AVAIL	C	N

4.7 ANALYSIS OF SEVERE ACCIDENT PROGRESSION

The results of deterministic calculations of severe accident progression were used in the individual plant examination (IPE) to assist in the quantification of the containment event tree (CET) and to assign source terms to release categories. In some cases, deterministic results obtained from open literature were used [e.g., calculations made with the HECTR code, (see Section 4.8.1.2)], but many new calculations were found to be necessary. For the most part, this was the case because many of the dominant plant damage states (PDS) identified in the Level 1 analysis differed significantly from those previously analyzed. In a few cases, hand calculations were performed, but most of the new calculations were made with the Modular Accident Analysis Program (MAAP) (Reference 4.7-1).

Sections 4.7.1 and 4.7.2 describe the models used for the calculations and the results obtained.

4.7.1 ANALYTICAL MODELS FOR SEVERE ACCIDENT ANALYSIS

This section describes the specific version of MAAP employed in the analysis and the phenomenological assumptions adopted for the base case calculations.

4.7.1.1 Version of MAAP Used for the Watts Bar IPE

MAAP was in a state of flux at the time that the Level 2 analysis commenced. The most recent version available, MAAP/PWR Revision 17.02, was soon superseded by Revision 17.03 and later by Revision 18. Revision 17.03 contained only minor improvements relative to Revision 17.02 whereas Revision 18 involved major enhancements to the program.

The primary motivation for the development of Revision 18 was to incorporate improvements developed under a program sponsored by the Electric Power Research Institute (EPRI) that benchmarked MAAP against plant data and detailed code calculations for sequences that did not involve core damage (Reference 4.7-2). The principal purpose of these modifications was to improve the ability of the program to model nonsevere accident transients. Specifically, it was desired to improve capability of MAAP to support the development of Level 1 success criteria. Moreover, many of the changes were directed at the modeling of Babcock & Wilcox plants.

MAAP was not used to develop success criteria in the Watts Bar IPE, although, in a few selected cases, MAAP results were used to determine that a postulated severe accident sequence did not, in fact, result in core damage. In addition, all project members had a strong desire to avoid changing code revisions in the middle of the project. Since the final release of Revision 18 was not available until well into the Level 2 effort, it was concluded that it should not be used. On the other hand, a preliminary version of Revision 18 was available. This version contained completed error corrections but only preliminary versions of the new success criteria-related models. For this reason, the error corrections from this version that were judged to affect the Sequoyah and Watts Bar IPE codes most directly were incorporated into the version used for the analysis.

All changes made to the program were independently reviewed, and are described in Appendix 4A.

4.7.1.2 Phenomenological Assumptions used in Base Case Calculations

Any deterministic calculation of severe accident progression must necessarily deal in some fashion with the many uncertainties in the underlying physical processes. In the case of MAAP calculations, the treatment of physical phenomena is controlled by the values that are input for so-called "model" parameters.

Two general types of MAAP calculations were made in the Watts Bar IPE. "Base case" calculations used a set of nominal model parameter values. These values were selected to be consistent and were chosen to be responsive to U.S. Nuclear Regulatory Commission (NRC) positions in Reference 4.7-3 with those recommended in Reference 4.7-4. One or more base case calculations were performed for each of the dominant PDSs to provide insights into the timing and likely primary system and containment response. Guided, in part, by the base case results, sensitivity calculations were also performed with MAAP. Along with hand calculations and results from the literature, this latter set of runs was used to assist in assessing the impact of uncertainties in the phenomena on the accident progression and the fission product source terms. Such sensitivity calculations thus provided important inputs into the process of quantifying the CET and into the assignment of release categories to CET end states. Usually, sensitivity calculations involved varying one of the key model parameters from its nominal value, leaving the other parameters fixed. For example, in the base case calculations, a relatively small fraction of the debris was assumed to participate in direct containment heating; in several sensitivity calculations, this assumption was changed to a more pessimistic view. Other calculations were used to assess hydrogen behavior in sequences with varying loss of coolant accident (LOCA) sizes, air return fan (ARF) operability, and ignitor availability.

The results of the base case calculations are summarized in Section 4.7.2. The important sensitivity calculations used in quantifying the CET are discussed in Section 4.8.1.2. The key phenomenological assumptions made in the base case MAAP calculations are as follows:

- Water lying on top of debris in containment was assumed to ingress into the debris; i.e., the upper debris crust was assumed to crack and thus not prevent water from penetrating. Parameters input to the critical heat flux model were adjusted to provide the assumed heat flux of 900 KW/m^2 for unquenched debris at atmospheric pressure.

- The vessel was assumed to fail soon (nominally 1 minute) after debris relocation to the lower head. This is consistent with the typical MAAP calculation of large debris relocation rates to the lower head. No credit was taken for cooling of the debris by conduction through the lower head to water in the reactor cavity. The lower head failure was assumed to initiate at an in-core instrument tube penetration, and ablation of this hole was calculated.

- The median containment failure pressure was estimated to be approximately 105 psia for Watts Bar based on the analyses documented in Reference 4.7-5 and summarized in Section 4.4. A relatively large failure area (1 ft^2 or greater) was assumed to develop at that time. As noted below, some of the calculations used a lower failure pressure; i.e., one more appropriate for Sequoyah. In a few cases, a

higher value, 130 psia, was used based on a preliminary version of the containment fragility curve.

- Most calculations involving sequences with very high primary system pressure were performed two ways: with and without an induced rupture of the hot leg. This was done since the occurrence of an induced rupture will have a large effect on the subsequent accident progression, by depressurizing the primary system and thus cannot be dealt with adequately with one or two sensitivity calculations.

- For sequences in which the primary system pressure at vessel failure remained sufficiently high to result in high pressure melt ejection of the debris, a relatively small fraction (3%) of the dispersed debris was assumed to fragment finely and therefore participate in direct containment heating (DCH) and rapid zirconium oxidation. The gas velocity, averaged over the cross section of the reactor cavity, was used to compute a Kutateladze number to define the threshold for entrainment.

- No core blockage was assumed. The MAAP PWR "core blockage" model, which assumes that melting in a region of the core will quickly terminate hydrogen production in that region, was considered not to be a best estimate treatment. As a result, calculated hydrogen source terms were generally consistent with the NUREG-1150 median values (see Section 4.8.1.2).

- All fission product tellurium was assumed to chemically bind with unoxidized zirconium. As such, it was released from the debris only if the zirconium was oxidized in subsequent ex-vessel concrete attack.

- Auto-ignition of hydrogen was assumed to occur for gas temperatures in excess of 1,310°F, regardless of the concentration of steam.

- Revaporization of fission products was assumed not to be affected by any chemical reactions between these materials and the steel surfaces on which they settle.

As noted above, these assumptions are the same as those documented in Reference 4.7-4; the key assumptions that could impact the timing of containment failure were varied in sensitivity calculations.

One additional simplification was made in the interests of practicability. A comparison of the Sequoyah and Watts Bar plants revealed that they were virtually identical from the standpoint of features that would affect their response to a severe accident. The only noteworthy differences were as follows:

- The containment spray pump flow in Watts Bar is 4,000 gpm versus 4,750 gpm for Sequoyah. In practice, this has the effect of slightly prolonging the time that injection is available in many accident sequences, leading to slightly later key event timings.

- The Watts Bar air return fans are rated at less flow.

- Very small differences in steam generator configuration and reactor coolant pump flow.

- The median containment ultimate pressure is approximately 105 psia for Watts Bar versus 80 psia for Sequoyah.

Except for the significantly higher containment ultimate pressure, these differences are considered to be negligible. For this reason, where identical accident sequences were studied in the two plants, it was considered acceptable to use Sequoyah results instead of repeating the same calculation for Watts Bar. In practice, this does not lead to any great overconservatism since a distribution of containment failure pressures was used for each plant when quantifying the CET. At most, the fission product releases assigned to a given late containment failure release category might be somewhat higher by employing a low estimate for the failure pressure. When new calculations were necessary for Watts Bar, a Watts Bar-specific set of parameters, which reflect the differences listed above, was used.

4.7.2 RESULTS OF ACCIDENT PROGRESSION ANALYSIS

This section will present the results for the MAAP base case calculations for each plant damage state.

4.7.2.1 Plant Damage State EGI

Plant damage state EGI was simulated with MAAP runs SQN4 and SQN4B. See Section 4.6.2.11 for a description of the representative sequence.

Sequence SQN4 assumed a 2-inch-diameter break and case SQN4B assumed a 0.5-inch break; these are, respectively, the high and low ends of the small break spectrum. In both cases, cooldown of the secondary side of the steam generators in accordance with the emergency operating procedures rapidly reduces primary system pressure and initiating accumulator discharge, reducing break flow and greatly prolonging the time until core uncovering. As a result, sequence SQN4B still had not progressed to core uncovering at 48 hours and will not be discussed further.

In the case of SQN4, core uncovery occurred at 4.2 hours, and the vessel was calculated to fail at about 8 hours at low pressure, as shown in Figure 4.7-1. The pressure is low during the core degradation process due to a combination of the effects of break flow and reflux condensation in the steam generators. It is worth noting in this regard that production of hydrogen does not result in any noticeable period of reduced condensation effectiveness [or increased reactor coolant system (RCS) pressure], as can be seen in some of the Sequoyah and Watts Bar seal LOCA calculations. This is presumably because the larger break flow in this case prevents substantial quantities of hydrogen from accumulating in the steam generator tubes and degrading condensation rates.

High pressure melt ejection (HPME) is precluded by the low vessel pressure at vessel failure. The remaining ice is depleted soon thereafter by the steam released at vessel failure and debris/water and debris/concrete interactions in the cavity. Core-concrete interaction begins quickly and produces large quantities of combustible gas over time, as shown in Figure 4.7-2. The ignitors and air return fans keep hydrogen concentrations low until burning is precluded by low oxygen concentrations, as shown in Figures 4.7-3

and 4.7-4. The overall rate of containment pressurization, due entirely to core-concrete interactions, is slow, and overpressurization would not be predicted until well after 1 day (see Figure 4.7-5).

4.7.2.2 Plant Damage State EIB

The base case for plant damage state EIB, steam generator tube rupture, is represented by MAAP case EIB. The representative sequence for EIB is described in Section 4.6.2.8.

The RWST is drained at 9.21 hours. This is long because the safety injection flow maintains the RCS in a subcooled condition; thus, the depressurization of the faulted steam generator (due to the stuck-open safety valve) does not reduce the primary system pressure (see Figure 4.7-6). Once injection is lost, the pressurizer loses level and RCS pressure quickly drops to a very low value determined by the faulted steam generator pressure. This low value is maintained until the break becomes uncovered, which leads to dryout of the faulted steam generator (see Figure 4.7-7) and an increase in RCS pressure. RCS pressure drops again after the core uncovers, at 23 hours, and vessel failure is calculated to occur at 26 hours at a pressure of about 600 psia.

The primary system pressure is just low enough that debris dispersal is not predicted to occur from the cavity. Concrete attack begins nearly immediately, and large quantities of hydrogen, carbon monoxide, and fission products are released. Hardly any ice has melted until after vessel failure (see Figure 4.7-8) so considerable benefit is obtained by decontamination of the containment atmosphere in the ice condenser. Partly for this reason, the release of fission products into the environment is wholly dominated by the volatiles released in-vessel (chiefly cesium iodide and cesium hydroxide); the calculated release fraction of these materials at 38 hours is approximately 20% as shown in Figure 4.7-9. This large value is caused by the stuck-open safety valve, which minimizes residence time, and, to some degree, because MAAP neglects the effects of the secondary steam separators and dryers when computing fission product retention.

The results discussed above are considered very much a worst case scenario since it is assumed that the operators isolate feedwater to the faulted unit, ensuring that it is dry when fission product release occurs, and also that they also never take action to depressurize the RCS, either via the secondary power-operated relief valves (PORV), the pressurizer PORV, or the pressurizer sprays.

4.7.2.3 Plant Damage State ENB

The representative sequence for ENB is described in Section 4.6.2.10. This sequence MAAP case ENB, is initiated by a double-ended break of a steam generator tube in one steam generator (in MAAP, this is designated as the "B" steam generator). The operators successfully isolate feedwater to steam generator B and depressurize the nonfaulted units (in MAAP this is designated as the "U" steam generators) at 15 minutes. However, the steam supply line from steam generator B to the turbine-driven AFW pump fails to isolate. Based on the size of the line, this creates the close equivalent of a stuck-open steam generator safety valve and results in a bypass of the containment. One train of ECCS is available in the injection mode; injection is lost at 10 hours since there is little water in the sump at the time that the operators would switch it into recirculation. Due to difficulties using the nonequilibrium steam generator thermodynamics model introduced into MAAP

Revision 17.02+ (see Section 4.7.1.1), this calculation was performed with Revision 17.02. The "B" Steam Generator would be expected to be saturated for the most part due to the unisolated leak from the steam space, so this is not considered to present a problem.

Primary system pressure initially remains high, (see Figure 4.7-10) since the available train B safety injection and centrifugal charging pumps (CCP) make up for the losses from the RCS and keep the system subcooled with a water level in the pressurizer (see Figure 4.7-11). Primary system pressure drops rapidly after loss of ECCS at 10 hours. During this 10-hour period, the operators would actually be expected to use either pressurizer sprays or the PORV to reduce RCS pressure; since these actions were not modeled, the progression of the accident was somewhat accelerated by the high RCS pressure. Nevertheless, the effects of steam generator B and U depressurization on the leakage rate through the steam supply line, combined with the eventual transition from water to gas flow through the failed tube, discharge of the accumulators, and the 10 hours of ECCS, result in an extremely late calculated core uncovering time of 47 hours. Presumably, there is ample time for recovery actions that were not credited here.

Hydrogen production begins at 51 hours, and vessel failure is calculated to occur at 57 hours. The extended period over which core damage occurs is due to the relatively low decay heat at 50 hours and also the fact that reflux condensation, while degraded by the presence of hydrogen in the primary system (see Figures 4.7-10 and 4.7-12), is still going on in the "U" steam generators. This prolongs the time required to dry out the core completely. For the same reason, the RCS fails at relatively low pressure into a dry cavity, and the code calculates that the debris will remain in the cavity. Concrete attack begins immediately there.

The calculated retention of volatile fission products is small in steam generator B due to the large vent area at the top and the fact that no water remains on the secondary side when the core becomes uncovered. Therefore, the calculated release into the environment is about 15% of the CsI and CsOH inventory, 70% of the noble gases, and a comparatively small quantity of the nonvolatile fission products, as shown in Figure 4.7-13.

4.7.2.4 Plant Damage State ENI

The base case accident progression expected for plant damage state ENI in Watts Bar is represented by MAAP calculations ENI8 and ENI10. While these are fairly similar, they will be described separately below.

ENI8 is initiated by a total loss of essential raw cooling water at time 0. See Section 4.6.2.1 for a description of the ENI representative sequences.

As is generally seen in such sequences, cooldown and subsequent discharge of the accumulators greatly extend the time of core uncovering, which, in this case, occurs at nearly 19 hours. Low pressure injection is of little use since the containment sprays drain the RWST soon after the seal LOCAs occur. The period of core damage is extended by the low decay heat and the continued effectiveness of reflux condensation in the steam generators. It is noteworthy in this regard that the production of hydrogen only results in a short period of repressurization (see Figure 4.7-14) caused by degradation of

condensation effectiveness in the steam generators. Thereafter, the hydrogen is swept out of the RCS through the LOCAs, and RCS pressure again drops to a value only slightly higher than the secondary-side pressure. RPV failure occurs at about 28 hours, at low pressure. Neither HPME nor direct containment heating would be expected to be a significant threat at these pressures.

The presence of a large mass of cold water in the containment reduces debris steaming rates, and while ice depletion occurs soon after vessel failure, containment failure would not be expected until well after 2 days (see Figure 4.7-15). Hydrogen does not pose a substantial threat to containment integrity since it is released continuously from the RCS and is controlled by the air return fans and ignitor system. The hydrogen concentration in containment never exceeds about 5% (Figure 4.7-16). Eventually, the containment becomes inerted due to both oxygen depletion and steam buildup (at about 40 hours). For the purpose of estimating source term, a failure was induced in the containment at 44 hours; releases of other than noble gases were very small, as expected. Note that revaporization from the RCS would be minimal, given the assumed long-term availability of AFW and the cool conditions in containment.

Sequence ENI10 is initiated by a loss of shutdown board A at time 0.

The low pressure injection pumps begin to function at about 2 hours as the primary system pressure (see Figure 4.7-17) drops below their shutoff head. For the next 1 ½ days, the system "floats" on the shutoff head of the pumps, which is very near the final secondary-side pressure, and injection is not lost until about 35 hours. Core uncovering would not occur until after 2 days (see Figure 4.7-18), which was the end of the calculation. While the ignitors are not available and ice depletion occurs somewhat earlier (at 28 hours), the post-core damage behavior and the fission product releases would be expected to be similar to the ENI8 case discussed above if the calculation were extended further. On the other hand, there is ample opportunity for recovery of injection.

4.7.2.5 Plant Damage States FGI and FNI

The representative sequences for FGI and FNI are described in Section 4.6.2.14 and 4.6.2.3, respectively. The only difference between the representative sequences for plant damage states FGI and FNI is that the sprays are expected to eventually overheat and fail in FNI but are available in FGI until the RWST empties. Since the RWST would be injected into containment by the ECCS pumps even if the sprays failed quickly, it was deemed to be more conservative to allow spray pump operation in the injection mode in FNI to shorten the period during which ECCS would be available.

The base case for the two plant damage states was represented by MAAP run SQN14B. Containment sprays initiate just after the LOCAs occur and deplete the RWST in about one-half hour. Thus, while ECCS was not credited in the MAAP calculation, very little benefit would have been obtained from injection due to the short period in which the RWST inventory was available. Cooldown, as in many of the other sequences modeled here, was very effective in depressurizing the RCS and initiating accumulator discharge (see Figure 4.7-19). A short period of repressurization is noticeable, caused by hydrogen interfering with reflux condensation after the core uncovers at 12.5 hours. After a short time, the hydrogen is swept out through the break, and the primary system once again equilibrates at a pressure only slightly higher than the steam generator pressure. The

vessel fails at low pressure at about 21 hours. In an additional calculation, denoted SQN14A, the sensitivity of the pressure at vessel failure to the time required to melt through the lower head was tested; that is, it was desired to investigate whether a delay would allow more steaming and increase vessel pressure substantially. Instead, it was found that virtually no increase in pressure resulted; i.e., reflux condensation was more than adequate to deal with the steaming rates expected in the lower head.

These results imply that containment phenomena dependent on high pressure in the RCS at vessel failure (e.g., DCH and seal table melt-through) would not be expected in sequences such as these with relatively large LOCAs. Instead, the debris will drain into the reactor cavity, quench (the best estimate scenario), and continue steaming. Ice depletion was calculated to occur at 24 hours. This caused the containment pressure to begin increasing, and the 80-psia range was reached at about 40 hours (see Figure 4.7-20). Given availability of AFW to keep the steam generator tubes cool, cool conditions in the containment, and minimal core-concrete interactions, source terms other than noble gases would be expected to be relatively small.

4.7.2.6 Plant Damage State KNI

The base cases for Watts Bar plant damage state KNI are represented by MAAP calculations KN12 and KN13. The representative sequences for KNI are described in Section 4.6.2.13. These differ only in that an induced rupture of the hot leg is assumed to occur in the latter.

Except for the absence of seal LOCAs and the availability of the air return fans and ignitors, these cases are identical to fast station blackout sequences. Steam generator dryout is followed by core uncovery at about 2 hours.

In case KNI2, it is assumed that the primary system remains intact, so the reactor pressure vessel (RPV) fails at high pressure at about 3.5 hours. All of the debris melted at the time of vessel failure (in this calculation, approximately 2.6×10^5 lbm) is dispersed out of the reactor cavity. While not modeled in the base case scenario, this could give rise to the production of substantial quantities of additional hydrogen via DCH or seal table melt-through and dispersal of debris against the containment shell. Assuming that the containment survives the loads imposed on it at the time of containment failure, continued steaming of the debris dispersed out of the cavity results in ice depletion at 7 hours and the achievement of containment pressures in the 130-psia range by 18 hours (see Figure 4.7-21). Aside from the expected large spike in hydrogen concentration at vessel failure, which occurs both in the ice condenser and the lower compartment, the air return fans and ignitor system control the concentrations of combustible gases at low values, (see Figure 4.7-22). Dispersing the bulk of the debris out of the reactor cavity means that the fission product releases are dominated by noble gases (see Figure 4.7-23). Revaporization of cesium iodide and cesium hydroxide in the RCS is limited due to the relatively cool conditions in the containment. The high containment pressure leading up to containment failure also enhances convective cooling of the RCS.

Case KNI3 is identical to KNI2 except that a large hot leg failure is allowed to occur at 3 hours when MAAP predicted that temperatures had increased to the point that creep rupture was likely. This causes a rapid depressurization of the RCS and discharge of the accumulators. The latter prolonged the time to RPV failure by about an hour compared to

the previous case. More importantly, the RCS is predicted to fail at low pressure, and the debris would be expected to largely be confined to the reactor cavity. This greatly lessens the threat posed by high pressure-related phenomena such as seal table melt-through, and also means that the subsequent pressurization of the containment will be caused by core-concrete interactions instead of steaming.

A large spike in hydrogen concentration is predicted to occur in the lower compartment and ice condenser at the time of the rupture, as shown in Figure 4.7-24. The threat posed by these high concentrations is discussed in Section 4.2.2. Thereafter, hydrogen concentrations are controlled by the air return fans and ignitors, and, to a degree, the achievement of gas temperatures sufficient to cause autoignition in the cavity (see Figure 4.7-25). In any event, the containment is rendered inert by low oxygen concentrations after about 8 hours. Assuming that the containment loads associated with the hot leg rupture do not fail the containment, the containment is predicted to fail due to overpressurization at roughly 40 hours, as shown in Figure 4.7-26. Fission product releases (see Figure 4.7-27) are rather low due to the long time available for natural settling processes, assisted by the high inert aerosol production predicted from core-concrete interactions.

4.7.2.7 Plant Damage State LCI

Plant damage state LCI was represented by MAAP case SQN13. The representative sequence for LCI is described in Section 4.6.2.4.

To represent this sequence, the operators were assumed to attempt feed and bleed at a conservatively late time; i.e., when the steam generator level reached 1 foot above the tubesheet. This occurred quite early, at 0.09 hours, due to a predicted delay in reactor scram of 1 minute; the latter may merely represent an oversimplification in the MAAP control system modeling. In any event, containment sprays were activated at 0.18 hours, which caused the lineup for high pressure recirculation to be accomplished successfully at 0.85 hours. Since, in recirculation, the safety injection and charging pumps take suction on the discharge of the LPI pumps, switchover causes an increase in the available injection flow. Partly for this reason, the RCS never undergoes any serious voiding, and the system is never in danger of core damage. Primary system pressure and water levels are shown in Figures 4.7-28 and 4.7-29. The corresponding figures for the steam generators are Figures 4.7-30 and 4.7-31. As shown in the latter set of plots, cooling of the primary side of the steam generator tubes by feed and bleed results in condensation of steam on the secondary side, an increase in level, and a drop in pressure.

4.7.2.8 Plant Damage State LNI

The representative sequence for LNI is described in Section 4.6.2.17. Watts Bar plant damage state LNI was represented by three different MAAP runs. Sequence LNI3 is initiated by a total loss of feedwater at time 0. Containment sprays are also lost as is one of the two pressurizer PORVs. Two trains of charging pumps, and one train each of low pressure injection and high pressure injection, are available in both the injection and recirculation phases. The operators are assumed to initiate feed and bleed at a wide range level of 25%, which occurs at about 15 minutes. This results in the initiation of ECCS soon thereafter, and the primary system equilibrates at a pressure of about 1,500 psia, as shown in Figure 4.7-32. At this pressure, the code predicts that sufficient flow occurs to

maintain once-through cooling with a solid RCS. Over time, the RCS pressure falls as the pressurizer water cools, increasing the subcooling of the water inlet to the PORV and increasing both ECCS and PORV flow. Thus, it appears that the Level 1 success criterion, which required two PORVs to be available, was too conservative for this particular sequence.

The other two variations of plant damage state LNI do result in a core melt.

This sequence was run in two ways. In the first case, denoted LNI1, no induced rupture was assumed to occur. In the second case, LNI2, the SBO-like RCS conditions are assumed to give rise to a large induced rupture of the hot leg; as in the other MAAP cases, this was triggered by the achievement of a 1,100°K hot leg temperature.

The steam generators quickly dry out due to the loss of feedwater. The RCPs were tripped when subcooling was lost at 1.2 hours. Core uncovery occurred at 1.5 hours.

In the case with no induced rupture, core uncovering was followed relatively soon by vessel failure at high pressure at 2.9 hours; a total of 800 lbm of hydrogen was calculated to be produced in the core. The high pressure at RPV failure resulted in HPME to the lower compartment and a moderate amount of DCH. The peak containment pressure reached was about 30 psia just after RPV failure (see Figure 4.7-33); this peak includes the effect of a relatively large burn in the lower compartment. The peak hydrogen concentrations reached in the ice condenser, lower compartment, and upper compartment at the time of vessel failure were 45%, 15%, and 7%, respectively, as shown in Figures 4.7-34 through 4.7-36. Since the lower compartment hydrogen peak coincides with a high steam concentration, DDT is only considered to be possible in the ice condenser. The likelihood of this would mainly depend on how likely it is that the ignitors could initiate burns under conditions that are calculated to be steam-inerted and then that the burns would propagate into the upper portions of the ice condenser where the hydrogen is concentrated. This is not considered to be very likely and was not modeled. The ignitors reduce hydrogen concentrations to the 5% range soon after vessel failure.

Steaming of the debris on the lower containment floor completes the process of ice melt at about 9 hours. A short period of concrete attack occurs in the reactor cavity, but this is not maintained in the long term for two reasons. First, a relatively small debris mass melts after vessel failure and drains into the cavity. Furthermore, the charging pumps are activated after the blowdown of the RCS, which fills the cavity solid. The RWST is fully drained at 14 hours. The containment pressure reaches the 80-psia range at about 1 day. Given the median failure pressure for Watts Bar, containment failure would not actually be expected for many additional hours, but failure was assumed to occur at this time. In the absence of concrete attack and with a relatively cool containment atmosphere, source terms for all species other than noble gases were quite low, and revaporization from the RCS was negligible.

As noted before, sequence LNI2 was identical except that a large induced rupture was assumed to occur at about 2.5 hours. (Indeed, conditions that would give rise to such a failure were calculated to occur so this should be regarded as the best estimate variant.) This was soon after the period that core melting began, and, in the MAAP case, discharge of the accumulators and initiation of flow from the one available charging pump were calculated to arrest the melting process. Based on the evidence of TMI, this is considered

to be quite reasonable, but it should be recognized that the MAAP models for recovery of a damaged core are insufficient by themselves to resolve whether recovery would be likely under these conditions.

The pressure spike due to the blowdown of the RCS reached about 33-psia, (see Figure 4.7-37). A very high hydrogen concentration was achieved in the ice condenser as in LNI1, although the spike in lower compartment hydrogen concentration was small in this case. Continued flow from the CCP kept the core covered, and core steaming caused complete ice melt at 7 hours and containment failure (assuming a failure pressure of 80-psia) at 15 hours. The RWST was depleted at 14.5 hours, which caused an accelerated rate of containment pressure rise and termination of injection. RPV failure occurred at 16.5 hours.

The fact that vessel failure was computed to occur after containment failure gave rise to a moderately high (and increasing) source term of volatile fission products, as shown on Figure 4.7-38. Since this results directly from the timing of containment failure relative to RPV failure, the releases are quite sensitive to the assumed containment failure pressure, and the assumption of a failure at 80 psia is overly conservative. Release of fission products ex-vessel is prevented by the large overlying pool in the reactor cavity.

4.7.2.9 Plant Damage State FCI

The representative sequence for FCI is described in Section 4.6.2.2. The base case for plant damage state FCI was simulated with MAAP calculation FC14.

Containment sprays initiate quickly, so the switchover to recirculation occurs at 0.4 hours, and all ECCS is lost at that time. Steam generator depressurization is assumed to be initiated by the operators at 15 minutes; the subsequent cooldown of the RCS extends the time to core uncovery to nearly 6 hours. A series of hydrogen burns begin at 7 hours in the lower compartment since the air return fans, the ice condenser, and containment sprays prevent this region from becoming steam inerted. The ignitors prevent any of these burns from threatening containment integrity, as shown in Figure 4.7-39, and prevent hydrogen concentrations from becoming flammable in any downstream region until after vessel failure. Vessel failure is calculated to occur at nearly 10 hours; the low vessel pressure prevents debris from being dispersed from the reactor cavity.

After the RCS blowdown has been completed, burns begin in the other containment compartments; again, the ignitors prevent any of these burns from threatening containment. Ice depletion occurs at about 11.5 hours. This has no noticeable effect on containment pressure since the containment sprays are still available for containment heat removal. Containment failure is not predicted to occur.

4.7.2.10 Plant Damage State GNI

The representative sequence for GN1 is described in Section 4.6.2.5. Plant damage state GNI is represented by two MAAP calculations, denoted as GNI1 and GNI4. These differ only in that air return fans are available in the former but not the latter.

Case GNI1 is initiated by a loss of offsite power. Other dependent and independent failures result in the loss of all ECCS, containment sprays, and AFW at time 0. Failure of

reactor coolant pump seal cooling is assumed to cause seal LOCAs (250 gpm per pump, evaluated at nominal system conditions) 1.5 hours later. Ignitors and, in case of GNI1 air return fans, are available throughout the sequence. It is assumed that induced rupture of the RCS does not occur; this is appropriate for cases with this size seal LOCA, but induced rupture might occur if the seal LOCAs were smaller. In any case, in the context of containment performance, it is conservative to neglect the case of induced rupture.

The early primary system behavior is typical of fast station blackout-type transients, as shown in Figure 4.7-40. RCS failure occurs at 4 hours at a pressure of about 800 psia. Eight hundred lbm of hydrogen is produced prior to vessel failure, and an additional 150 lbm is produced in the RCS by core remnants left behind after vessel failure, as shown in Figure 4.7-41.

The pressure in the primary system is sufficiently high to disperse some debris out of the reactor cavity but not high enough to make the dispersal complete, as shown in Figure 4.7-42. The dispersed debris quenches quickly in the containment, and the debris left in the reactor cavity dries out and begins attacking concrete at about 9 hours. By the end of the calculation, the ex-vessel debris has generated over 1,000 lbm of hydrogen as well as a large quantity of carbon monoxide (see Figure 4.7-41).

Ice depletion occurs at 7 hours. This causes steam concentrations to begin to increase and terminates the long series of local burns that had occurred up to this time. As shown in Figure 4.7-43, the ignitors and air return fans were able to limit peak hydrogen concentrations to less than 7%, the peak occurring at the point of vessel failure. The containment pressure reached the 105-psia range, corresponding to the estimated median failure pressure for Watts Bar, at about 1 day.

Source terms for fission products other than noble gases were dominated both by cesium iodide and cesium hydroxide, which revaporized in the RCS, and tellurium compounds released in concrete attack, as shown in Figure 4.7-44. Revaporization is relatively pronounced in this sequence due to the dry secondary side, the relatively high initial RCS retention, and the high cavity temperatures. Perhaps most important, the code predicts that about 30,000 lbm of fuel remains in the original core boundary until after containment failure (see Figure 4.7-45); this adds a considerable amount of extra heat to the RCS and accelerates revaporization. Obviously, there is considerable uncertainty associated with such predictions.

Case GNI2, in which the air return fans are unavailable, behaves similarly. Compared to the previous case, ice depletion occurs at 9 hours (about 2 hours later), and containment failure occurs at 27 hours (about 3 hours later). On the other hand, peak hydrogen concentrations are significantly higher, as shown in Figure 4.7-46. Fission product releases are somewhat lower, as shown in Figure 4.7-47. This is caused by the fact that all of the core is released at vessel failure (no fuel remnants were retained) so that the reduced heat load lowers revaporization from the RCS. In addition, release of the entire core accelerates core-concrete attack somewhat; combined with the later time of containment failure, this results in a longer period between tellurium release and containment failure, allowing more settling.

4.7.2.11 Plant Damage State HGI

The representative sequence for HGI is described in Section 4.6.2.9. Plant damage state HGI is initiated by a loss of offsite power.

The operators are assumed to initiate feed and bleed when the steam generator level reaches a low level, which occurs, in this case, at 1.4 hours; this causes containment sprays to initiate, so RWST dryout occurs at 2.2 hours, at which point the operators close the pressurizer PORVs.

The plot of primary system pressure (see Figure 4.7-48) shows the drop in pressure when feed and bleed is initiated, and the rapid increase when injection is lost and the PORVs are closed. Due to the continued inability to remove decay heat, the reactor vessel fails at about 6 hours at high pressure; while not modeled, this sequence could also have resulted in an induced rupture of the hot leg, and, thus, a failure of the RCS at low pressure.

High pressure at RPV failure results in the dispersal of most of the core debris to the lower compartment (see Figure 4.7-49). Both the lower compartment and ice condenser hydrogen concentrations spike to relatively high values at RPV failure, and then are quickly reduced by the air return fans and ignitors (see Figure 4.7-50). Ice depletion occurs at 13 hours, and the containment begins to pressurize (see Figure 4.7-51). At the end of the calculation, 24 hours, the containment pressure is 60 psia, so overpressurization failure would not be predicted until about 1 ½ days. Due to the large water pool lying over the debris, fission product releases would be expected to be small when failure did occur.

4.7.2.12 Plant Damage State ENS

The representative sequence for ENS is described in Section 4.6.2.7. Plant damage state ENS is represented by MAAP calculation ENS1. Seal LOCAs, assumed here to correspond to a leakage rate of 250 gpm evaluated at nominal RCS conditions, occur in response to loss of seal cooling at 1.5 hours. In addition, it is assumed that the No. 1 seal return lines are not isolated, creating a bypass of the containment. AFW is available, and the operators begin a cooldown 15 minutes into the accident.

MAAP does not allow leakage of fluid from a LOCA simultaneously to the containment and to the auxiliary building. For this reason, all the LOCA effluent was directed to the auxiliary building. This represents a conservatism, since only a fraction of the break flow would actually pass through the No. 1 seal return lines.

One last key assumption was made. This sequence, like the other cases involving cooldown, develops over an extended period of time. Vessel failure was not predicted to occur until 27 hours. For this reason, it was assumed that the operators would secure the ventilation system in the auxiliary building at some point prior to fission product release. This increases residence time and should, all else being equal, result in higher fission product retention in the auxiliary building.

The RCS fails at low pressure. All the debris is confined to the reactor cavity, and concrete attack begins immediately after vessel failure. A series of hydrogen burns begin even earlier in the auxiliary building; these stop after vessel failure, but burns then begin in the reactor cavity. Containment pressure (see Figure 4.7-52) begins to rise after vessel

failure; this occurs due to generation of noncondensible gases and is only partially mitigated by the ice condenser. Unmelted ice remains in the ice condenser at the end of the calculation.

Fission product releases to the auxiliary building (see Figure 4.7-53) are dominated by the nobles, cesium iodide and cesium hydroxide which are released through the seal return lines prior to vessel failure. Only relatively small quantities of tellurium and other compounds released in core-concrete attack make their way out of the containment prior to settling. Since AFW is available, revaporization of fission products from the RCS is small. Releases from the auxiliary building to the environment are shown in Figures 4.7-54 and 4.7-55. Comparing the two figures, we see that relatively good retention is predicted. This can be attributed to the tripping of the fans and the fact that fission products generally proceed through the building to the rupture panels located on the roof. Both factors contribute to relatively long residence times.

4.7.2.13 Plant Damage State KNS

The representative sequence for KNS is described in Section 4.6.2.12. The reactor coolant pumps operate until tripped by the operators. Further, it is assumed that seal LOCAs occur at time 0, and that the No. 1 seal return line from each reactor coolant pump is not isolated. This results in a bypass of the containment. Finally, it is assumed that a set of containment penetrations are not isolated. For the purpose of the MAAP calculation, the containment isolation failures were represented by six 2-inch diameter holes in the MAAP dead-end compartment control volume.

Since MAAP does not allow simultaneous primary system breaks to the containment and the auxiliary building, all the seal LOCA effluent was assumed to be directed to the auxiliary building; this is conservative since only a fraction of the fluid would leak into the auxiliary building through the No. 1 seal return lines. Given the relatively large seal LOCA size assumed in this calculation, the conditions for induced rupture of the RCS were not predicted to occur.

The RCS failed at relatively high pressure (1,100 psia) at 3 hours. Most of the debris is either not entrained by gas flow out of the reactor cavity or melts after vessel failure and collects there; consequently, there is an extended period of concrete attack beginning at about 9 hours as shown in Figure 4.7-56. This releases both fission products and combustible gases to the containment, and causes the reactor cavity to reach high temperatures.

Note that a portion of the fission products released early in the sequence will leak out through the seal return lines; after vessel failure, there are two leakage paths for fission products, through the seal return lines and also through the unisolated lines which enter the containment. As shown in Figure 4.7-57, fission products are released to the auxiliary building in two stages. A relatively small release occurs later, as pressure builds in the containment as concrete attack proceeds. The auxiliary building is calculated to retain much of this release. In the case of cesium iodide, for example, about 40% of the total inventory is released to the auxiliary building by the end of the run (48 hours). About 1/5 of this; i.e., 8% of the total, is released into the environment as shown in Figures 4.7-58 and 4.7-59. Release of nonvolatile fission products is small compared to the release of

cesium iodide, cesium hydroxide, and noble gases. It is worth noting that decontamination factors would have been higher if the ventilation fans or fire dampers tripped.

4.7.3 REFERENCES

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4.7-2. Gabor, J. R., et al., "MAAP Thermal-Hydraulic Qualification Studies," prepared for Electric Power Research Institute (to be published).

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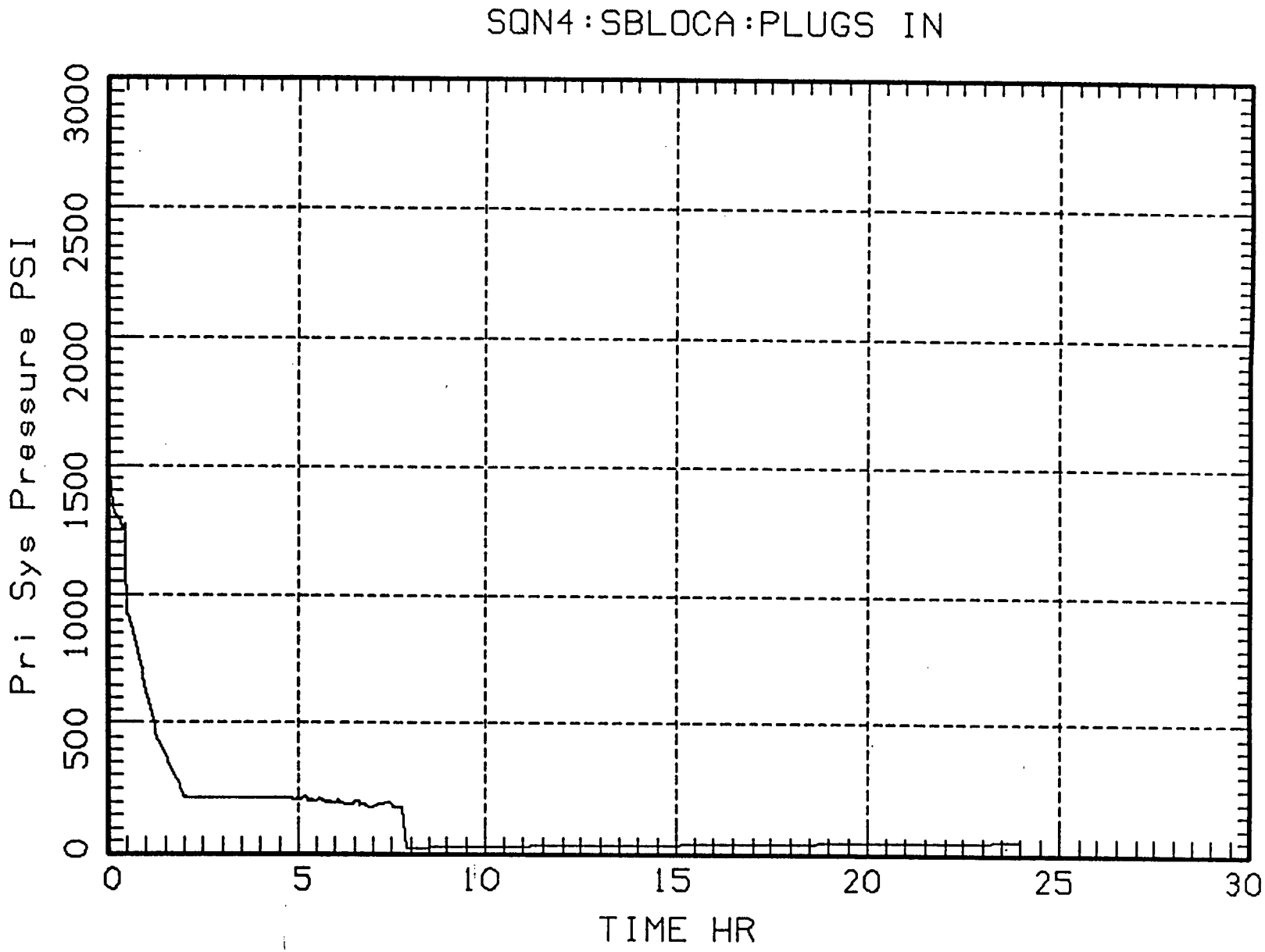

Figure 4.7-1. Primary System Pressure in Case EGI

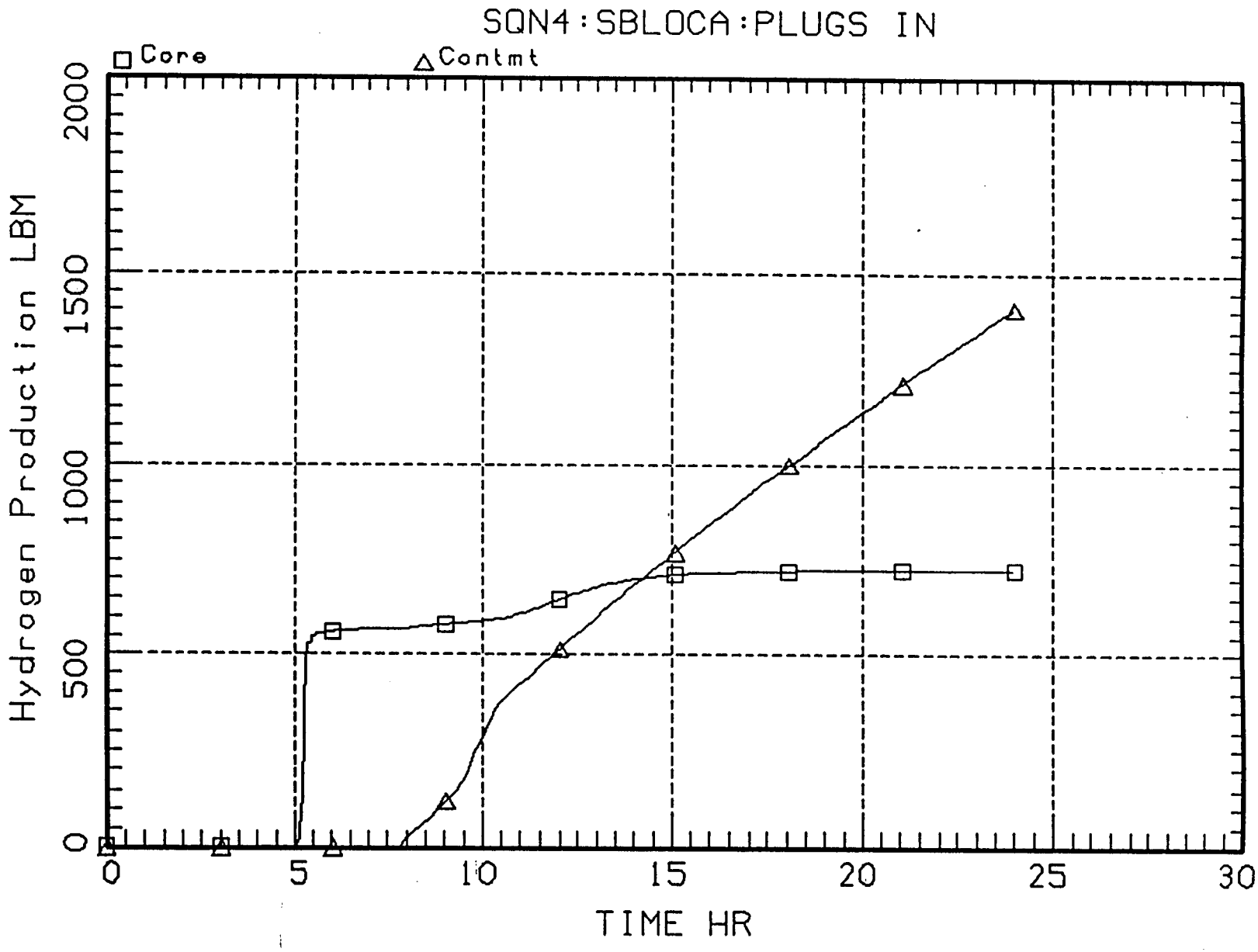

Figure 4.7-2. Hydrogen Production in Case EGI

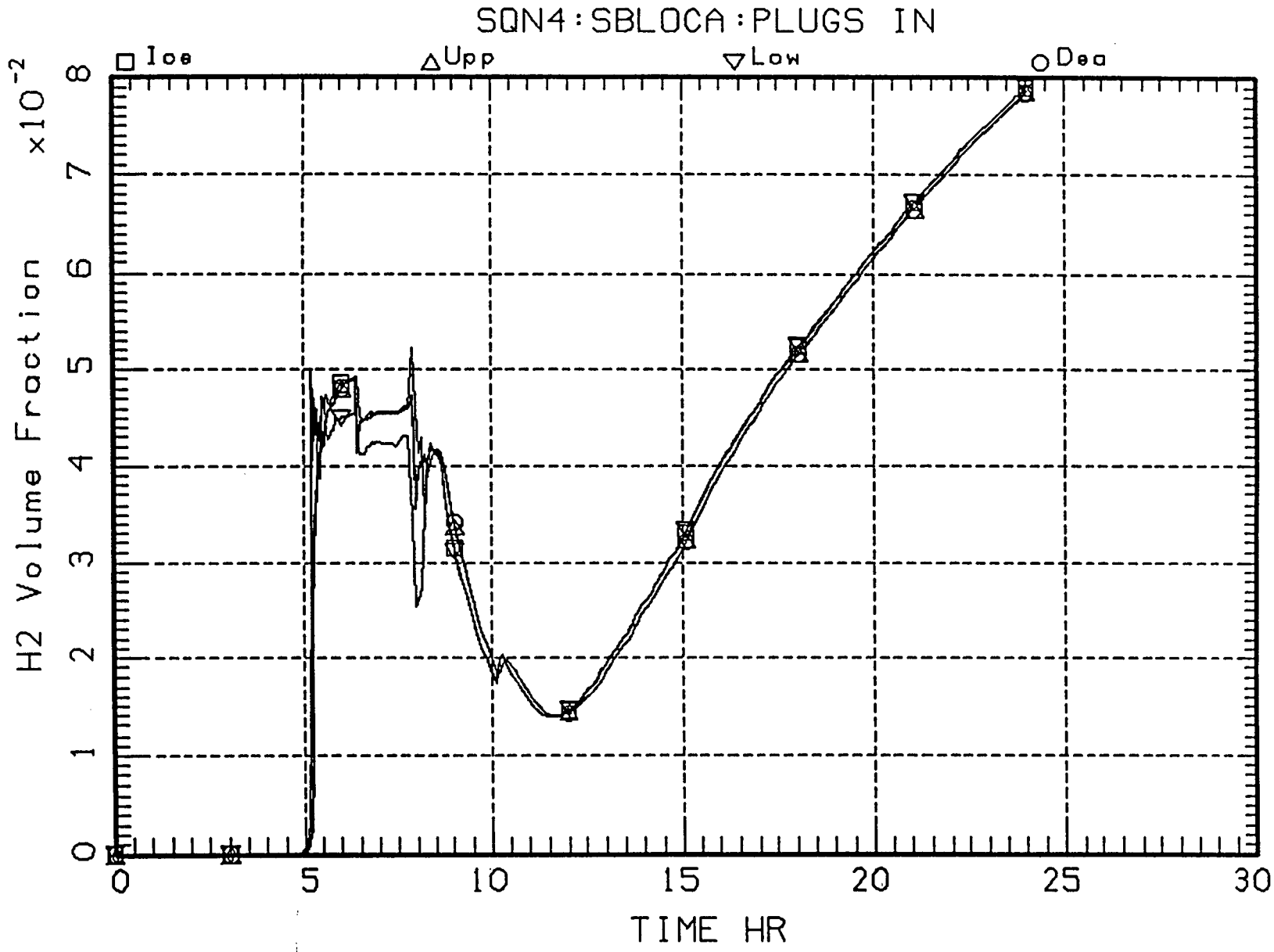

Figure 4.7-3 Hydrogen Concentration in Containment in Case EGI

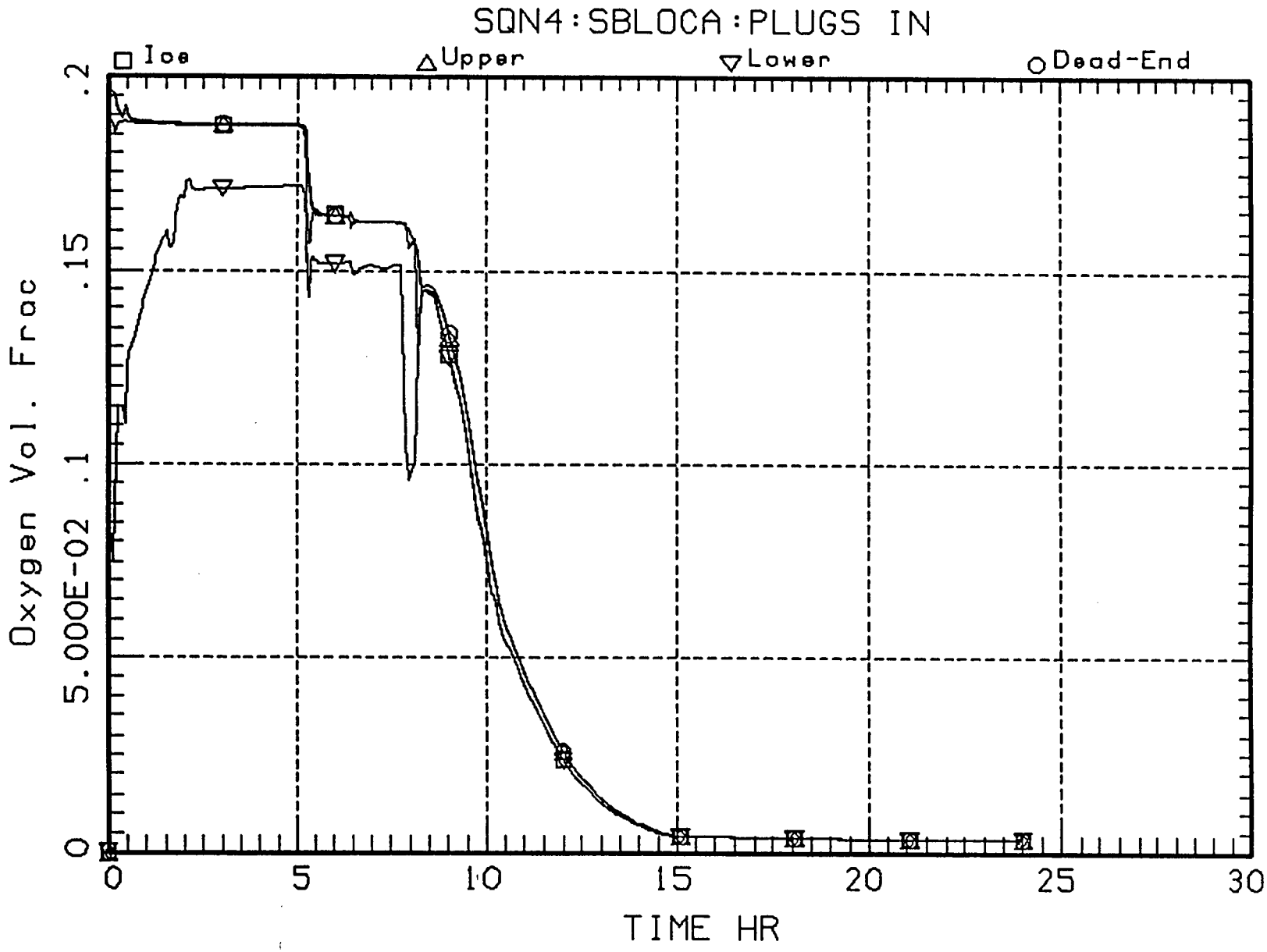

Figure 4.7-4. Oxygen Concentration in Containment in Case EGI

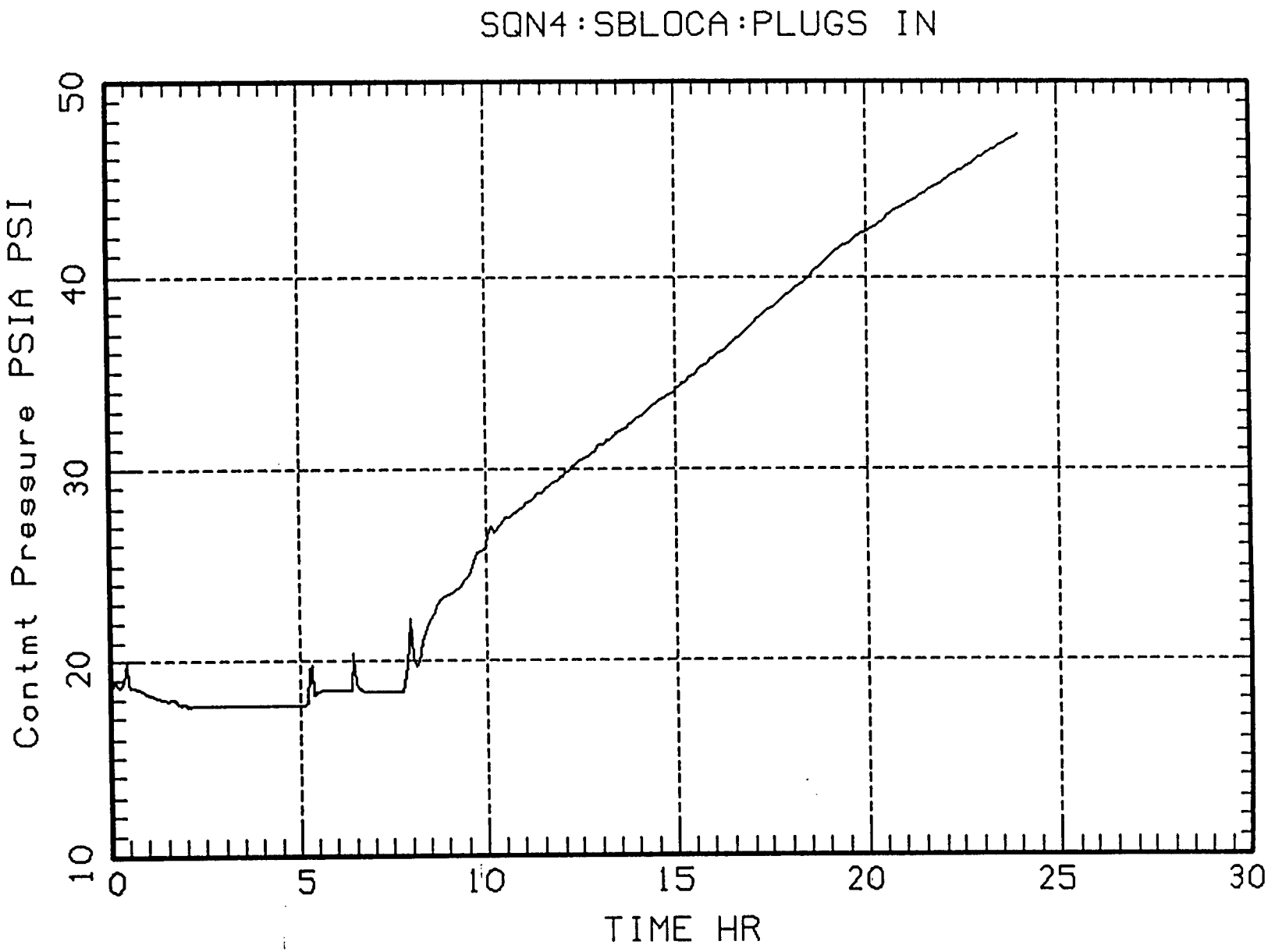

Figure 4.7-5. Containment Pressure in Case EGI

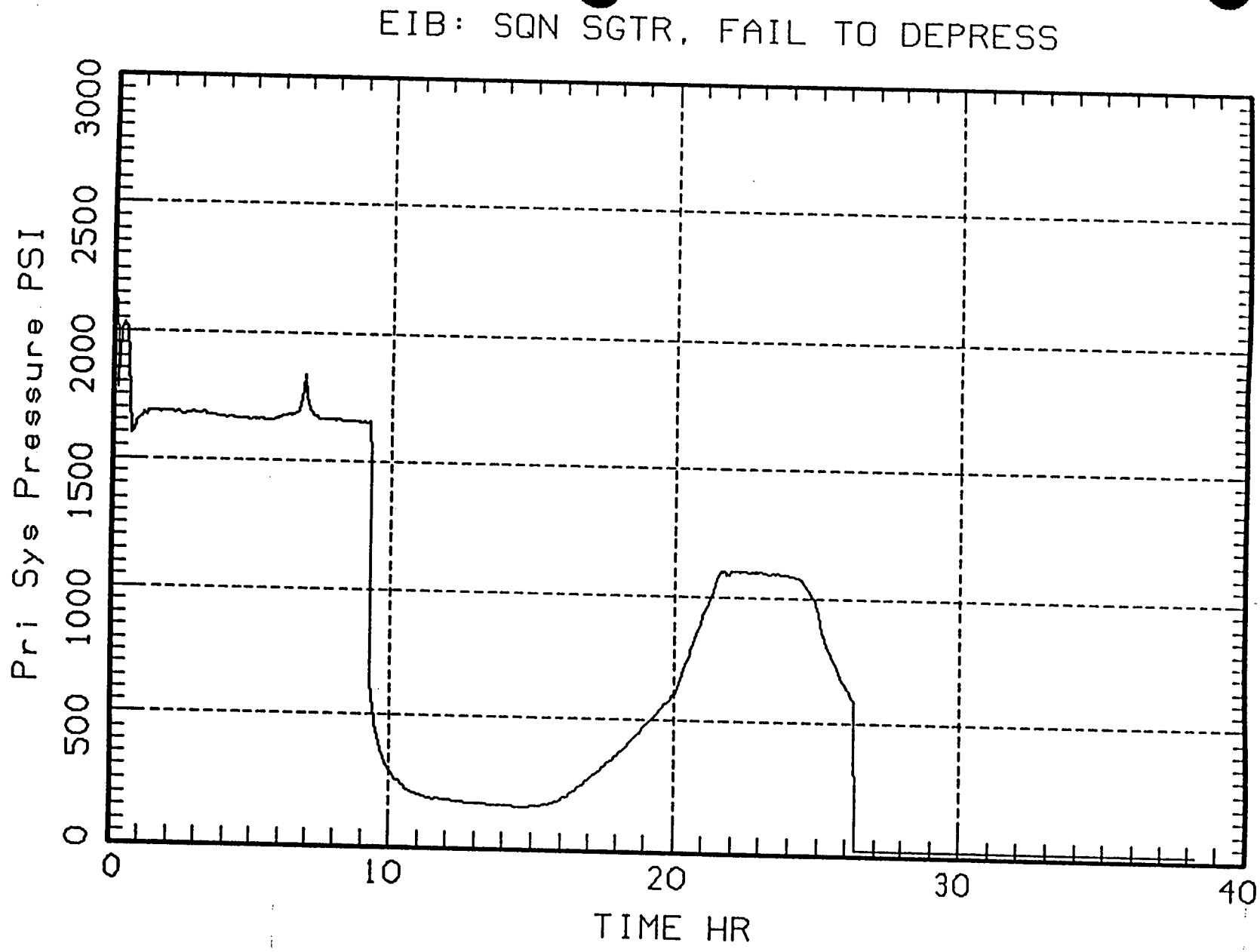

Figure 4.7-6. Primary System Pressure in Case EIB

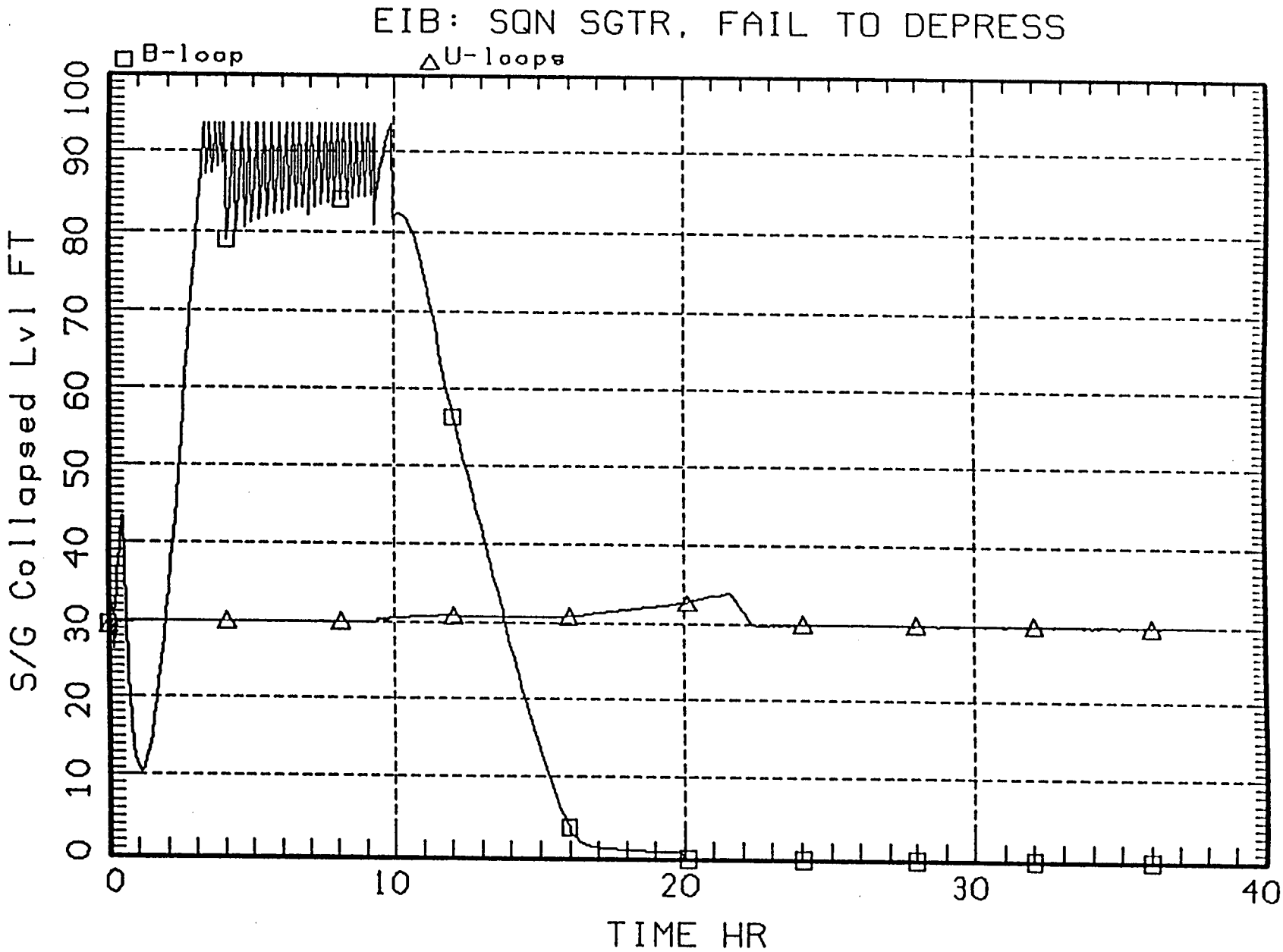

Figure 4.7-7. Steam Generator Levels in Case EIB

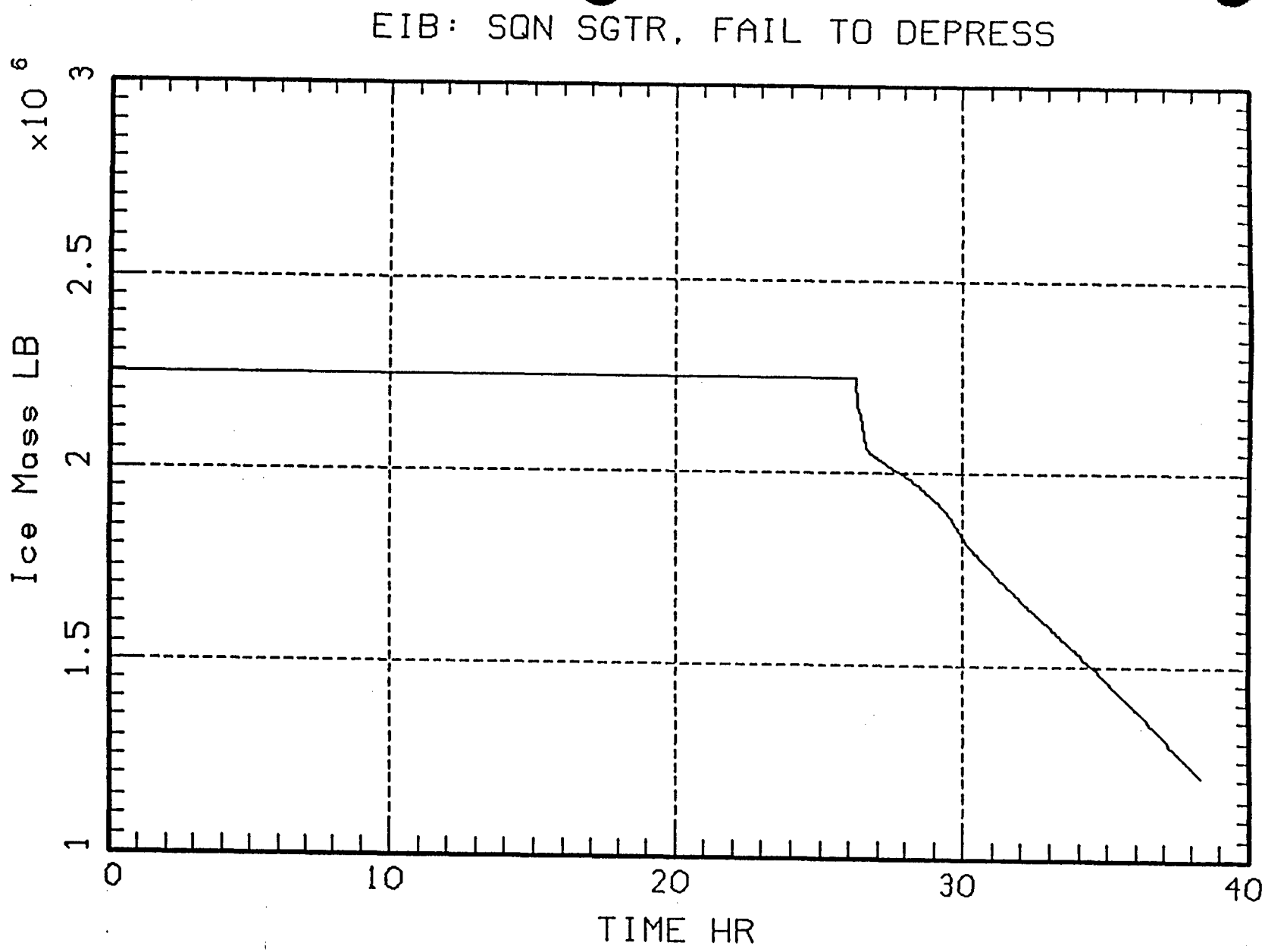

Figure 4.7-8. Ice Mass in Case EIB

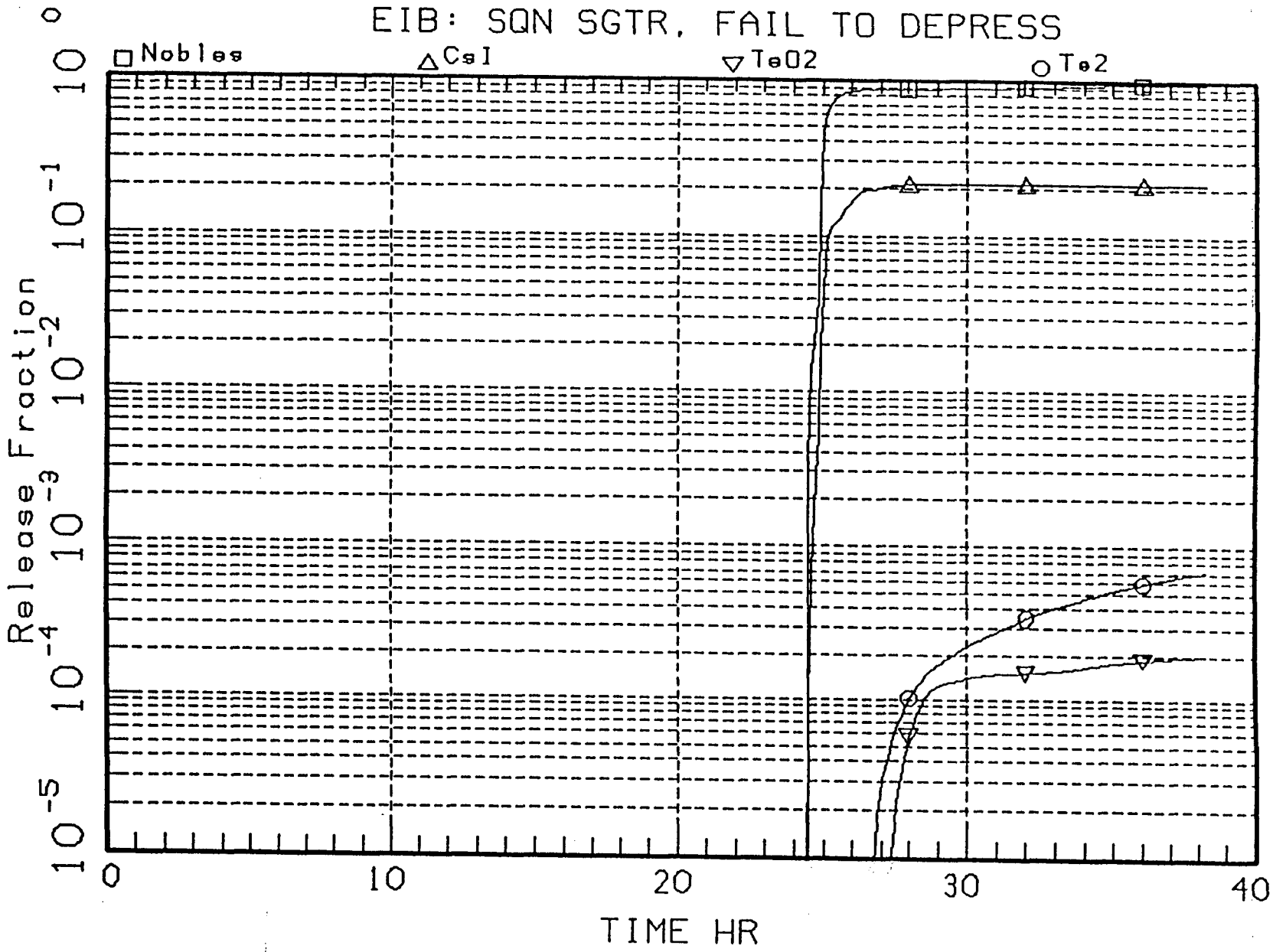

Figure 4.7-9. Fission Product Environmental Release Fractions in Case EIB

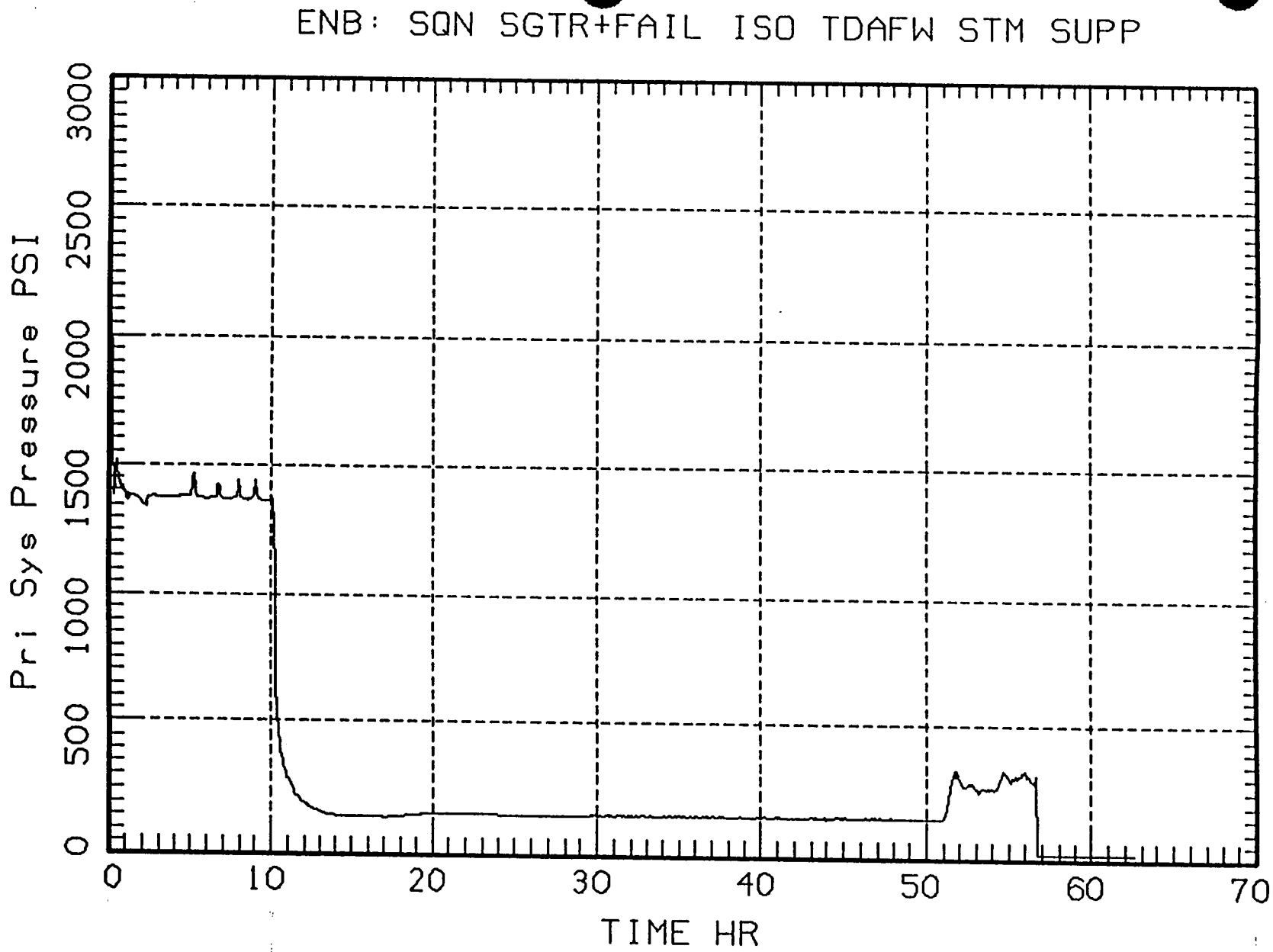

Figure 4.7-10. Primary System Pressure in Case ENB

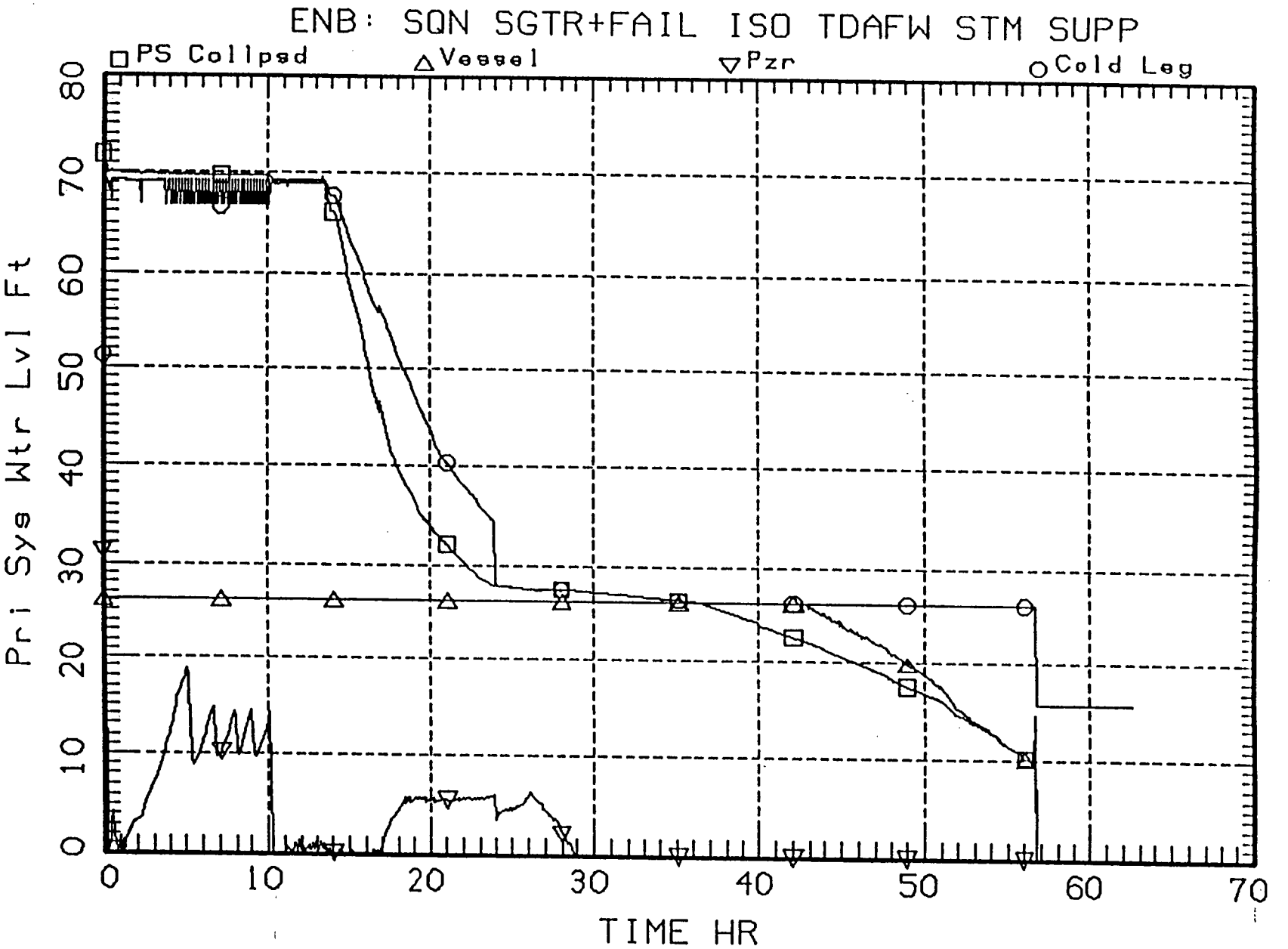

Figure 4.7-11 Primary System Water Levels in Case ENB

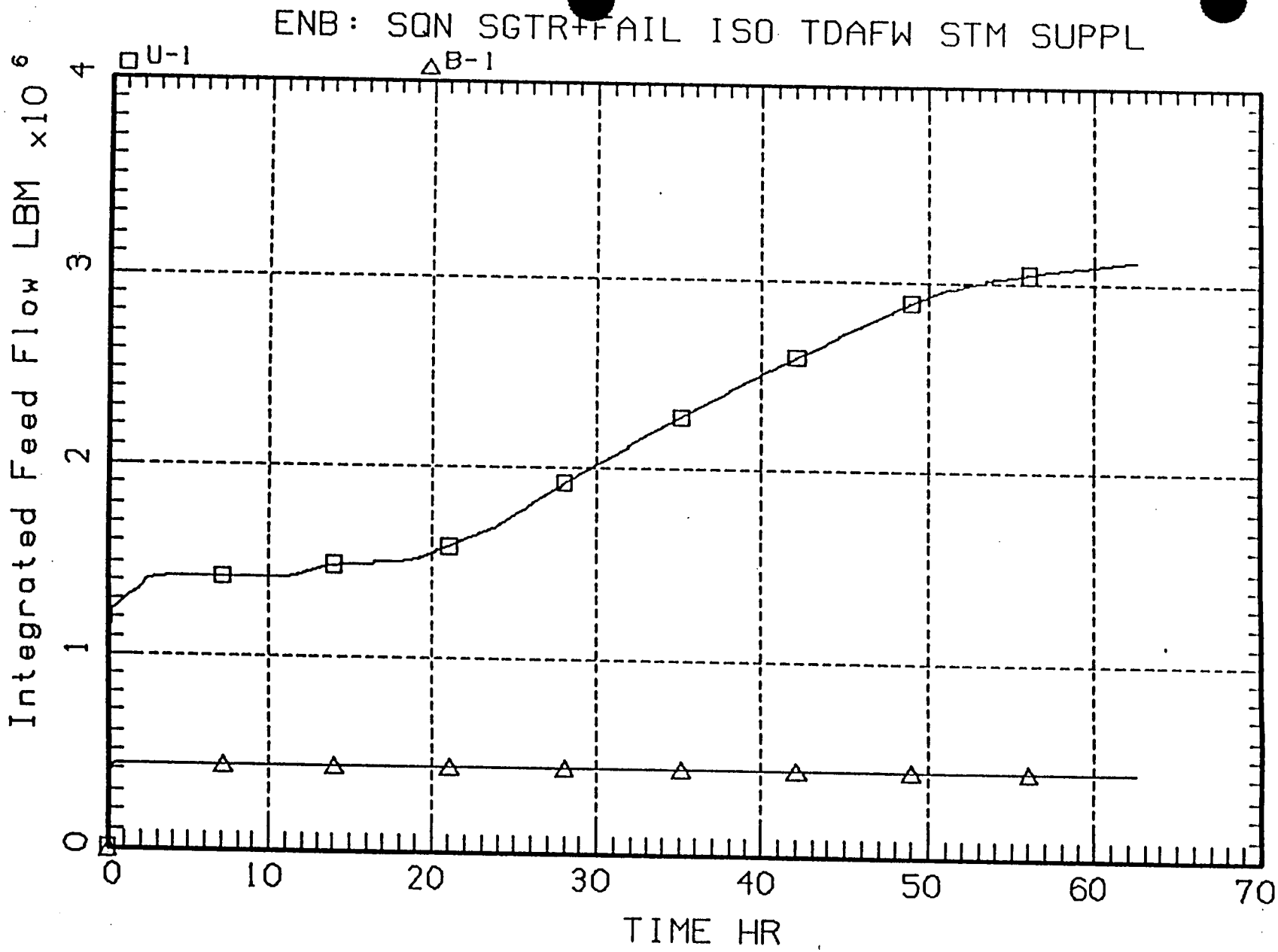

Figure 4.7-12. Integrated Feedwater Flow in Case ENB

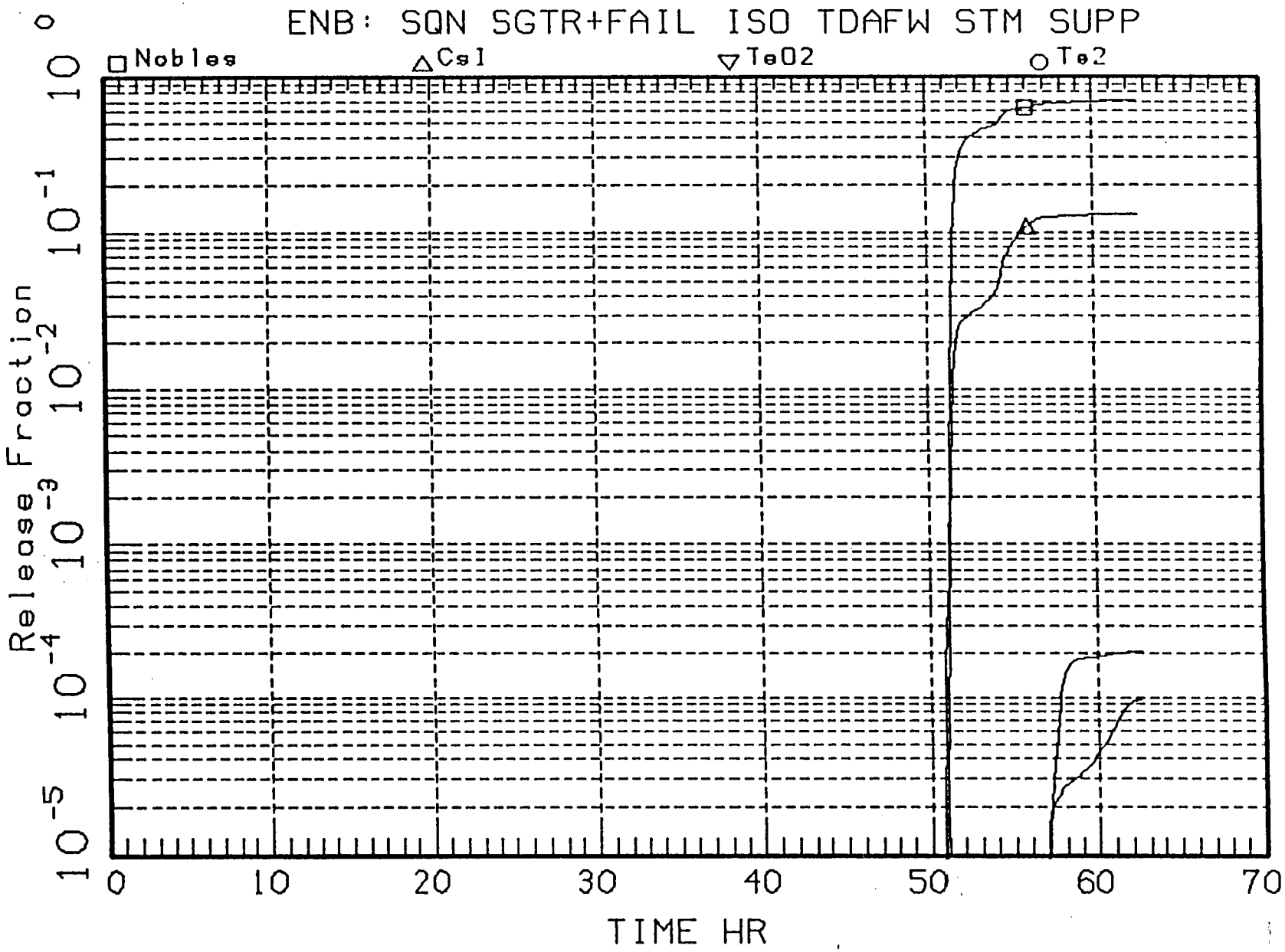

Figure 4.7-13. Fission Product Environmental Release Fractions in Case ENB

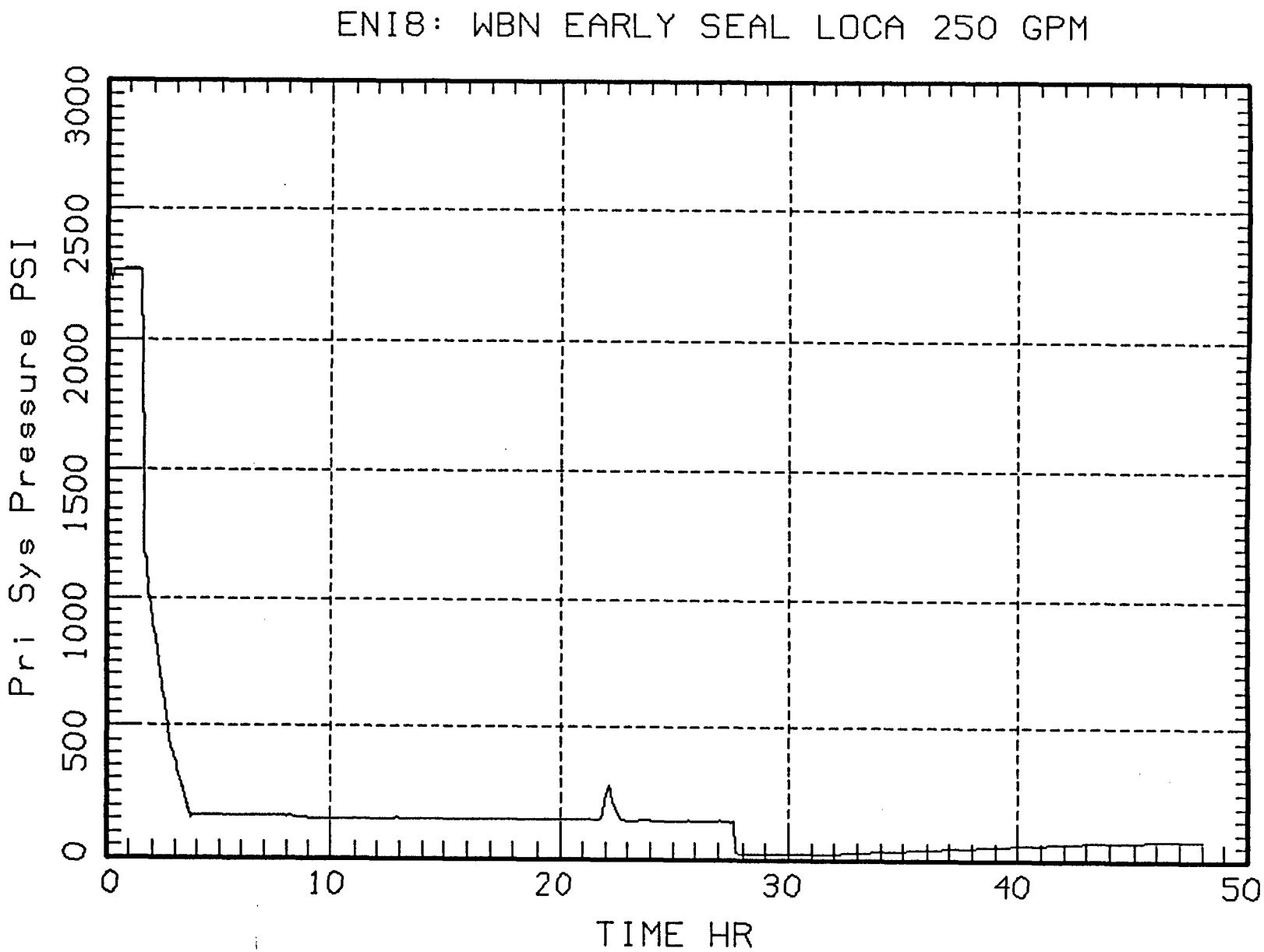

Figure 4.7-14. Primary System Pressure in Case EN18

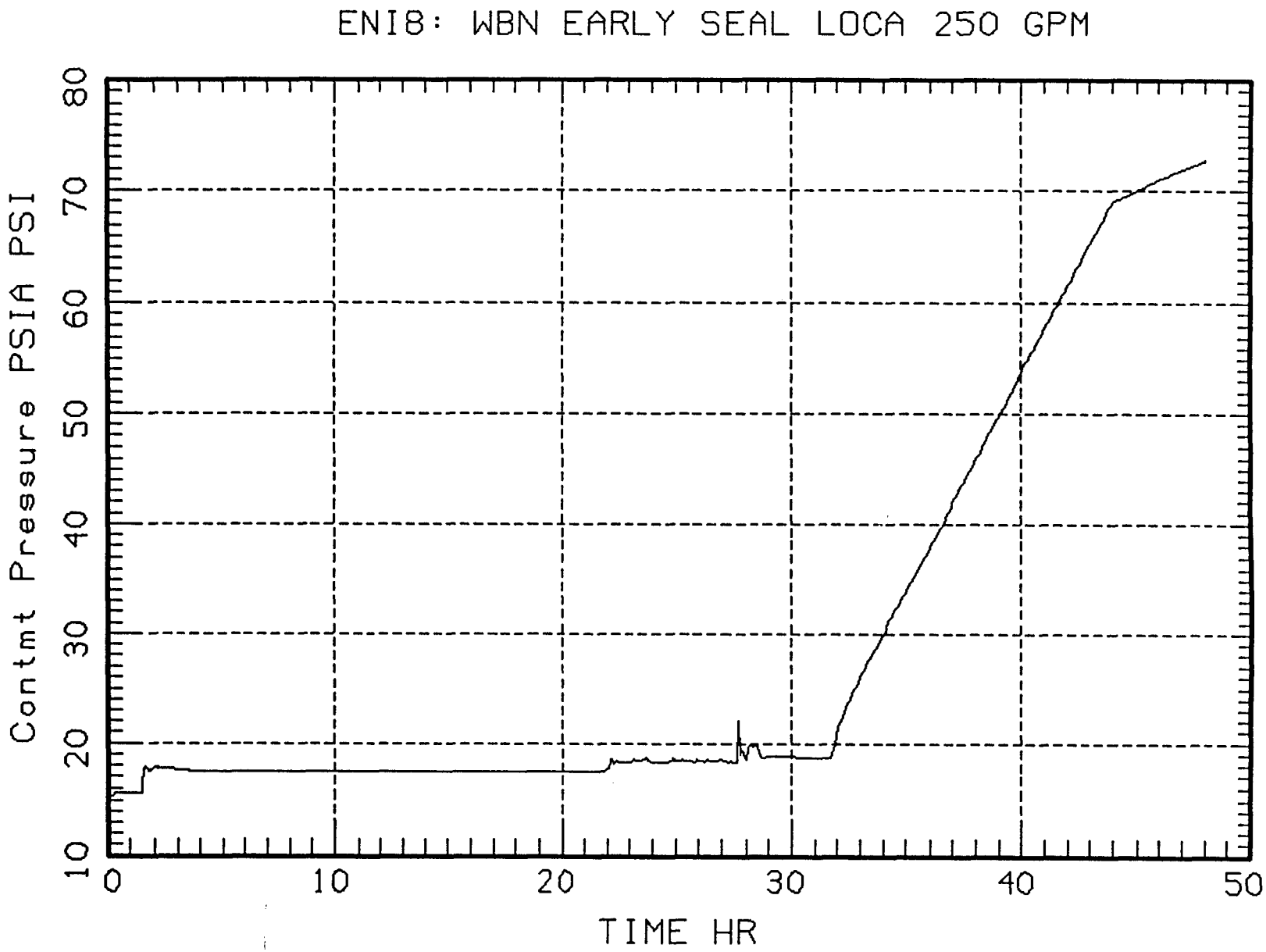

Figure 4.7-15. Containment Pressure in Case EN18

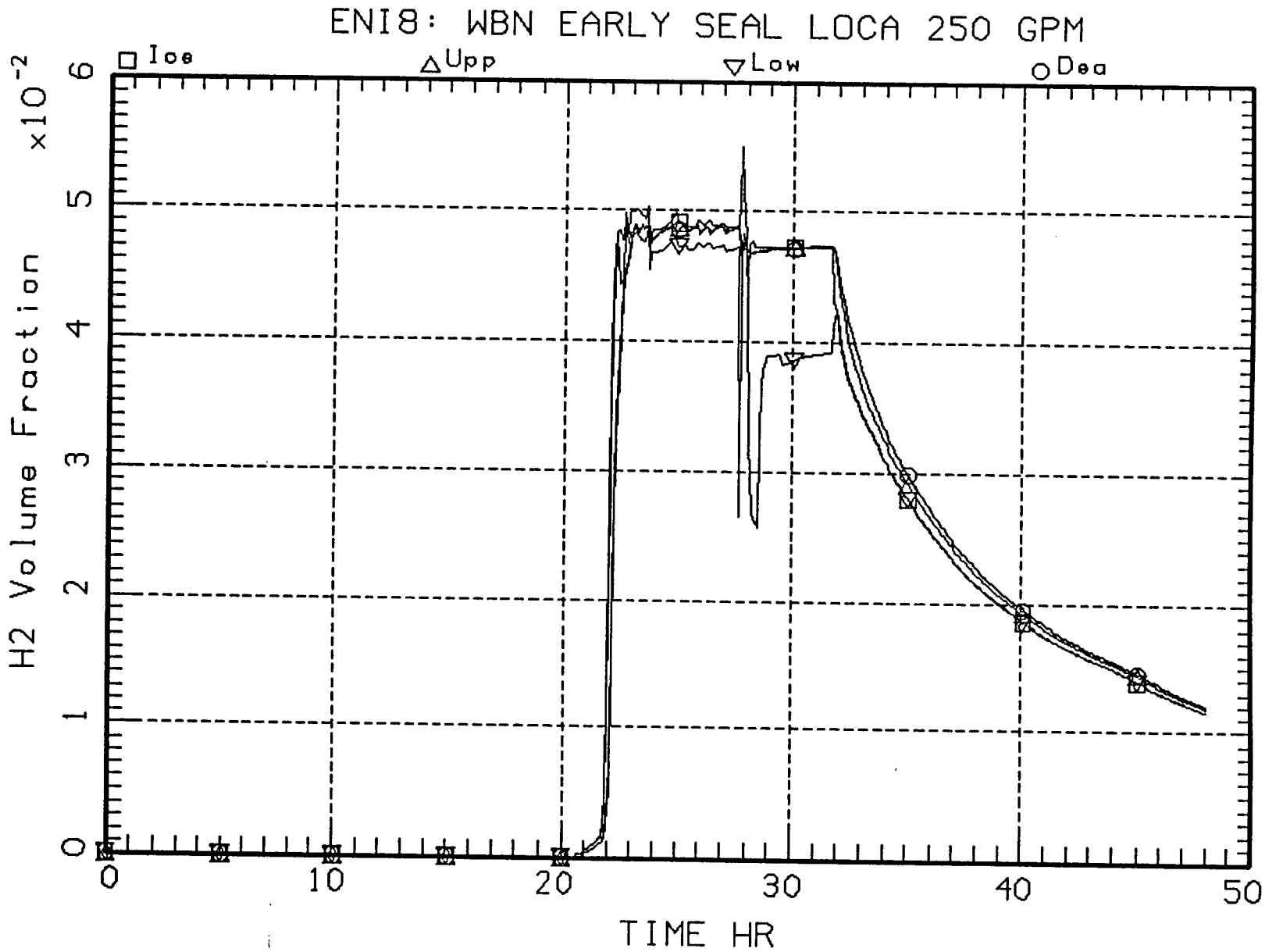

Figure 4.7-16. Hydrogren Concentrations in Containment in Case ENI8

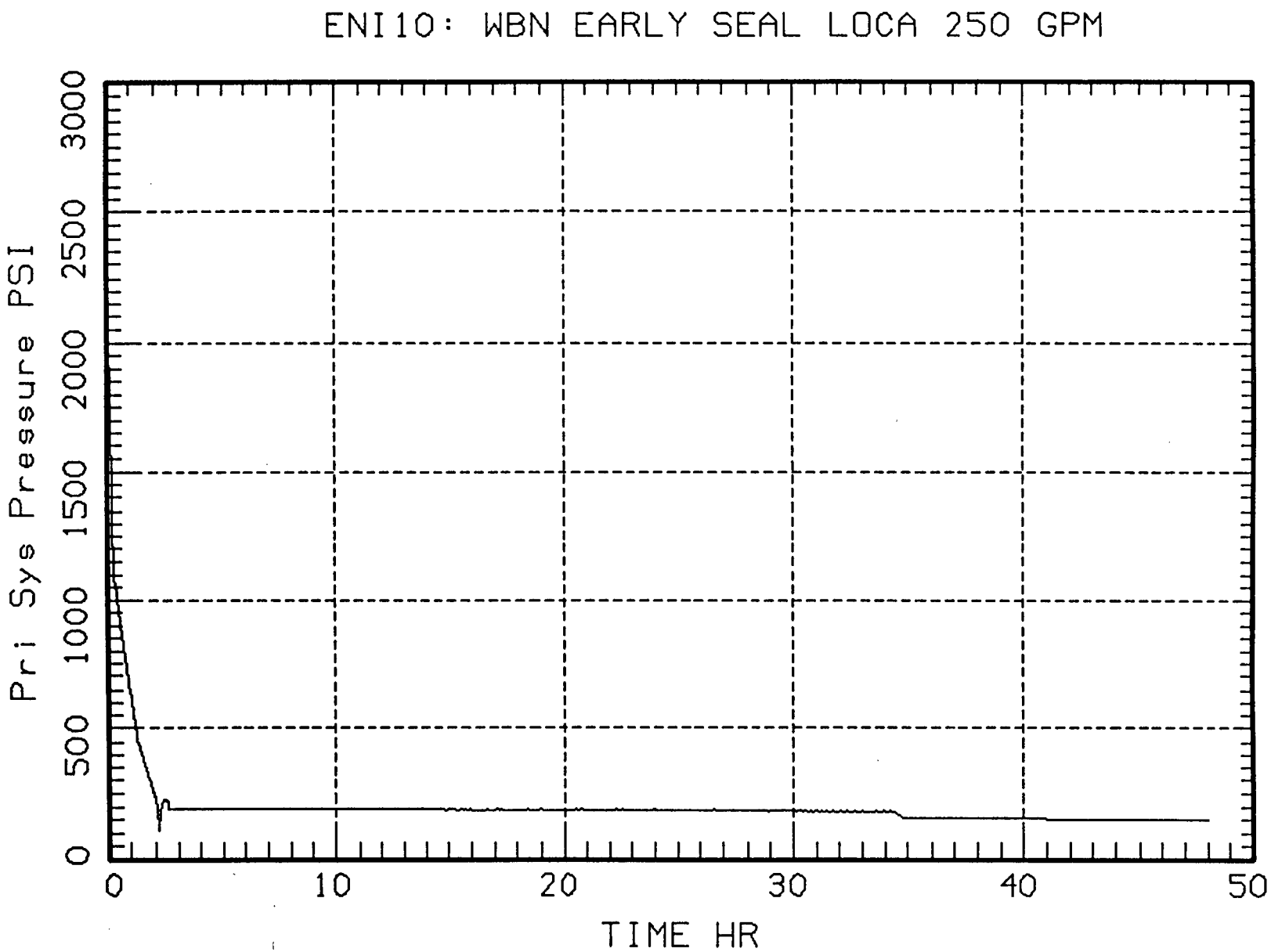

Figure 4.7-17. Primary System Pressure in Case ENI10

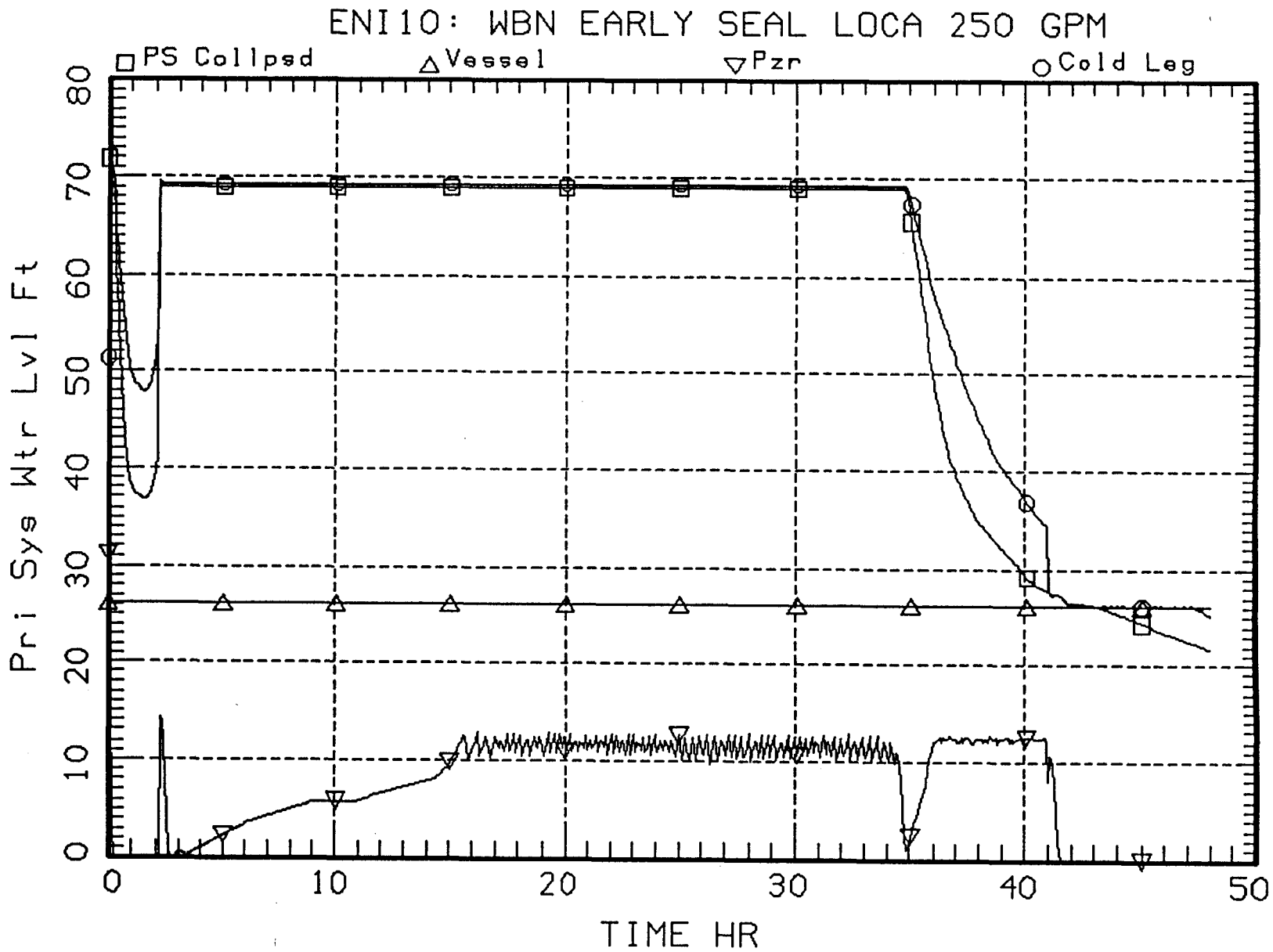

Figure 4.7-18. Primary System Water Levels in Case ENI10

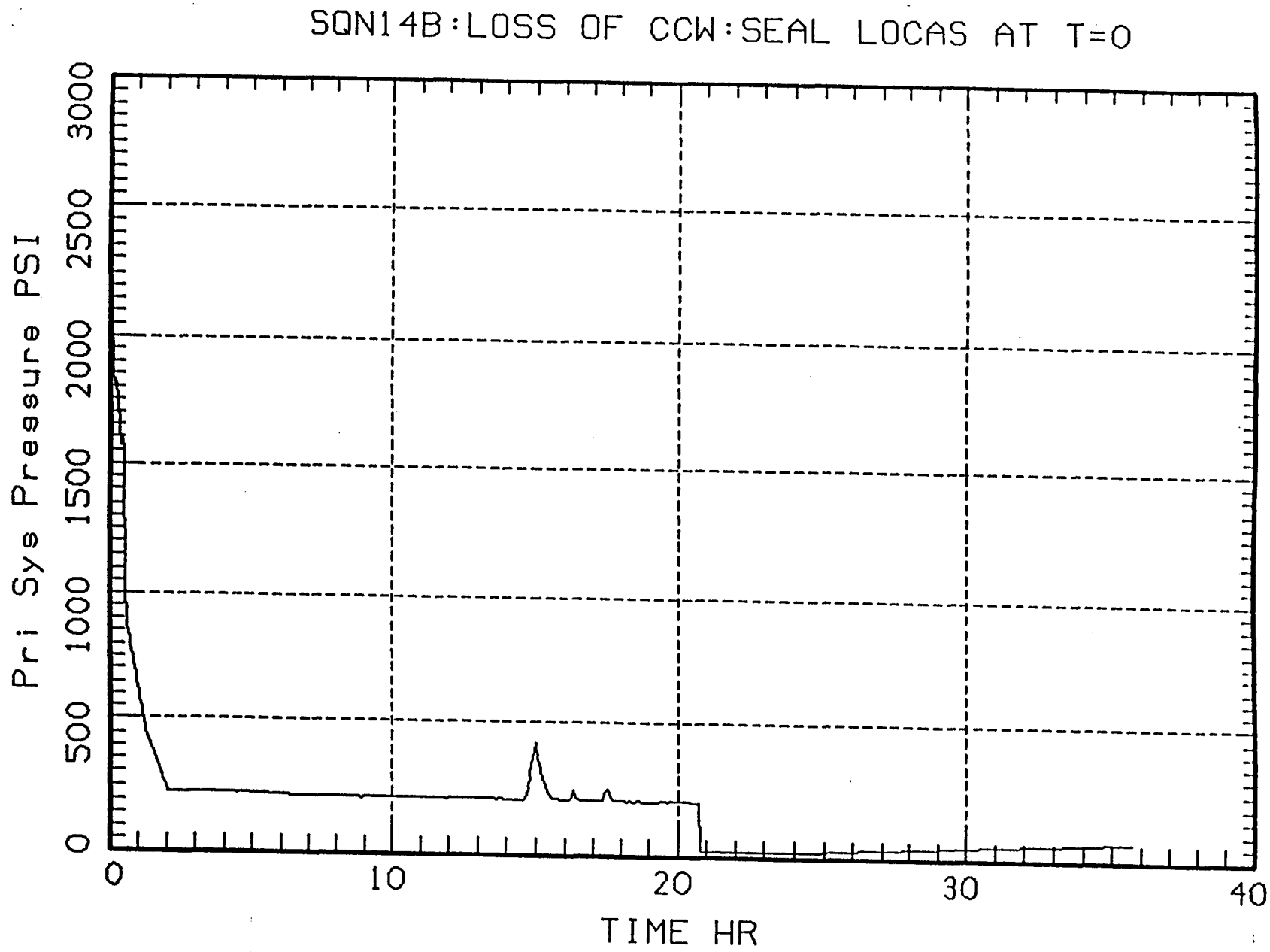

Figure 4.7-19. Primary System Pressure in Case SQN-14B

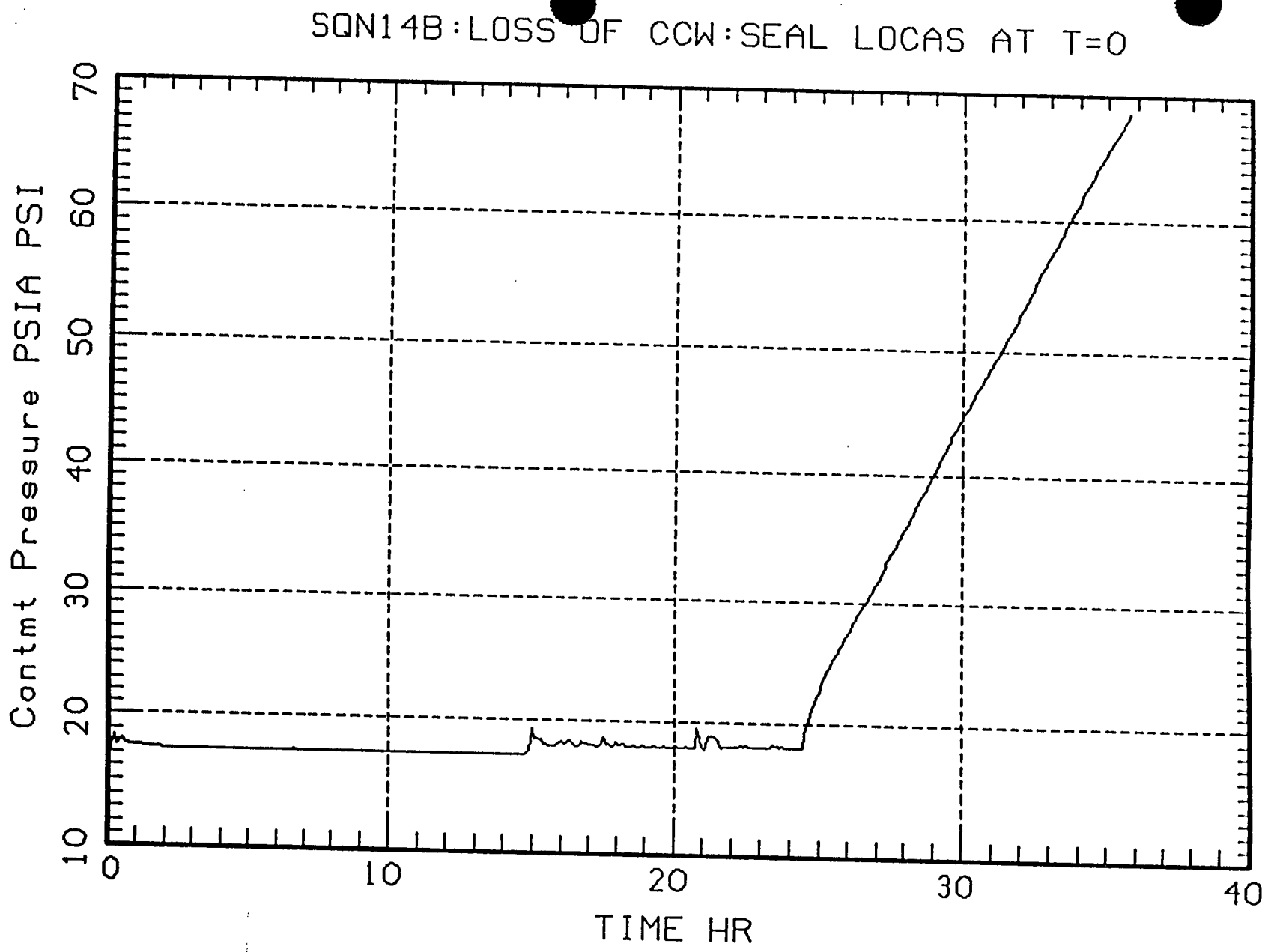

Figure 4.7-20. Containment Pressures in Case SQN-14B

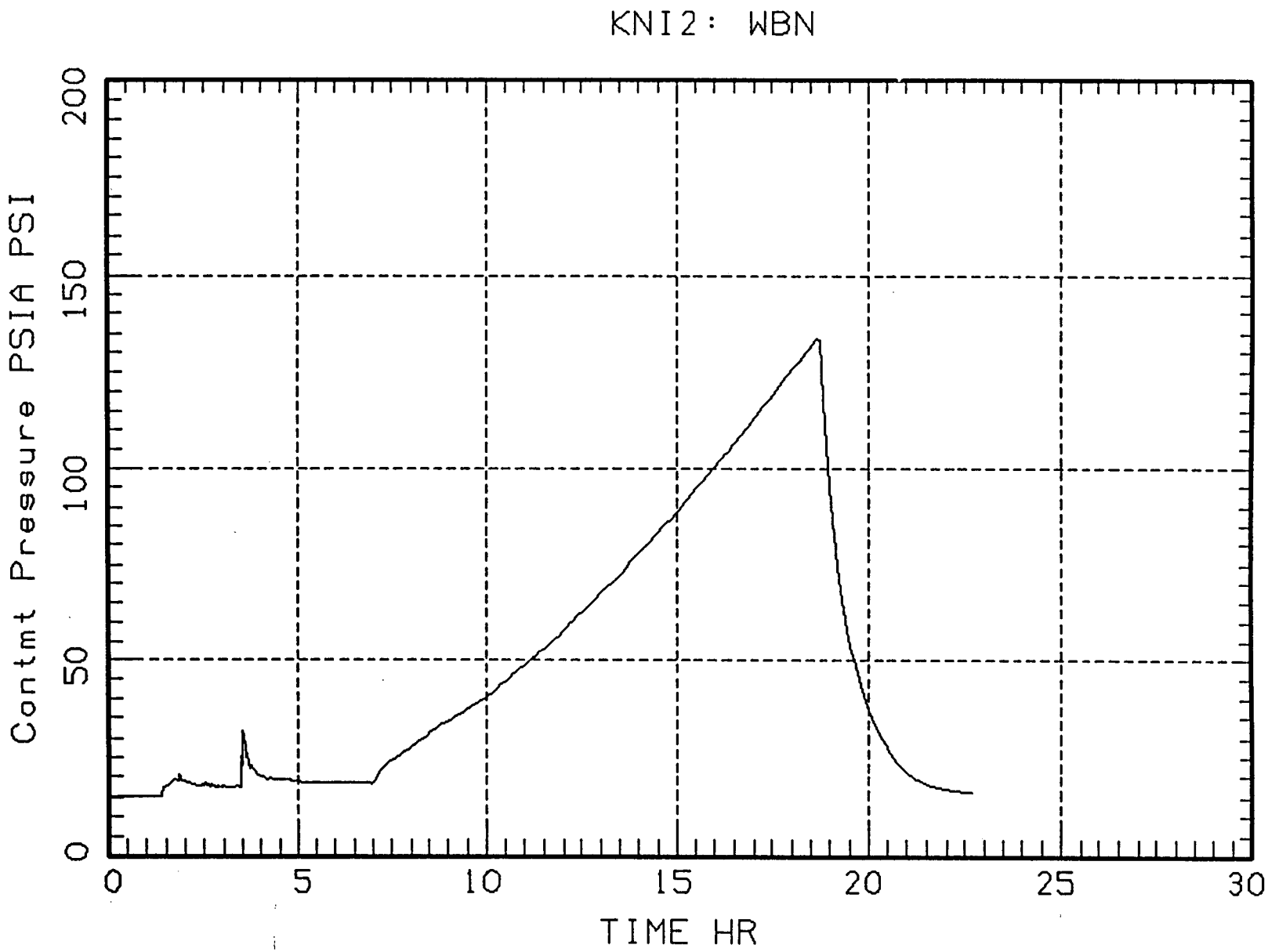

Figure 4.7-21. Containment Pressure for Case KNI2

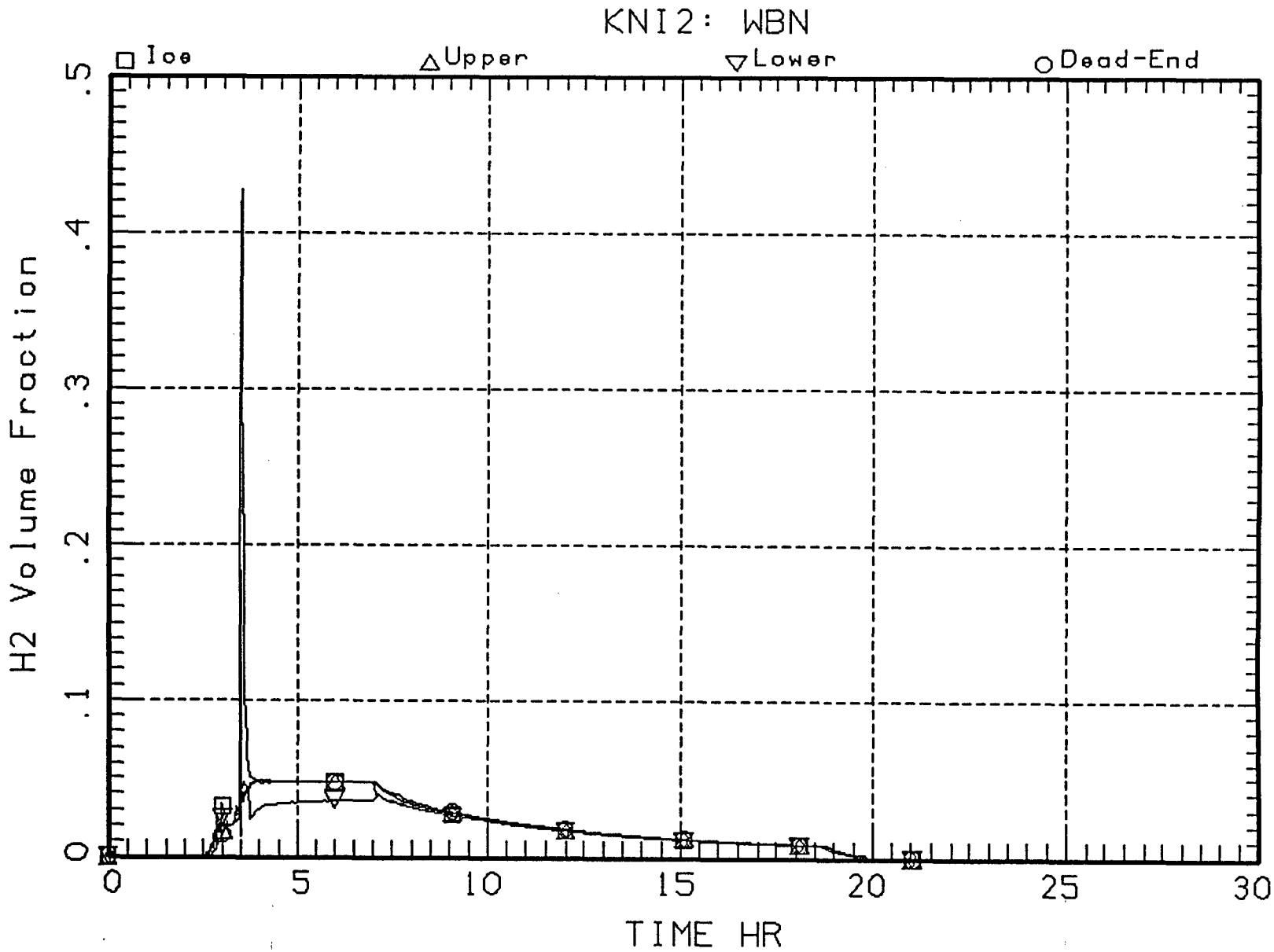

Figure 4.7-22. Hydrogen Concentrations in Containment for Case KNI2

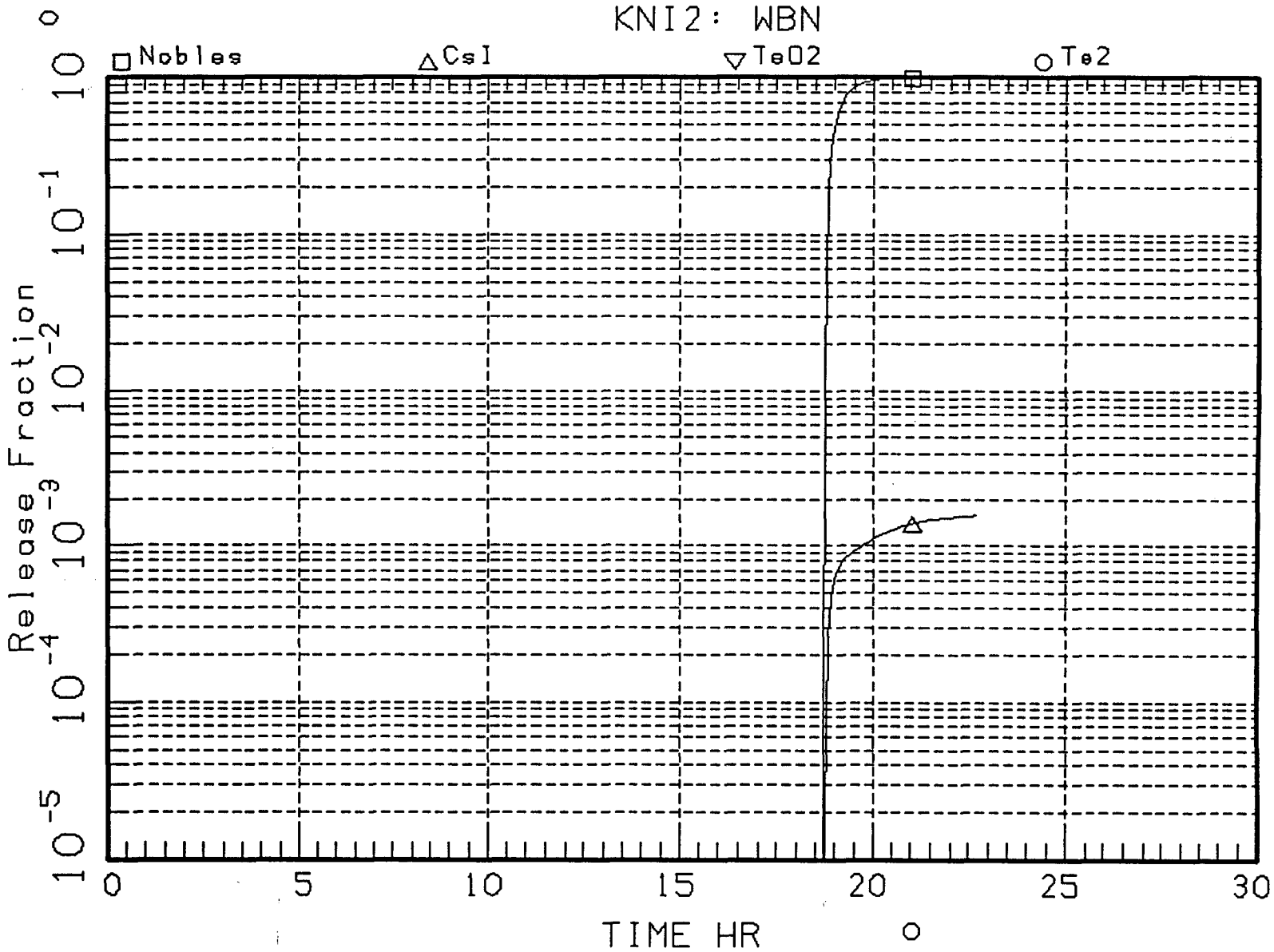

Figure 4.7-23. Fission Product Environmental Releases for Case KNI2

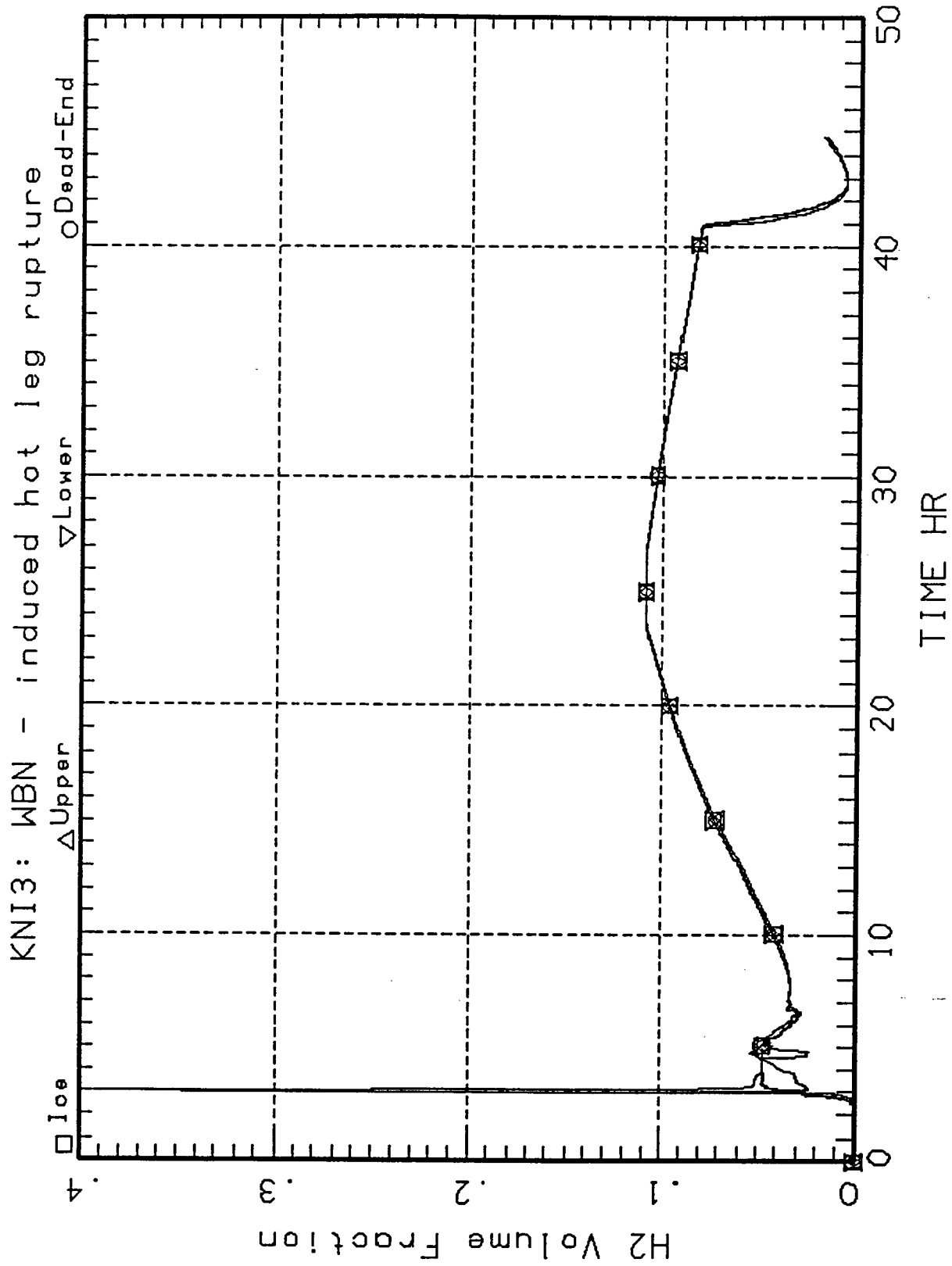

Figure 4.7-24. Hydrogen Concentrations in Containment for Case KNI3

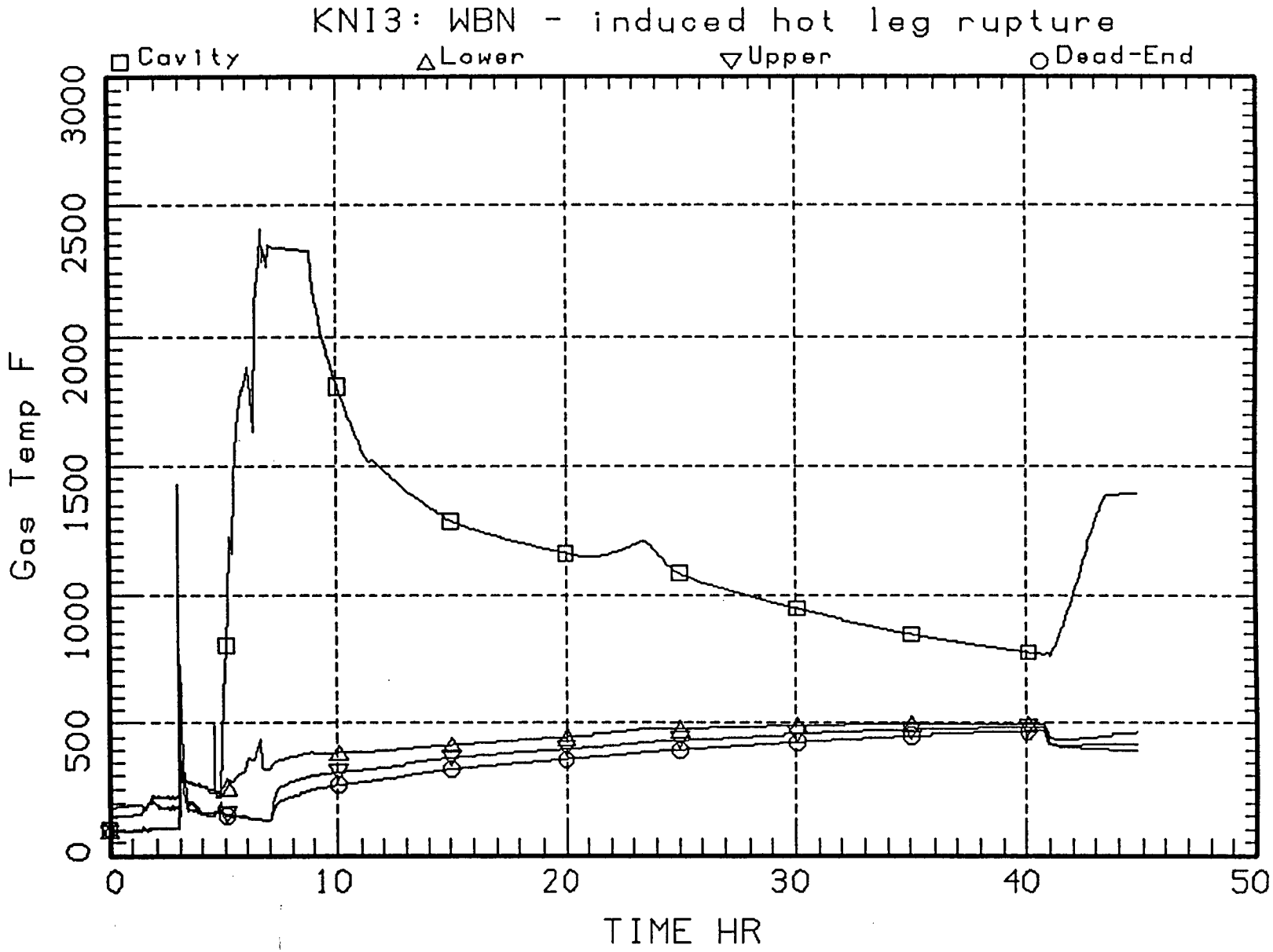

Figure 4.7-25. Gas Temperatures in Containment for Case KNI3

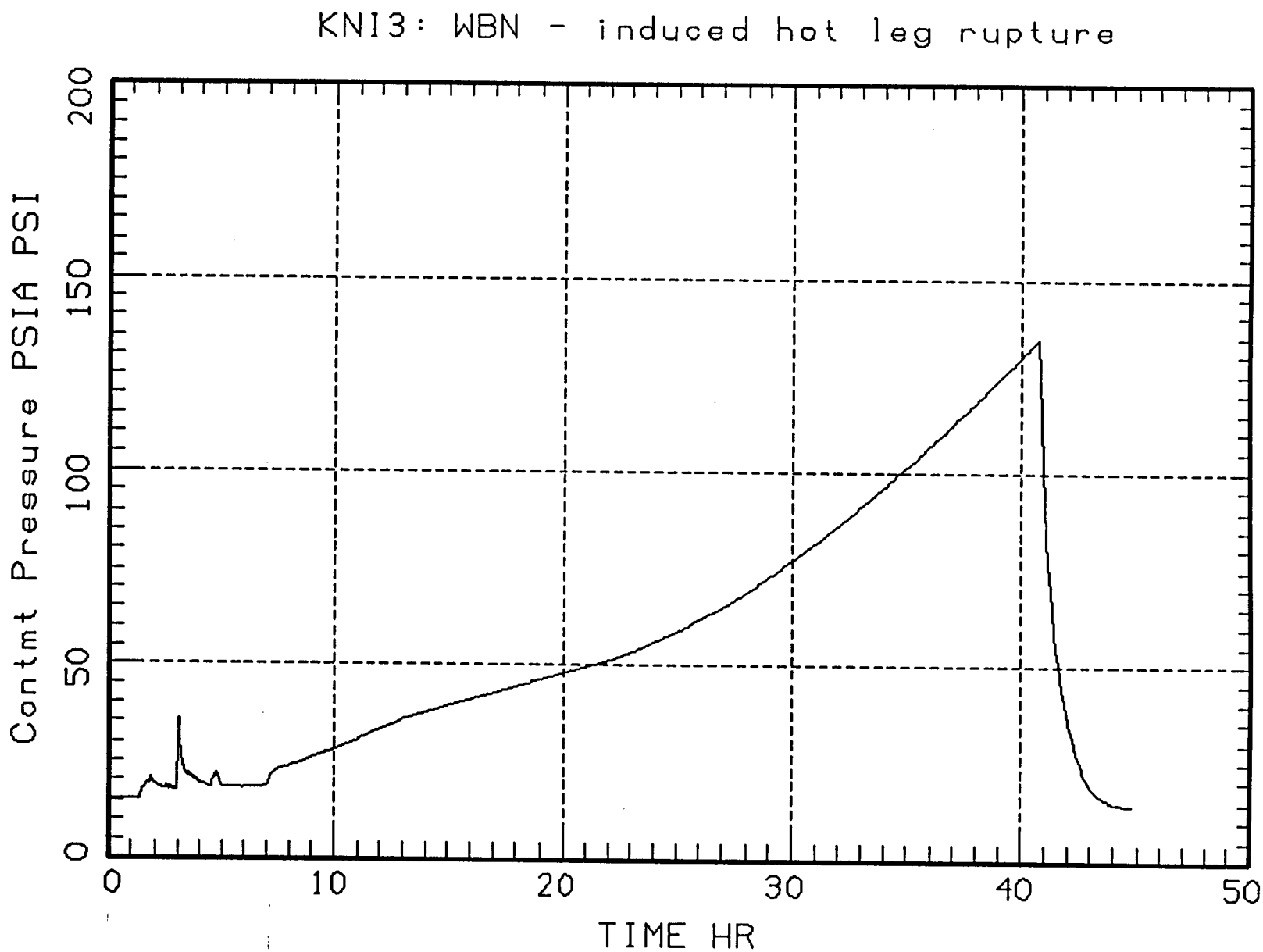

Figure 4.7-26. Containment Pressure for Case KNI3

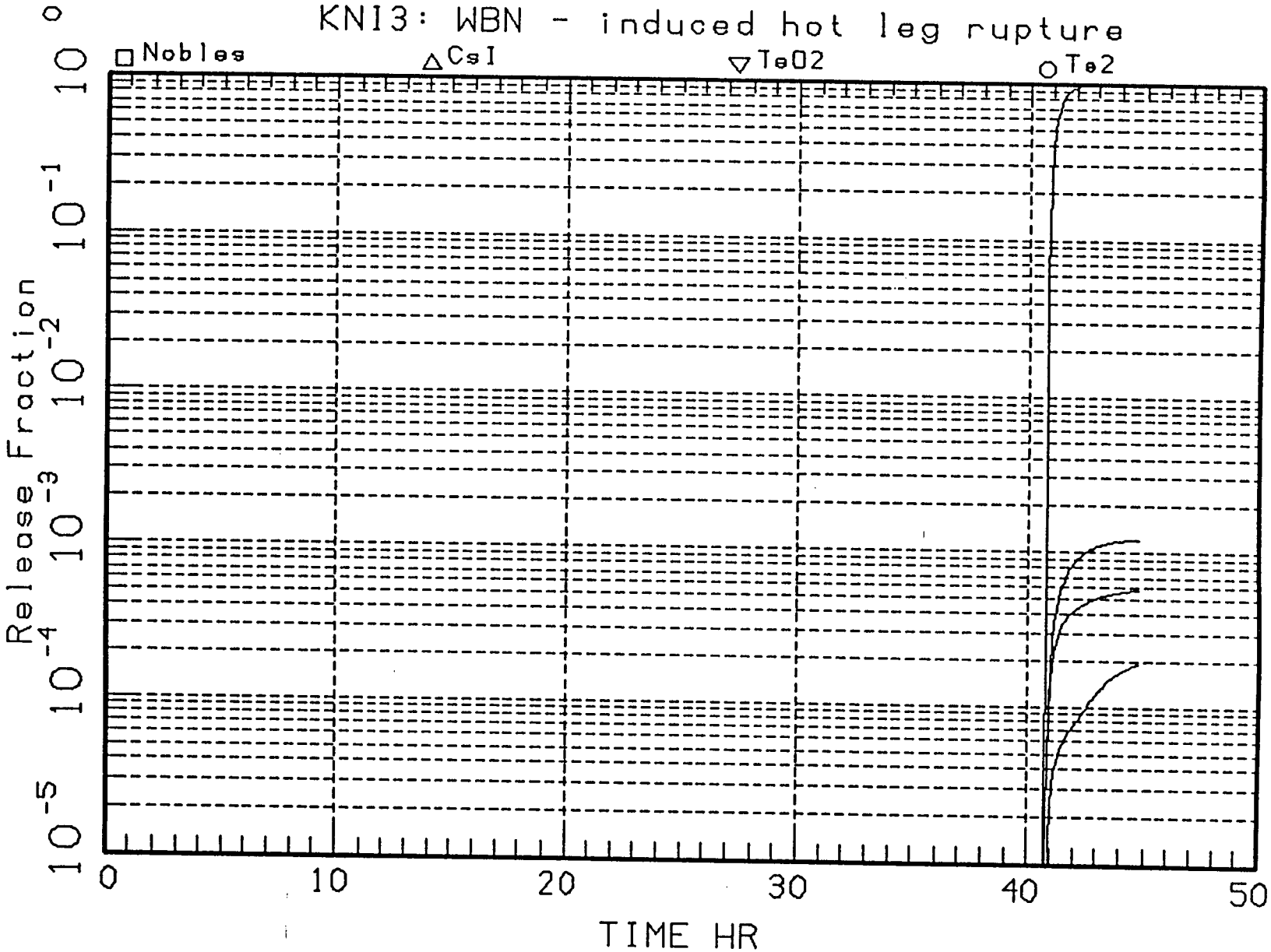

Figure 4.7-27. Fission Product Environmental Releases for Case KNI3

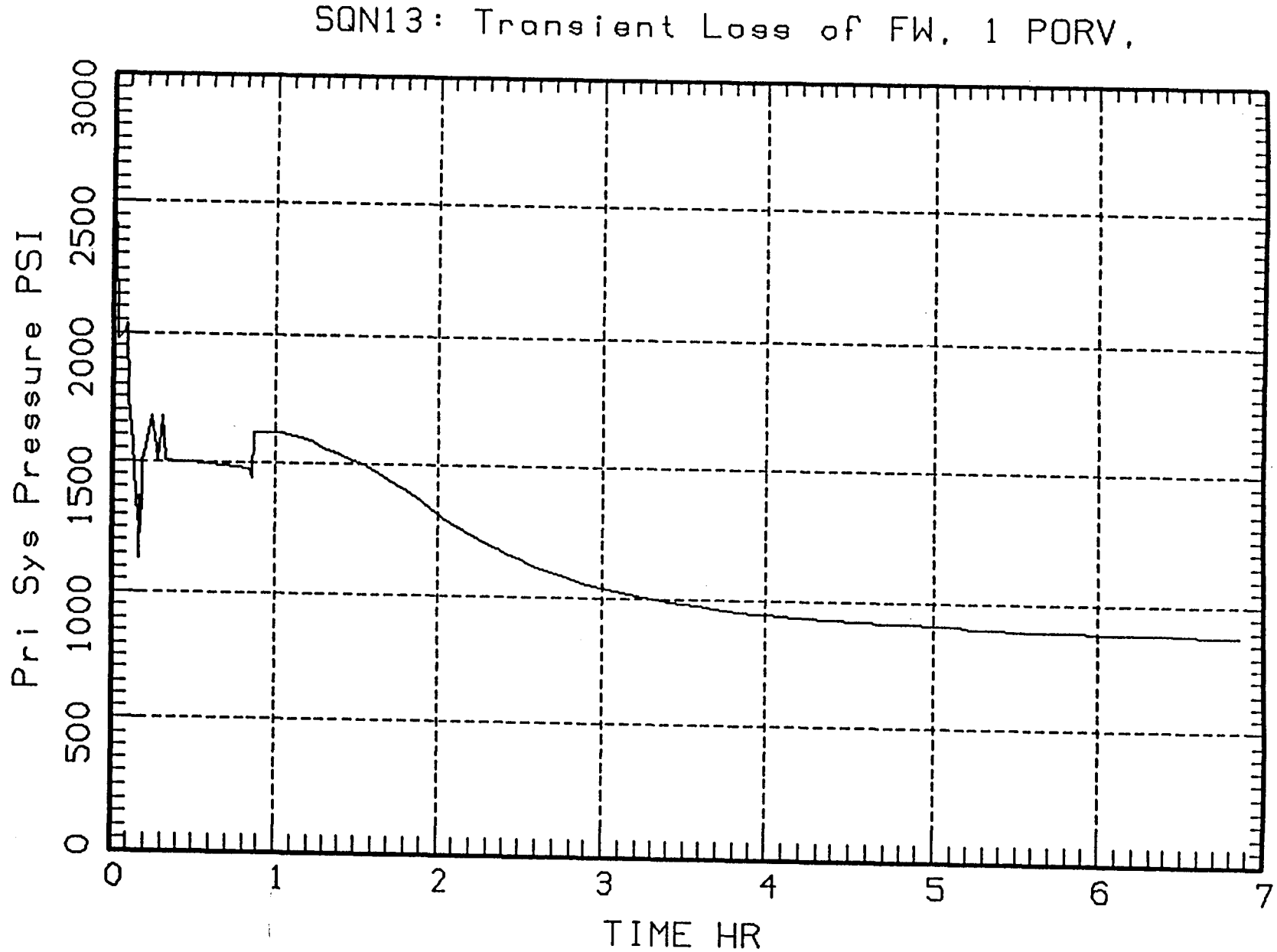

Figure 4.7-28. Primary System Pressure in Case LCI

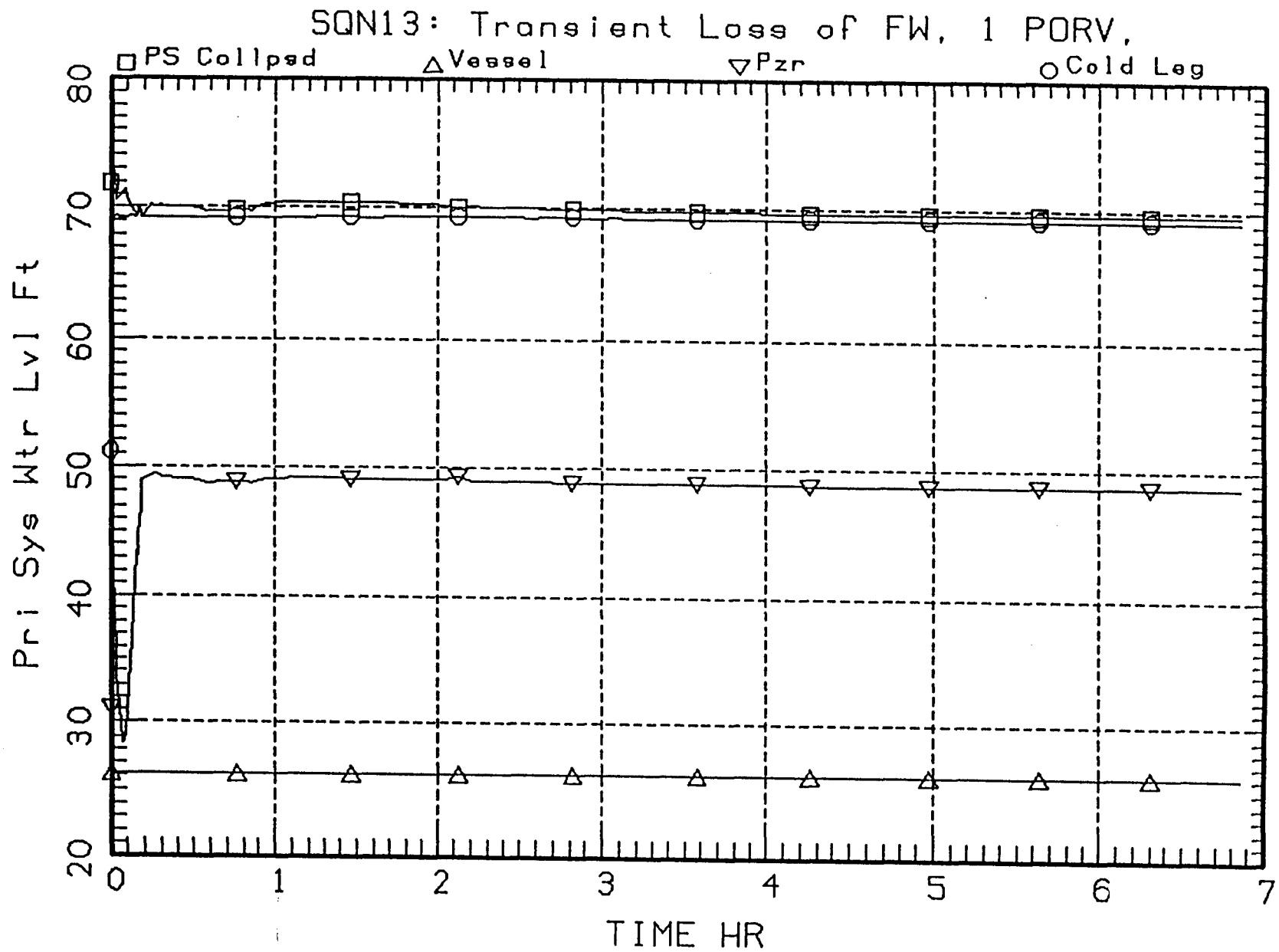

Figure 4.7-29. Primary System Water Levels in Case LCI

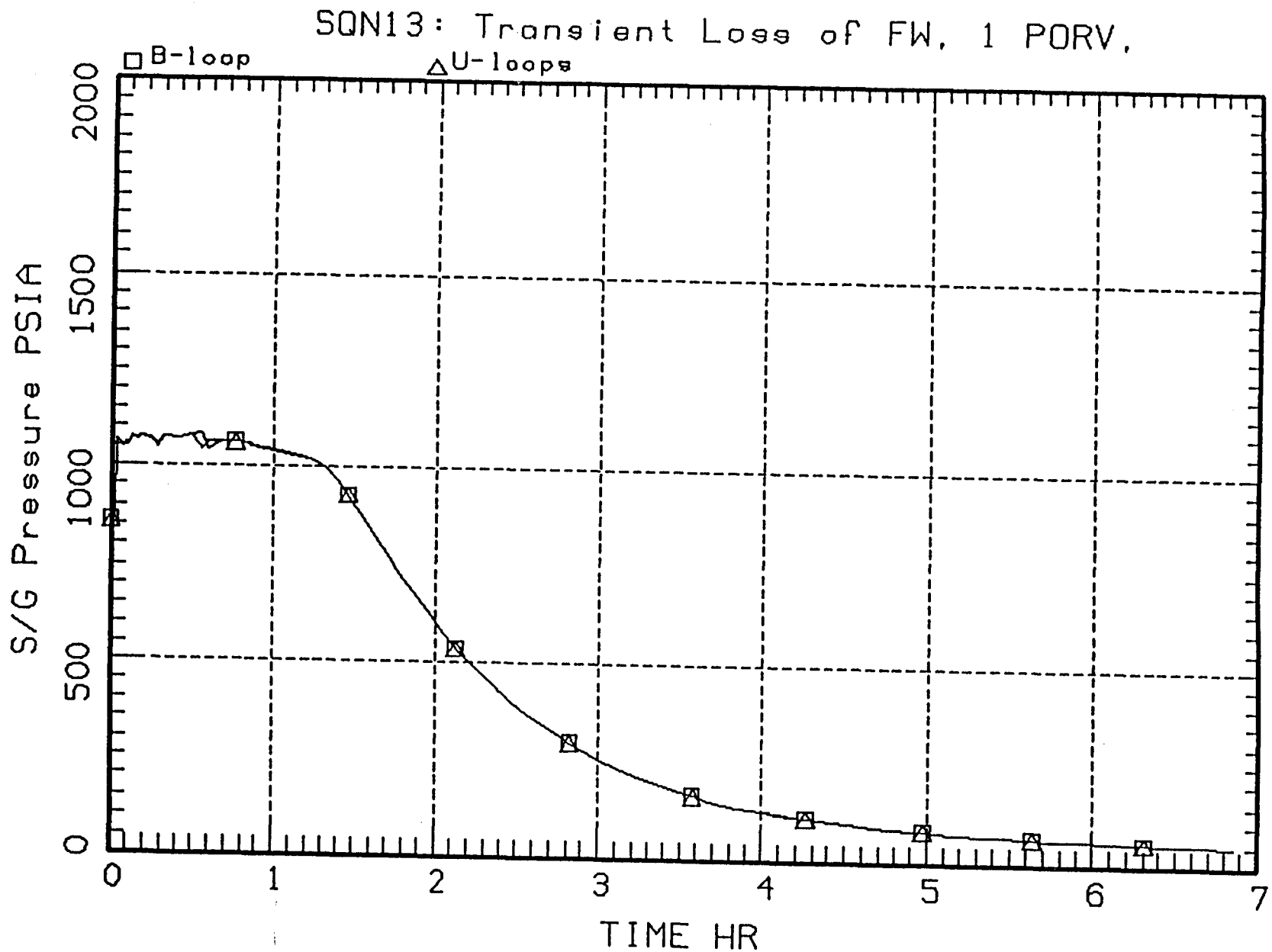

Figure 4.7-30. Steam Generator Pressures in Case LCI

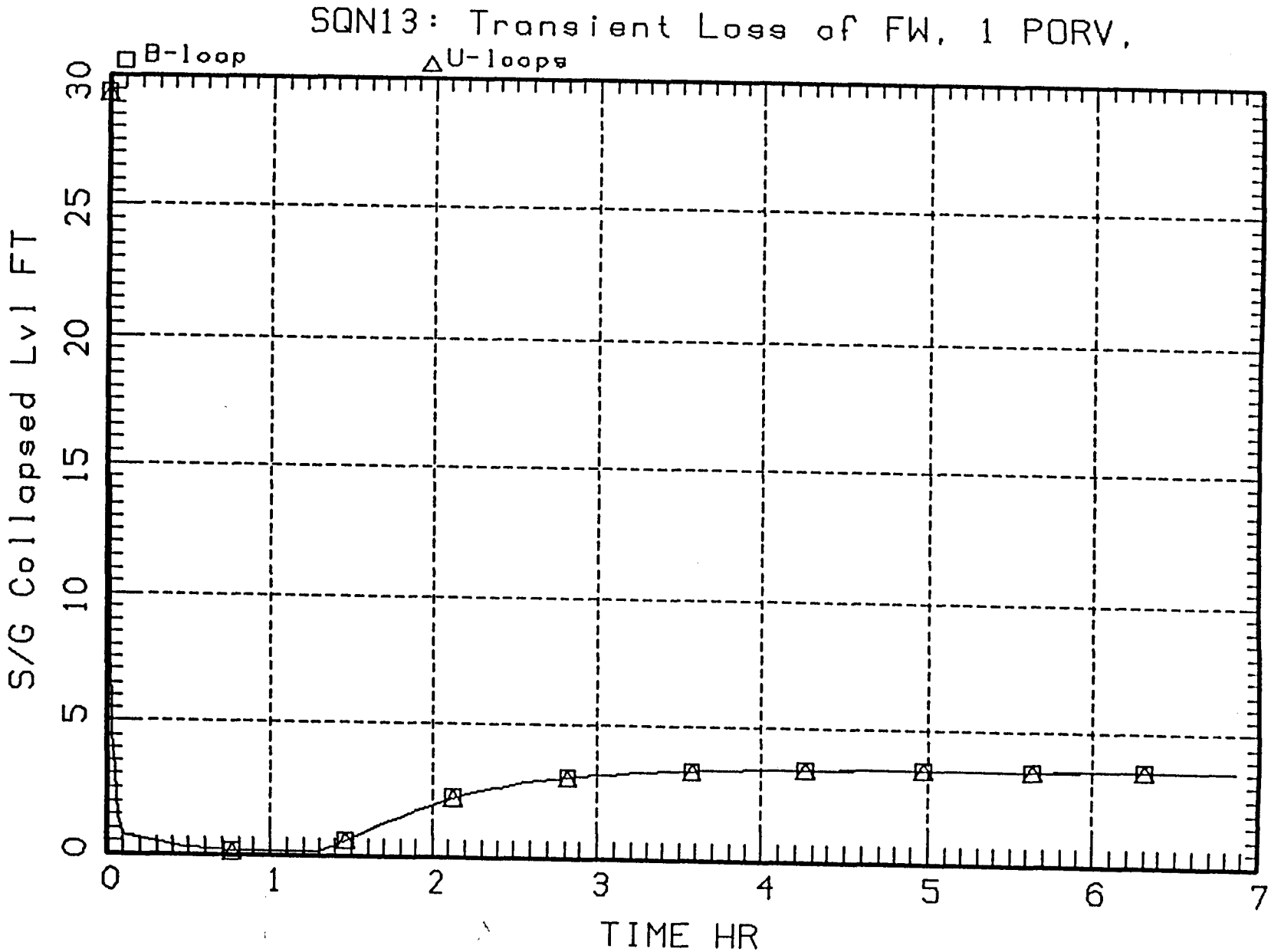

Figure 4.7-31. Steam Generator Levels in Case LCI

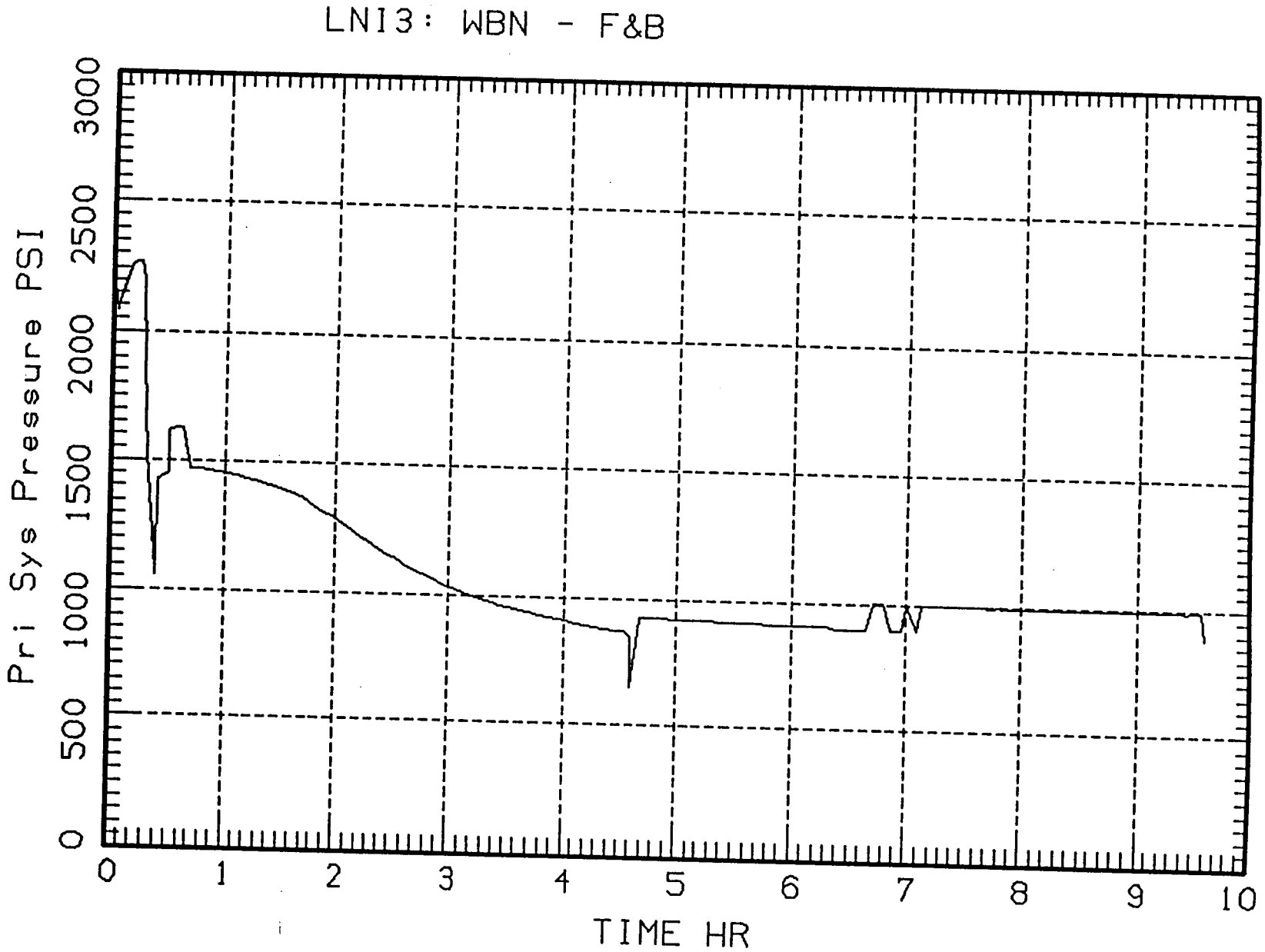

Figure 4.7-32. Primary System Pressure in Case LNI3

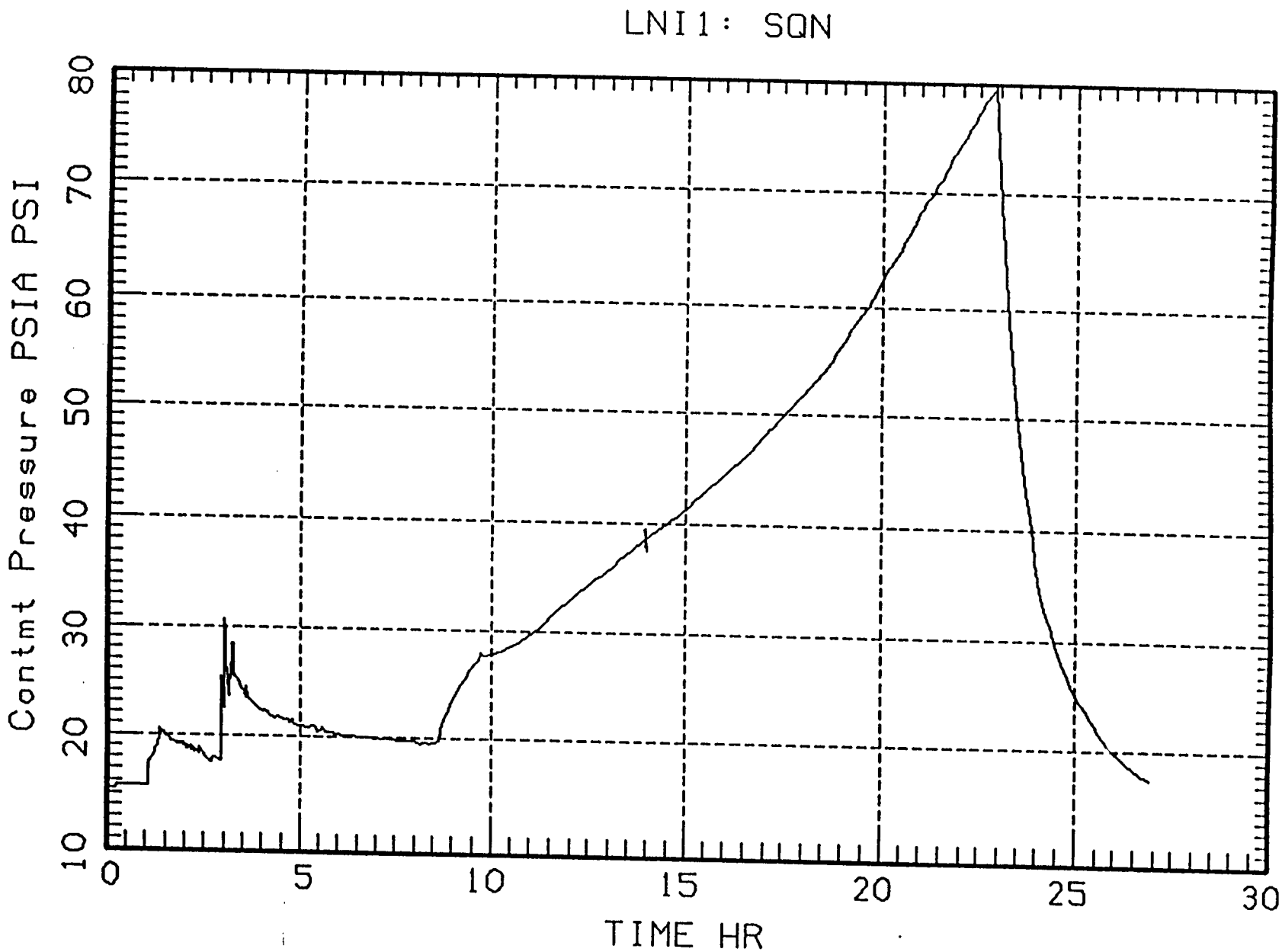

Figure 4.7-33. Containment Pressure in Case LNI1

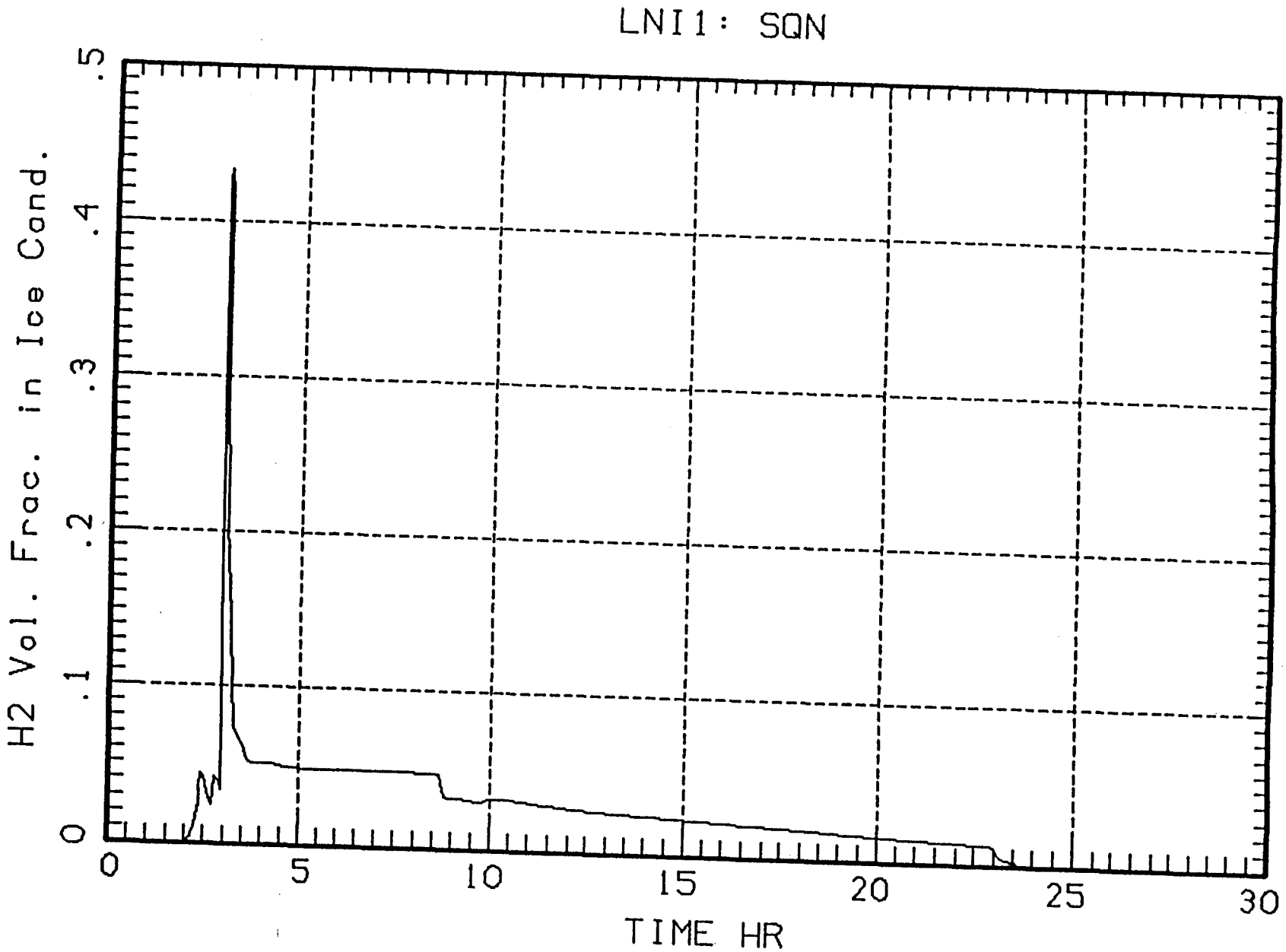

Figure 4.7-34. Hydrogen Concentration in Ice Condenser in Case LNI1

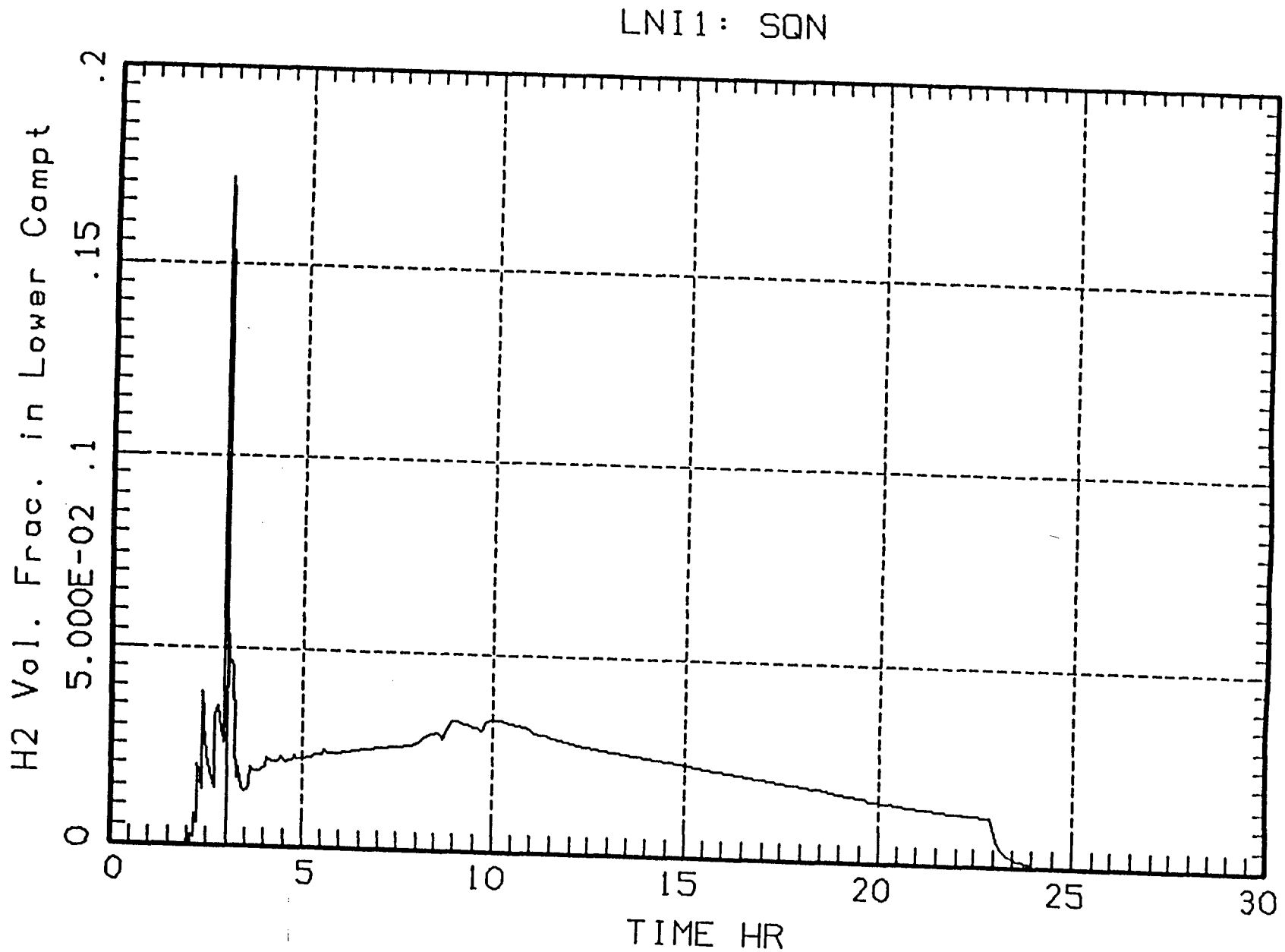

Figure 4.7-35. Hydrogen Concentration in Lower Compartment in Case LNI1

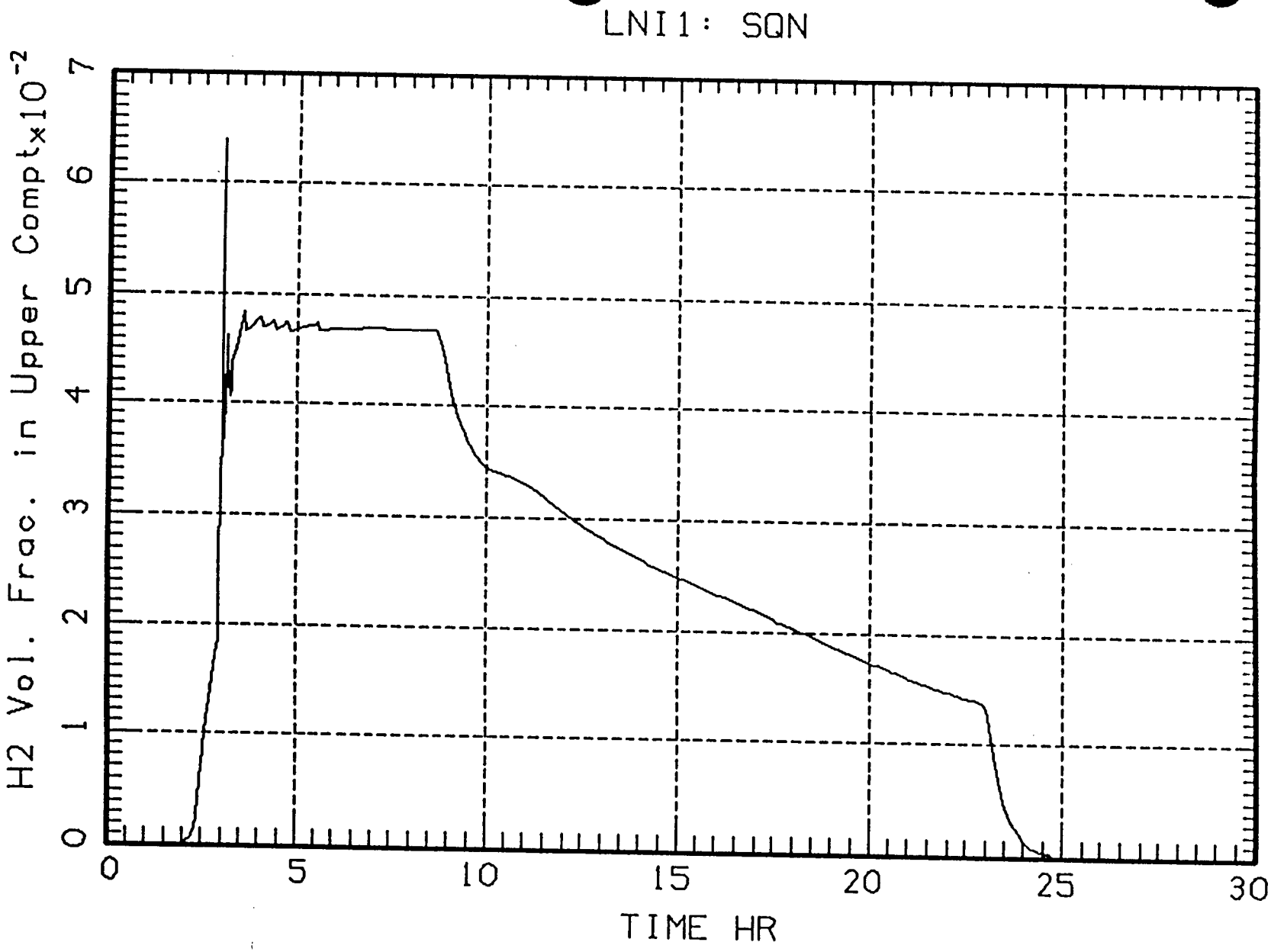

Figure 4.7-36. Hydrogen Concentration in Upper Compartment in Case LNI1

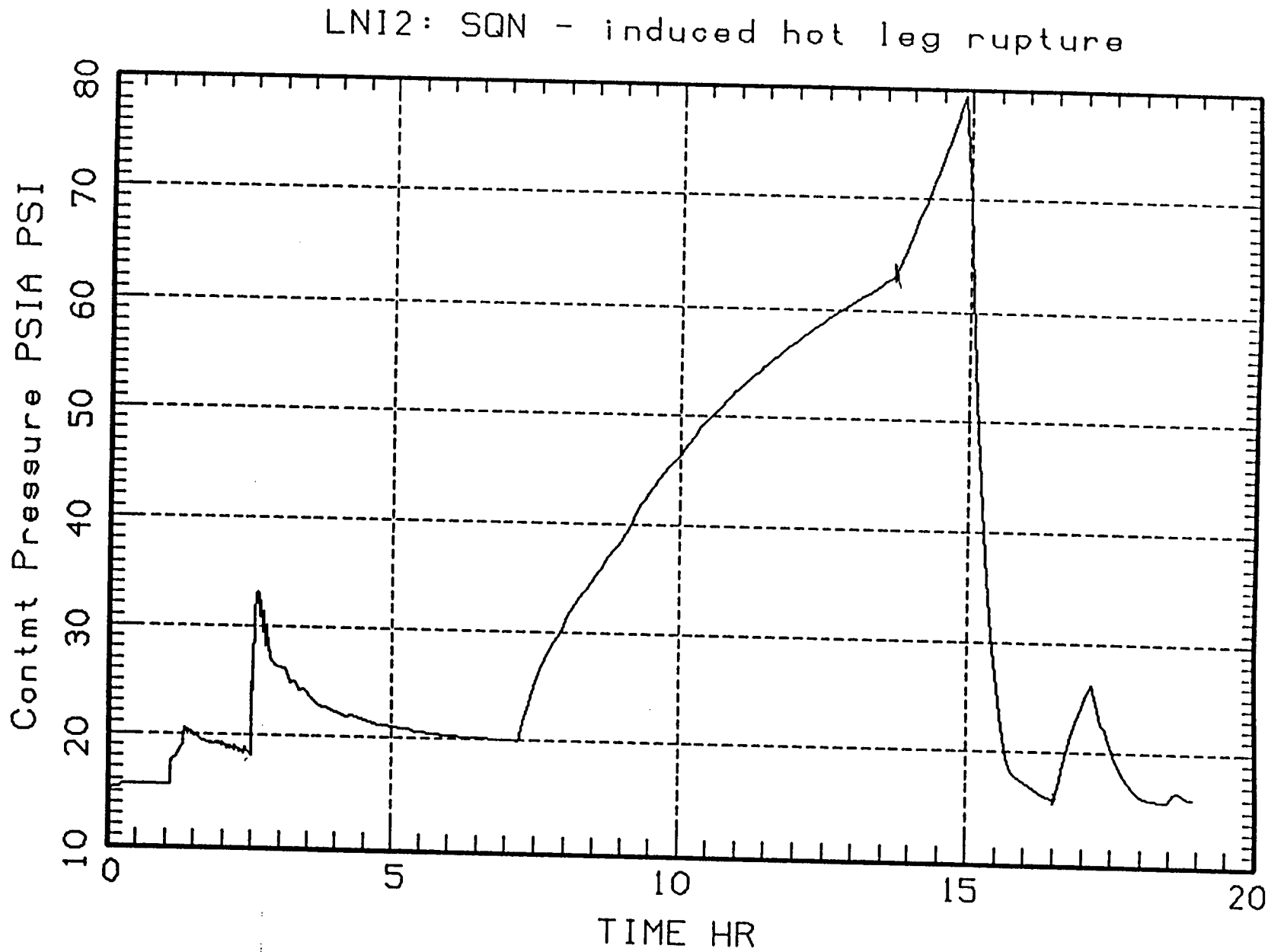

Figure 4.7-37. Containment Pressure in Case LNI2

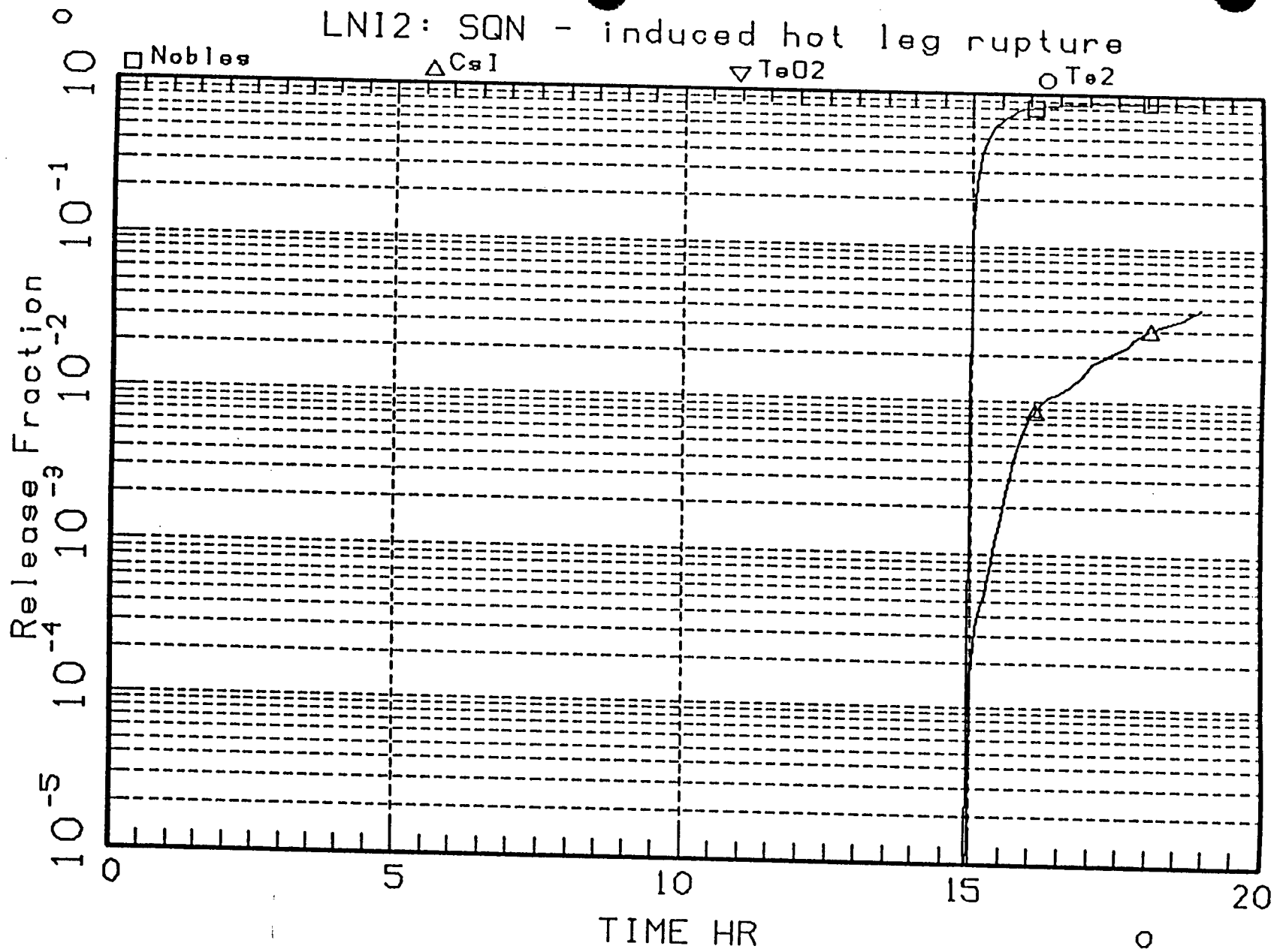

Figure 4.7-38. Fission Product Environmental Release Fraction in Case LNI2

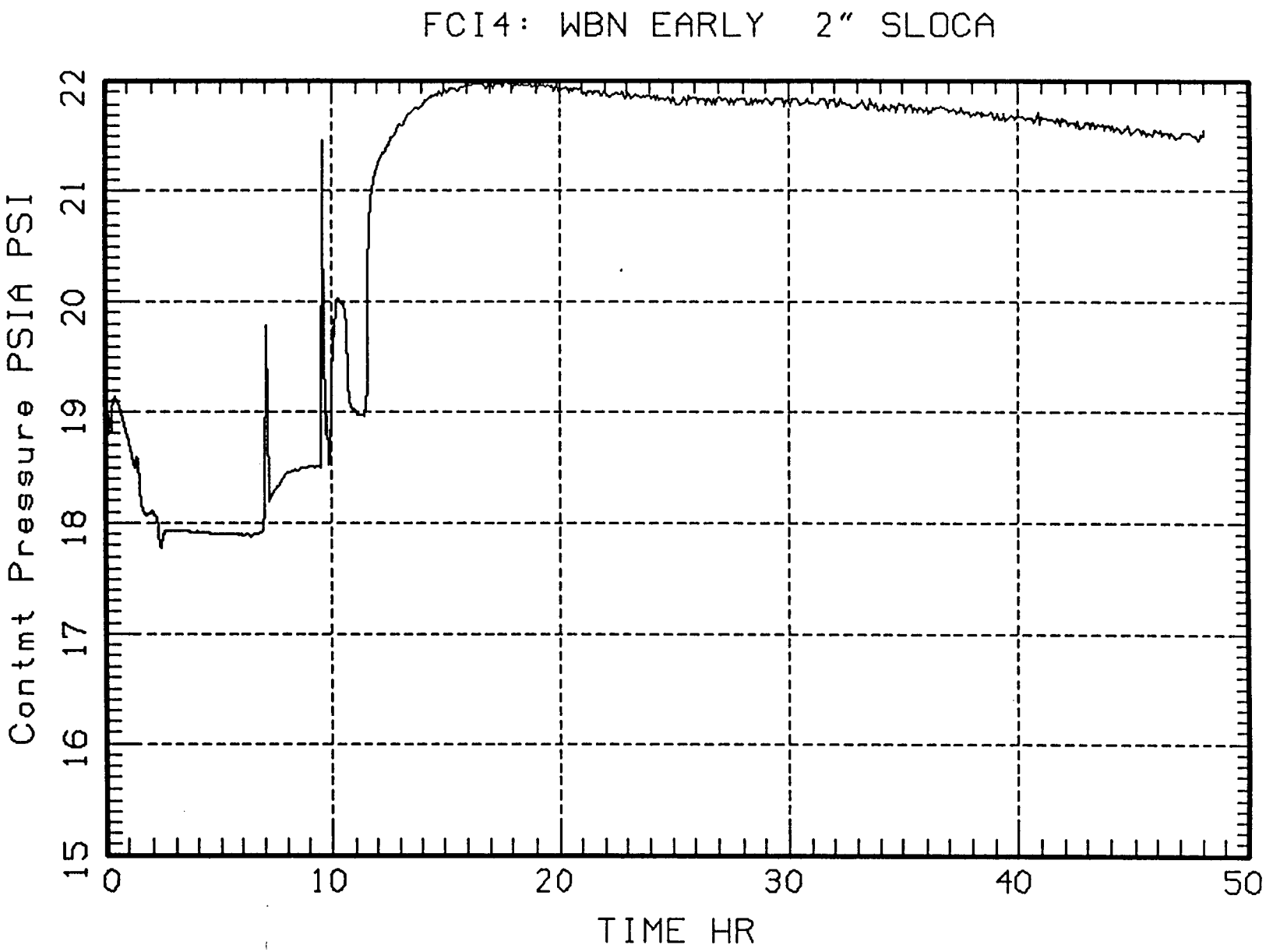

Figure 4.7-39. Containment Pressure in Case FCI4

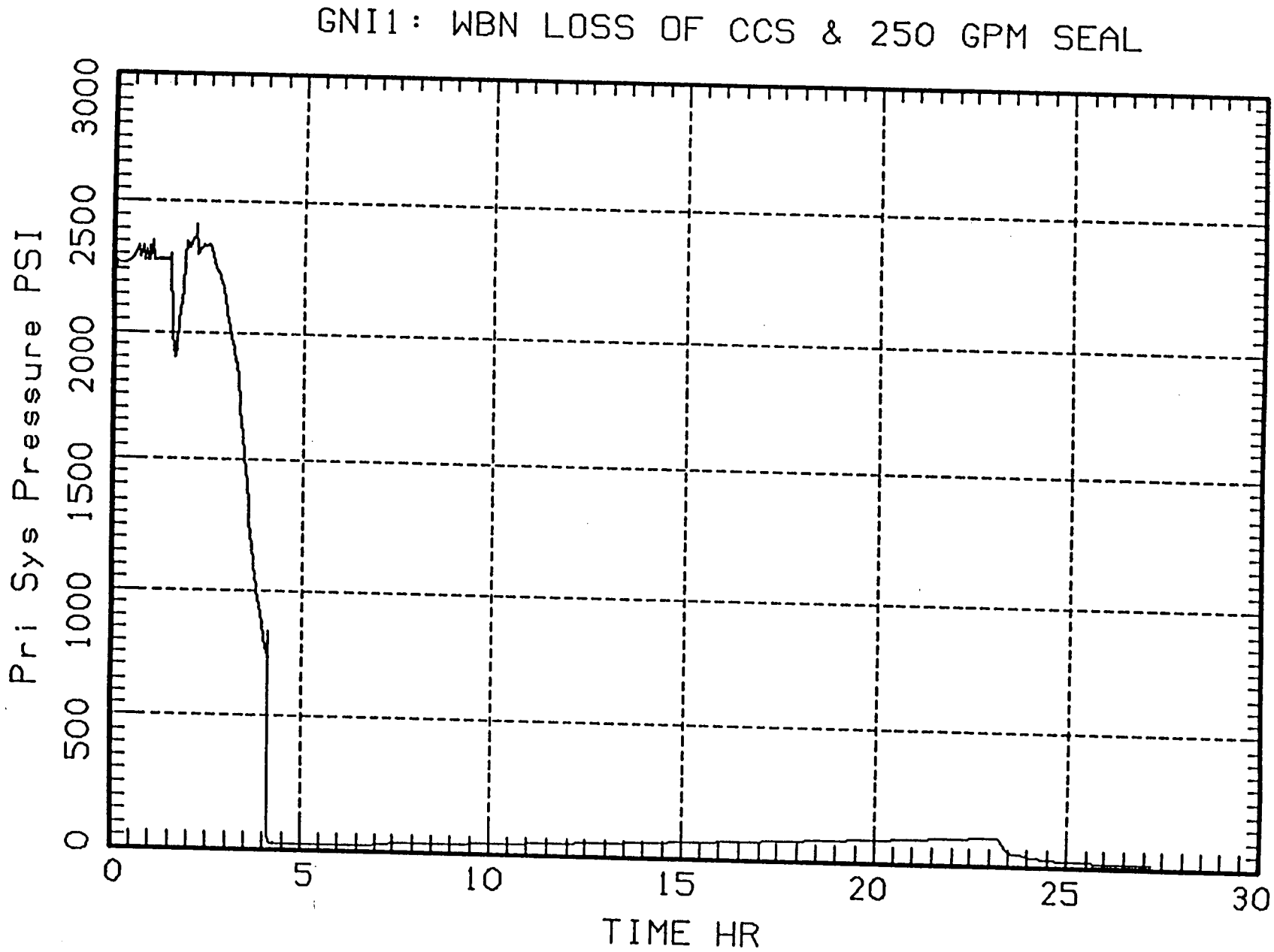

Figure 4.7-40. Primary System Pressure in Case GNI1

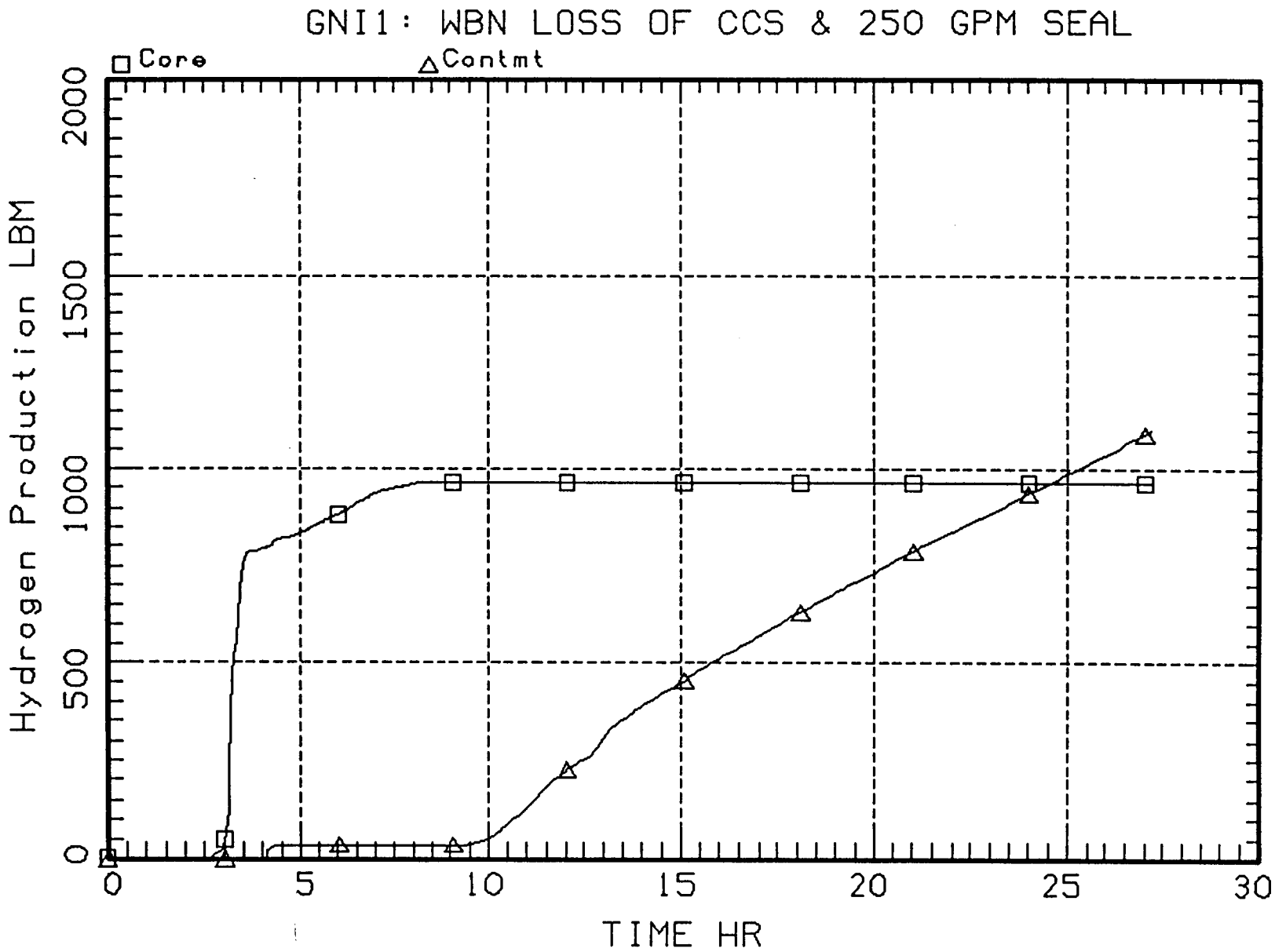

Figure 4.7-41. Hydrogen Production in Case GNI1

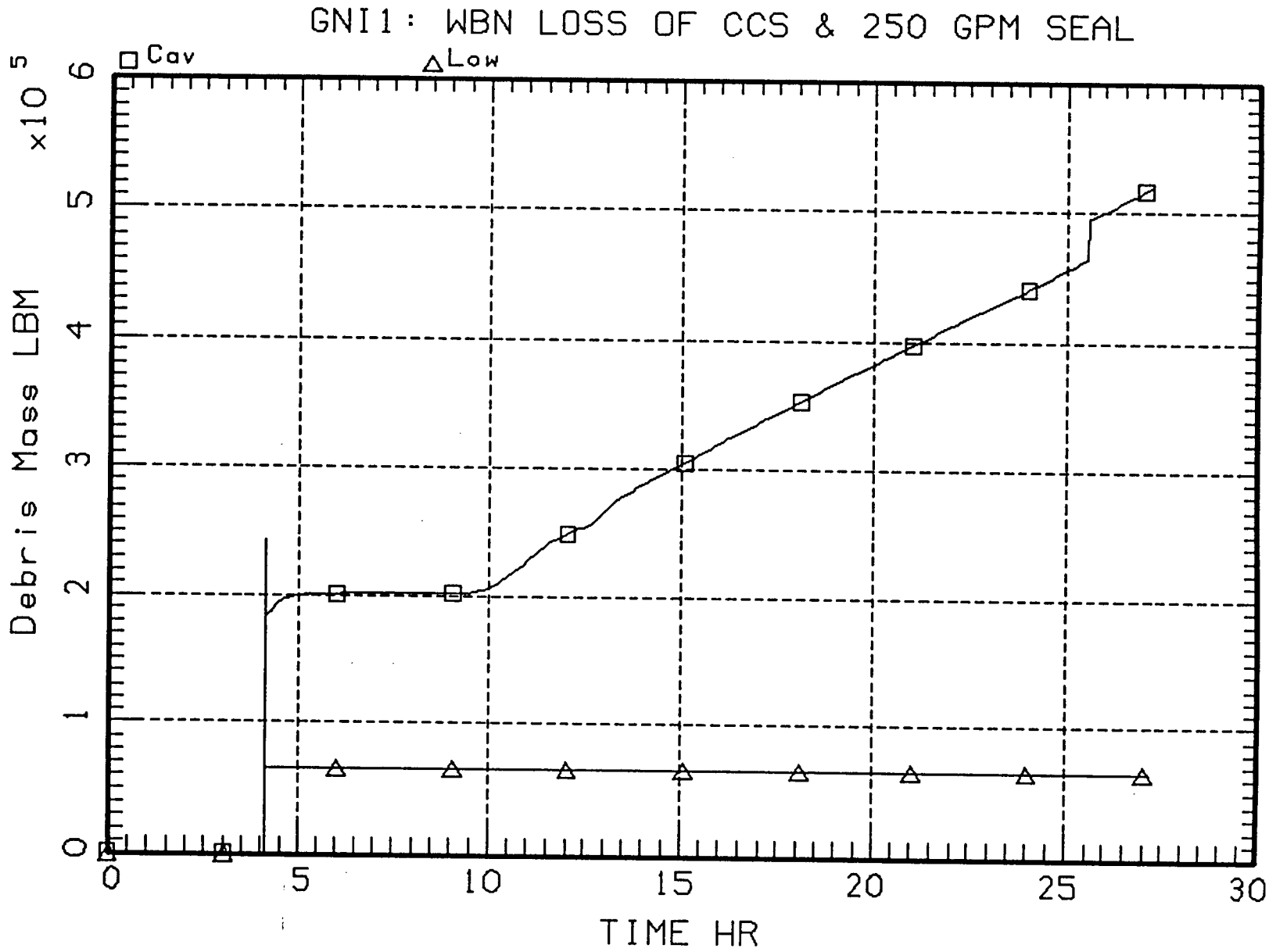

Figure 4.7-42. Mass of Debris in Cavity and Lower Compartment in GNI1

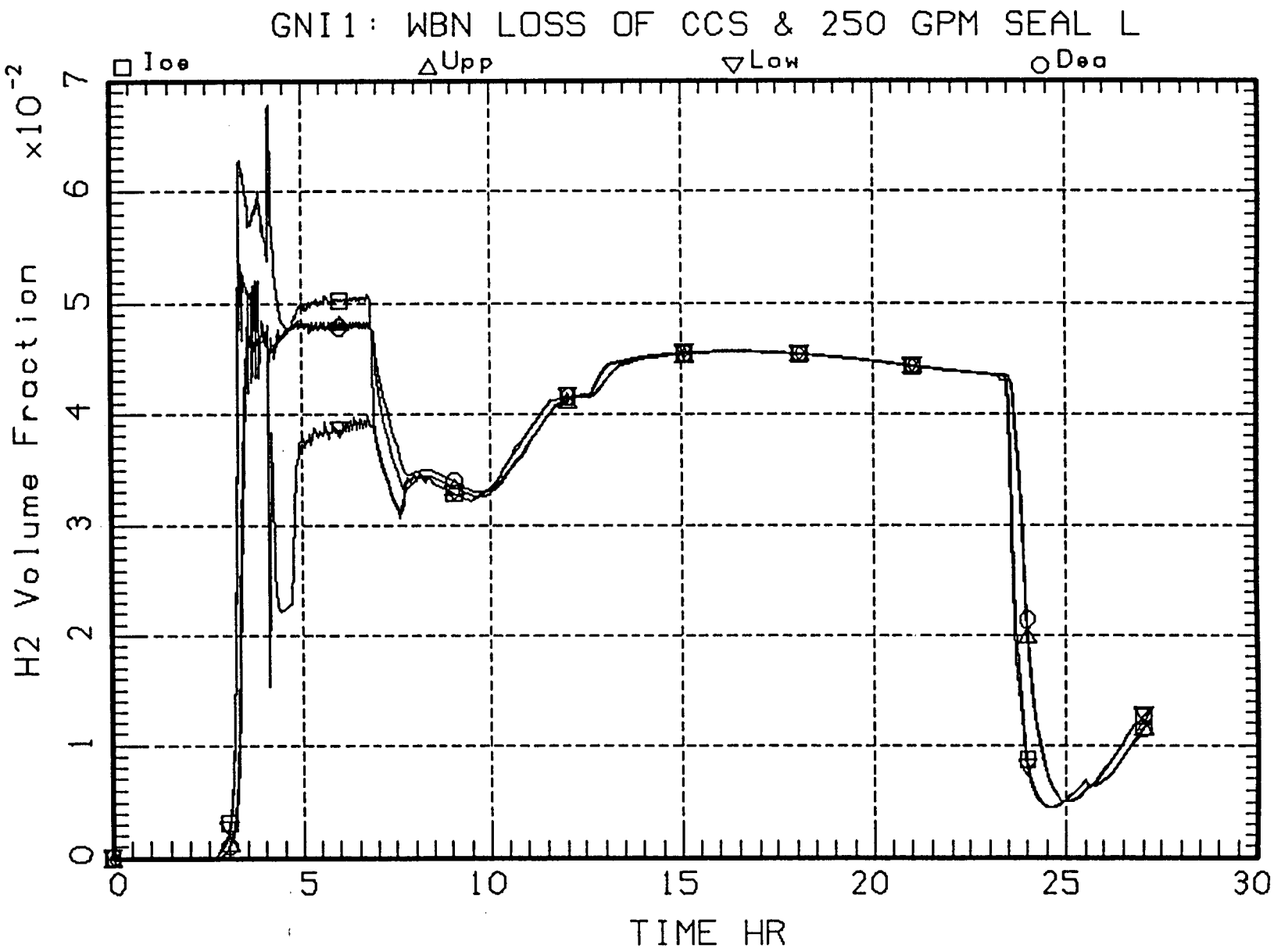

Figure 4.7-43. Hydrogen Concentrations in Containment for Case GNI1

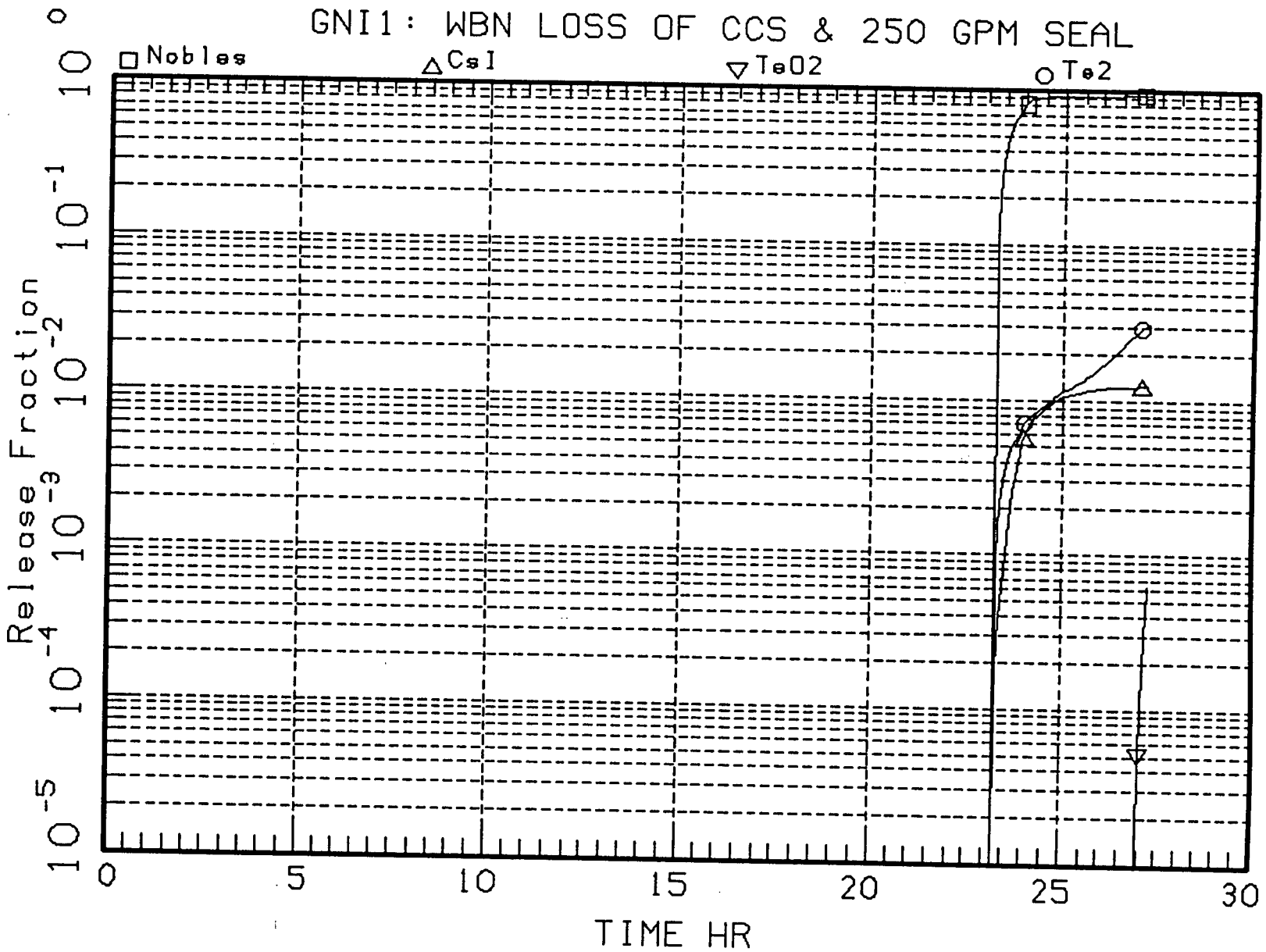

Figure 4.7-44. Fission Product Environmental Releases for Case GNI1

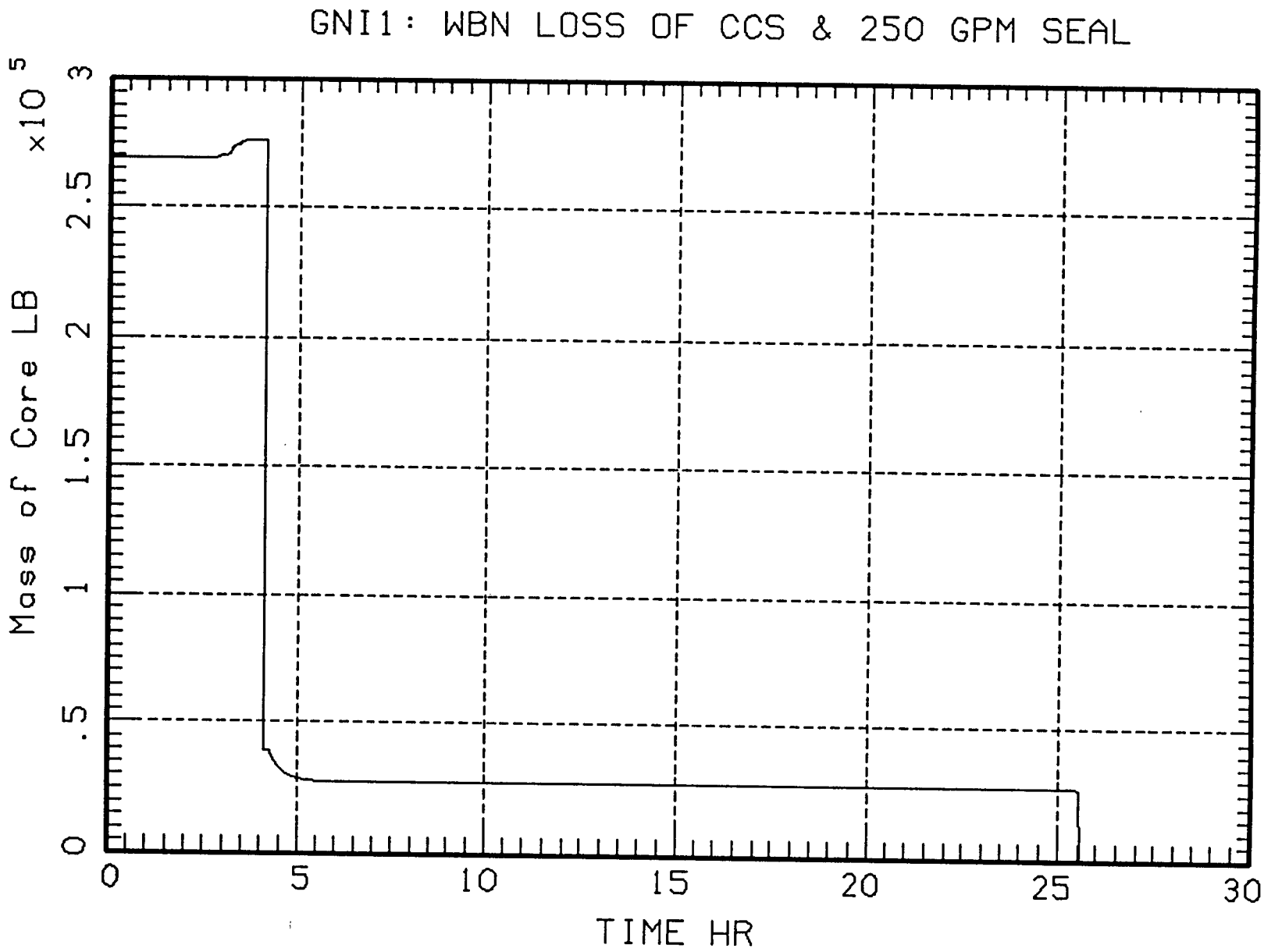

Figure 4.7-45. Core Mass in Case GNI1

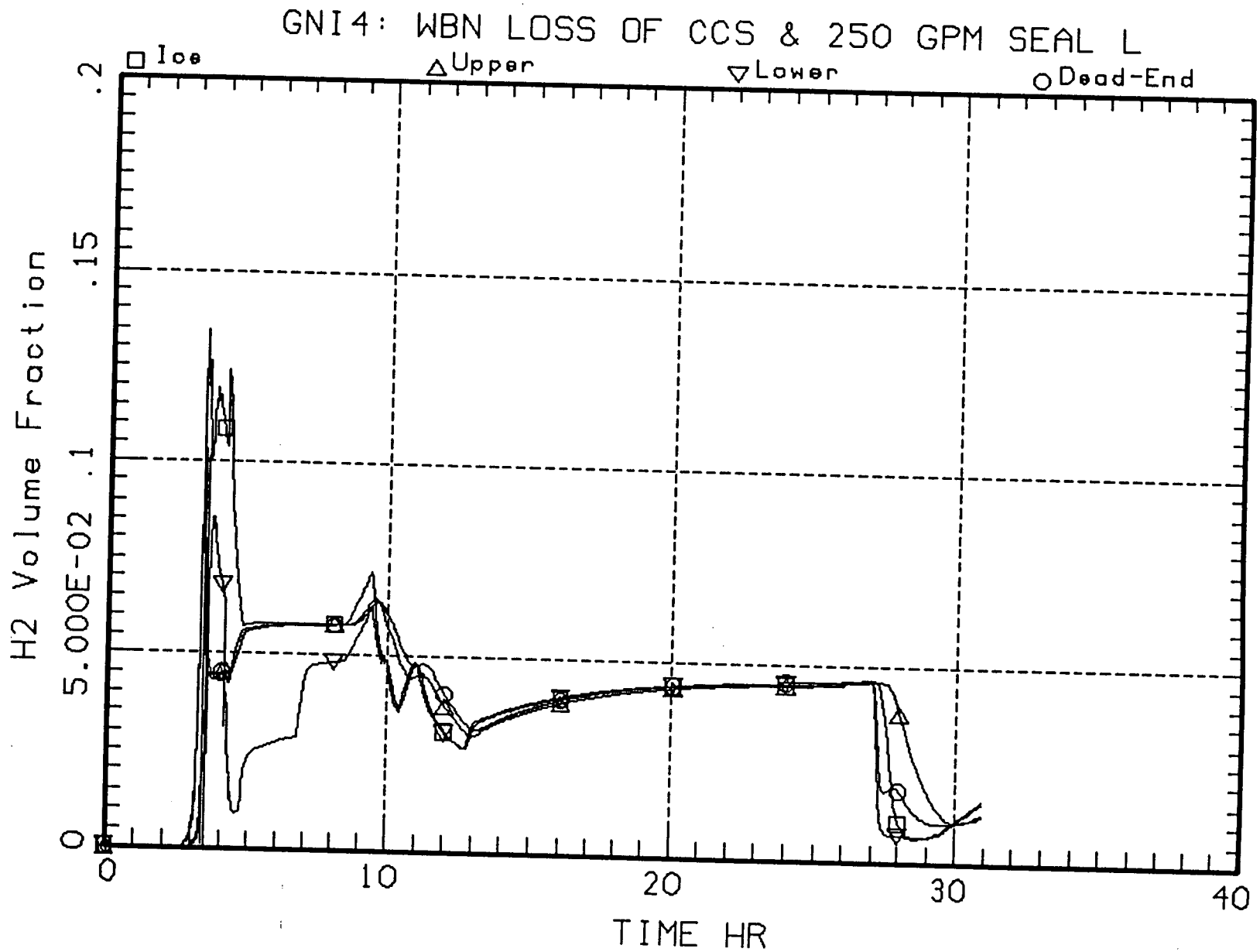

Figure 4.7-46. Hydrogen Concentrations in Containment for Case GNI4

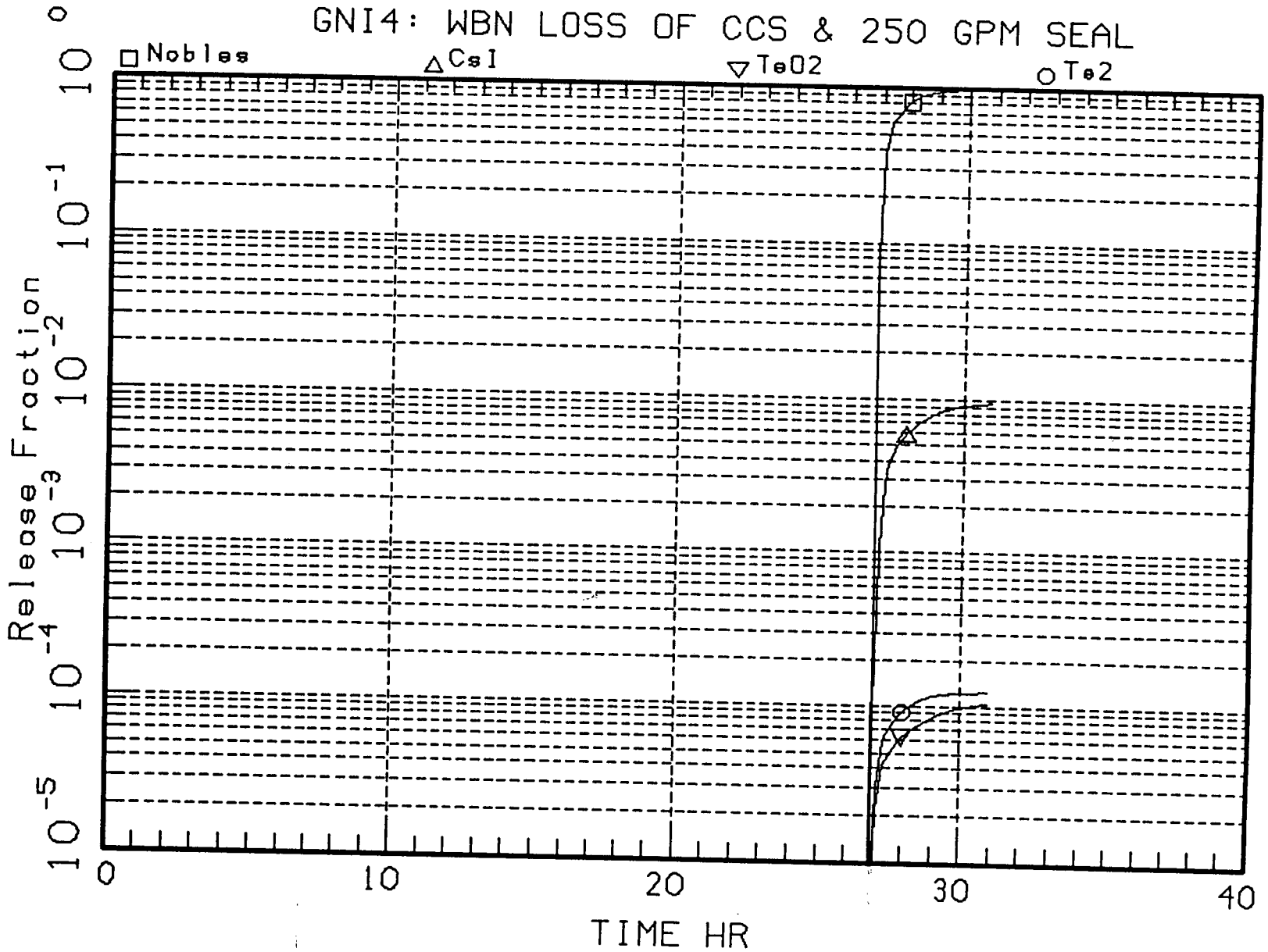

Figure 4.7-47. Fission Product Environmental Releases for Case GNI4

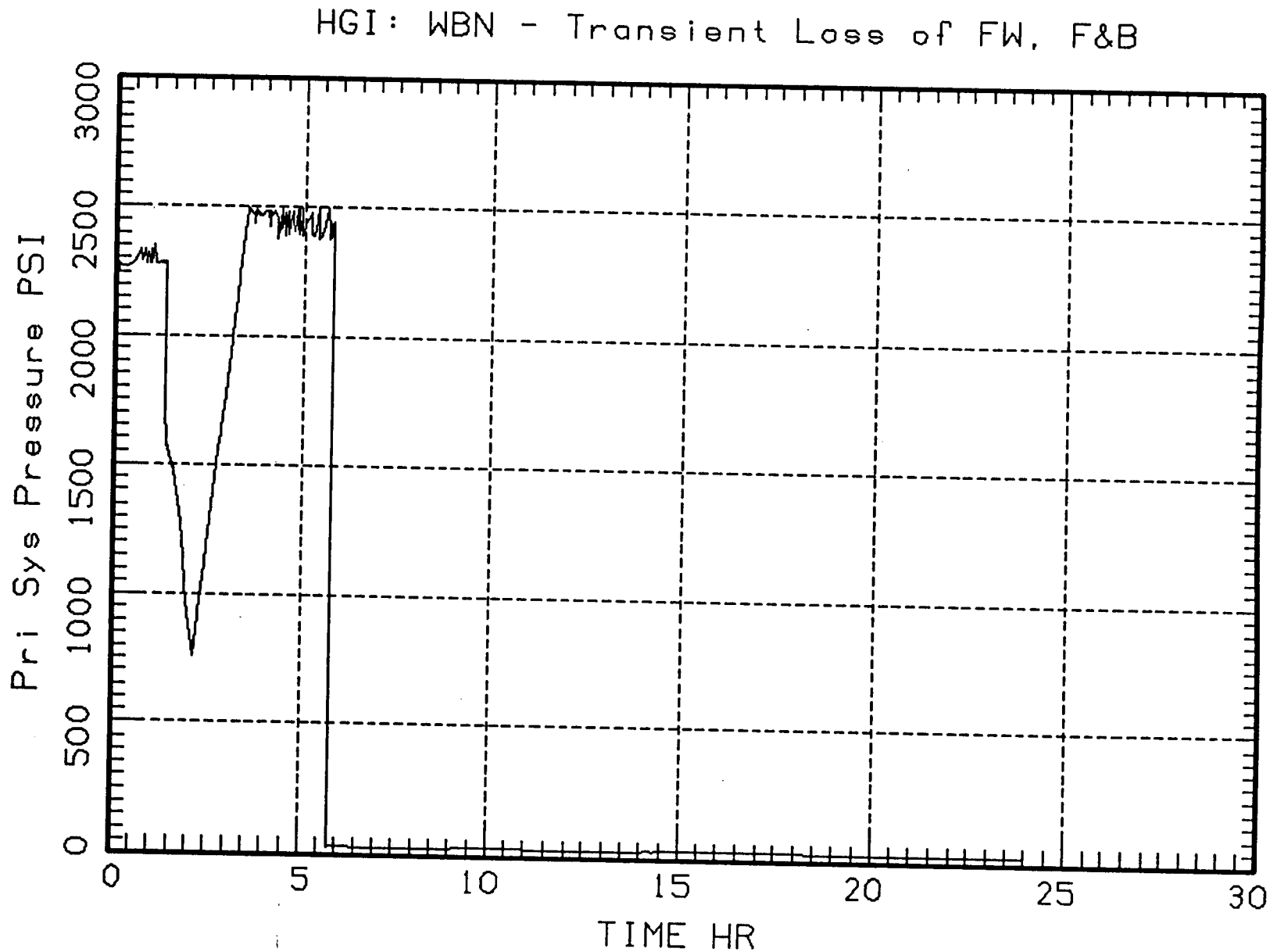

Figure 4.7-48. Primary System Pressure for Case HGI

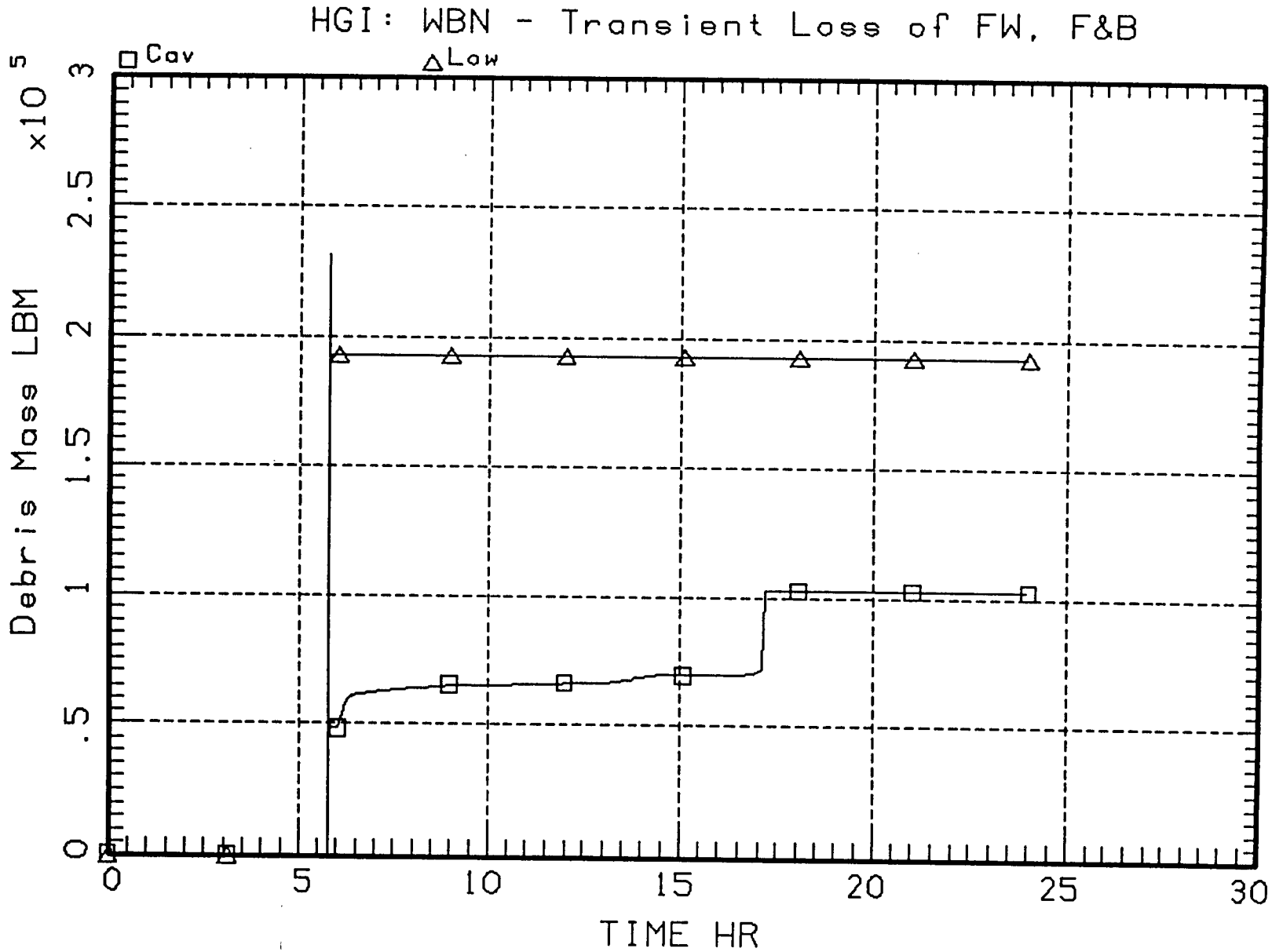

Figure 4.7-49, Debris Mass in Containment for Case HGI

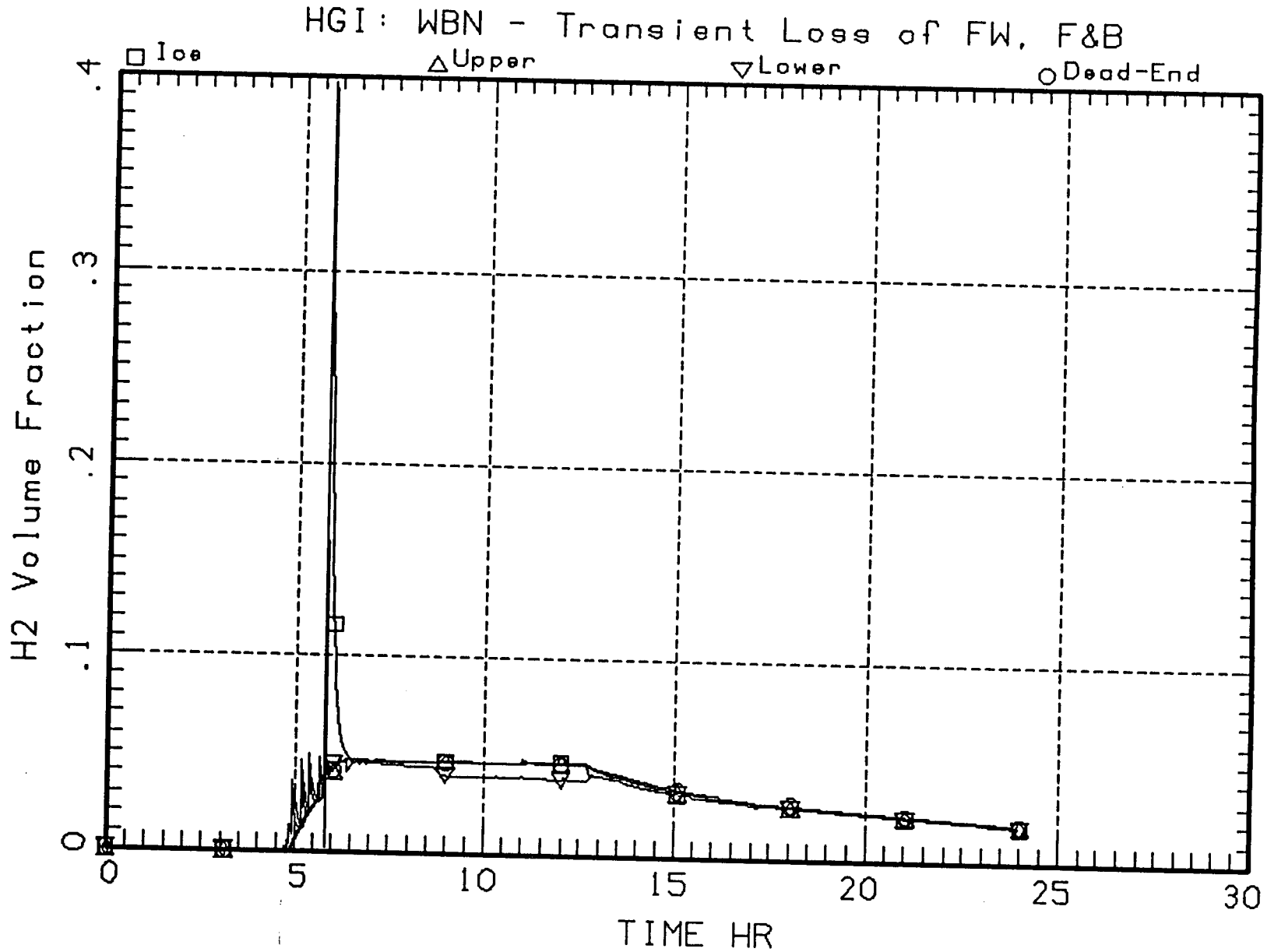

Figure 4.7-50. Hydrogen Concentrations in Containment for Case HGI

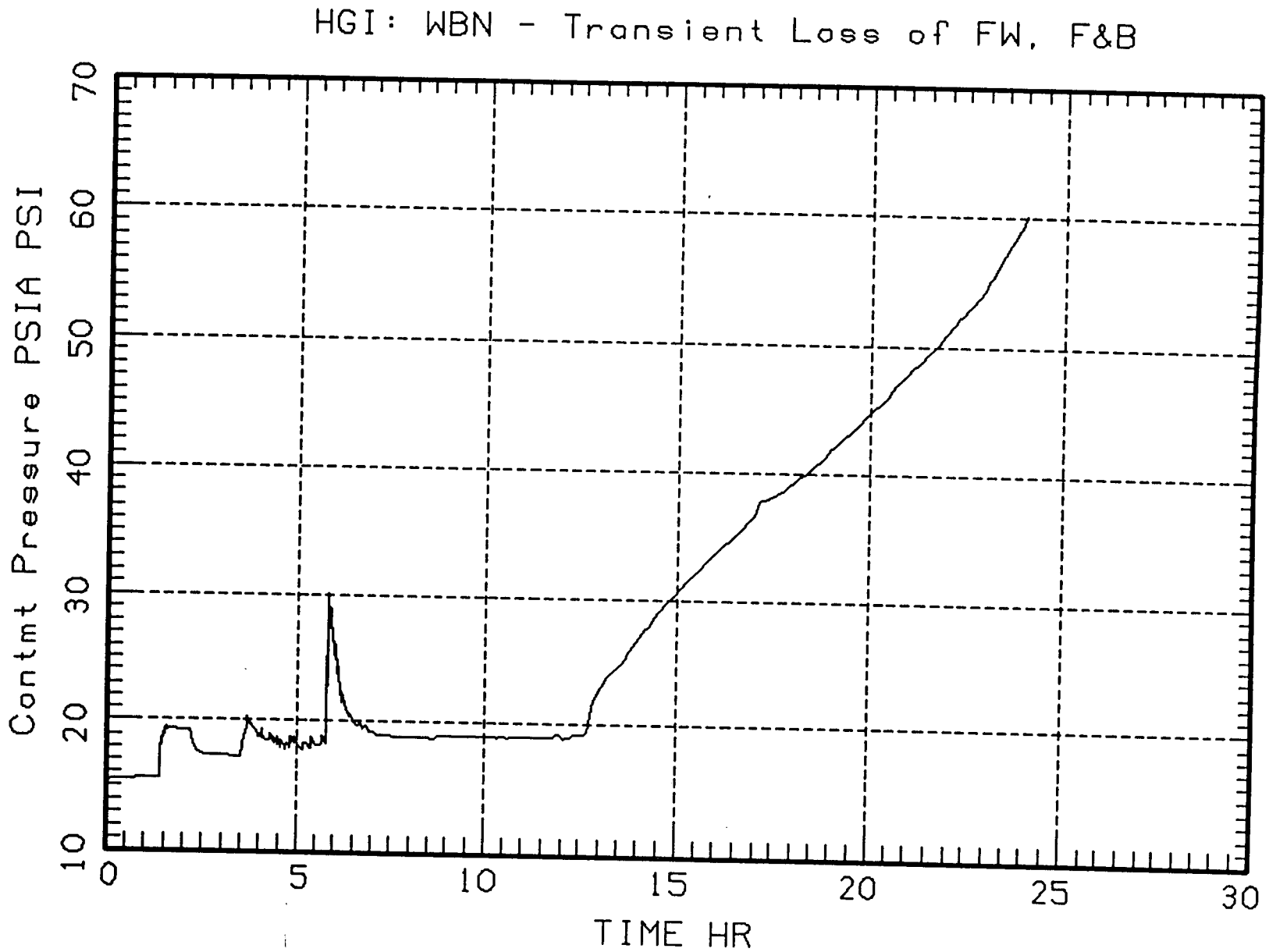

Figure 4.7-51. Containment Pressure in Case HGI

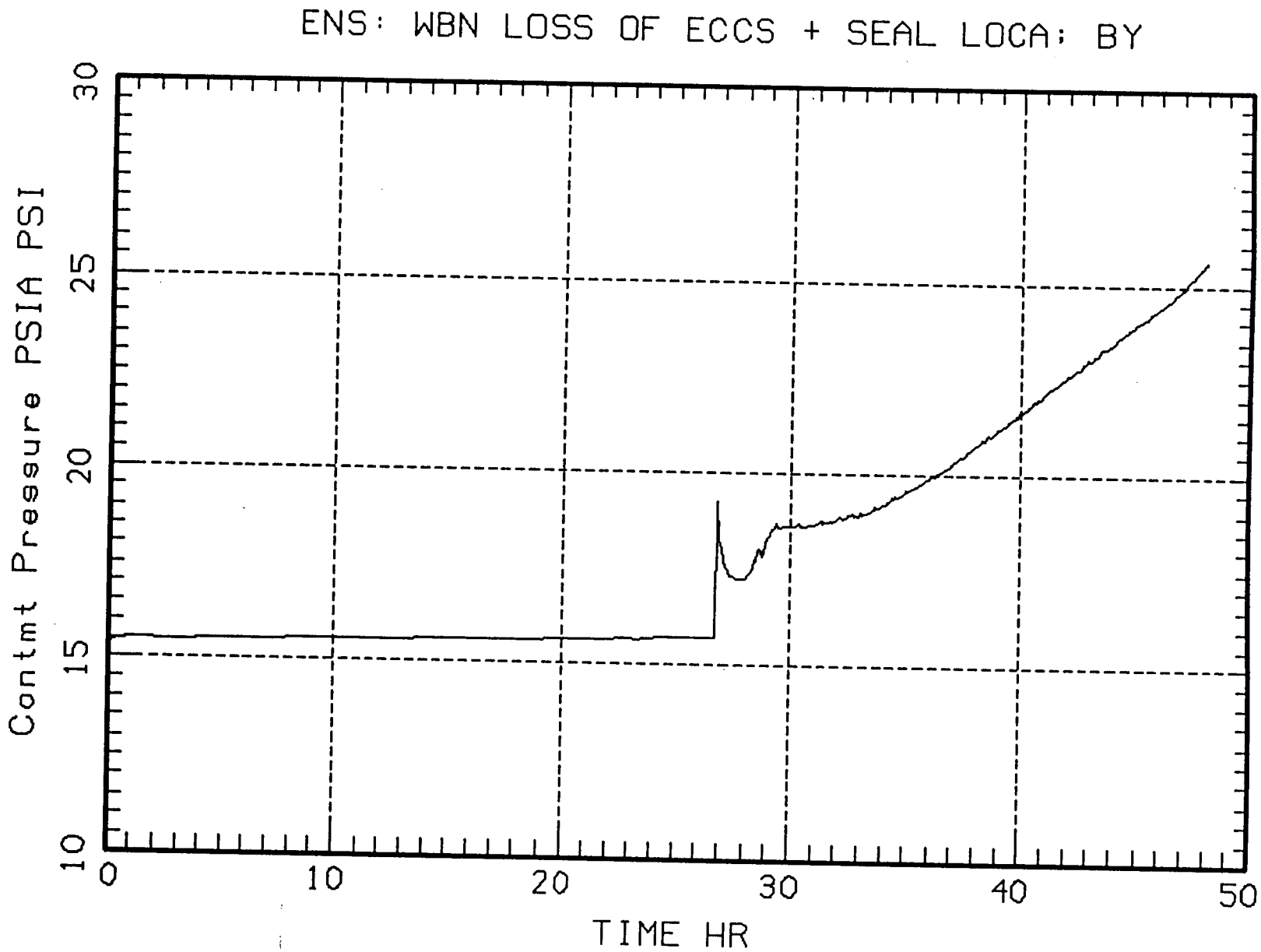

Figure 4.7-52. Containment Pressure in Case ENS

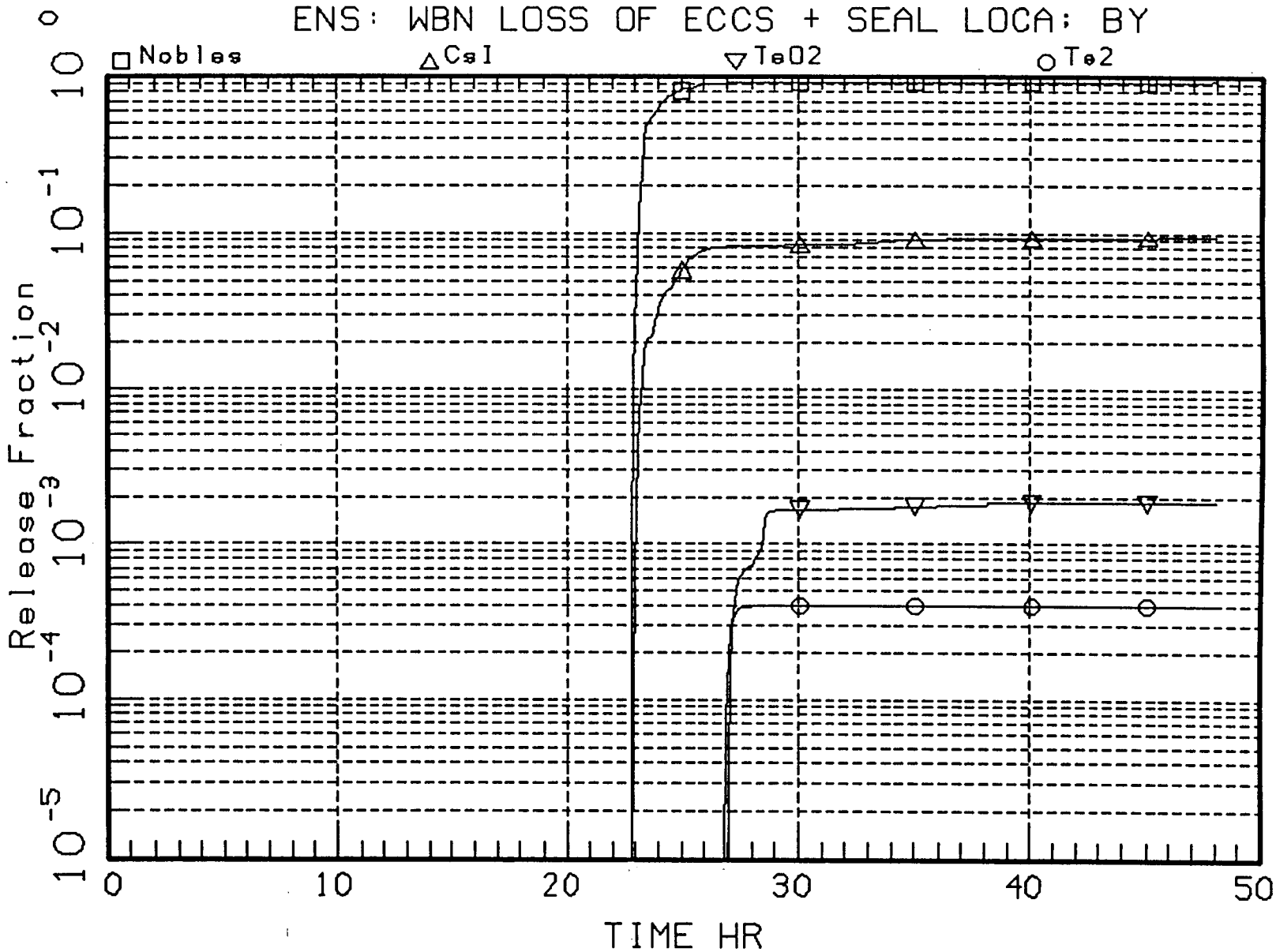

Figure 4.7-53. Fission Product Release to the Auxiliary Building in Case ENS

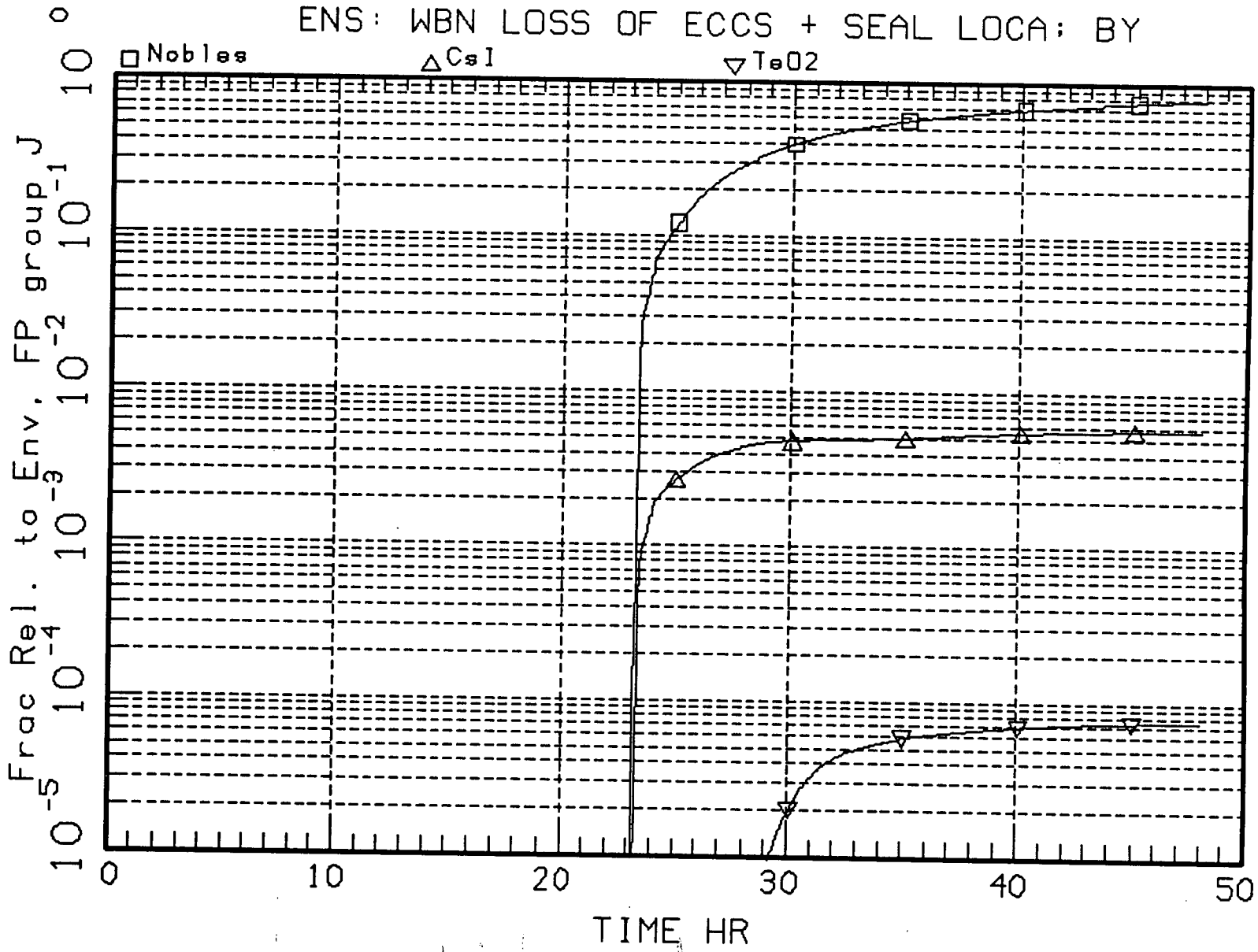

Figure 4.7-54. Fission Product Release from the Auxiliary Building in Case ENS - Groups 1, 2, 3

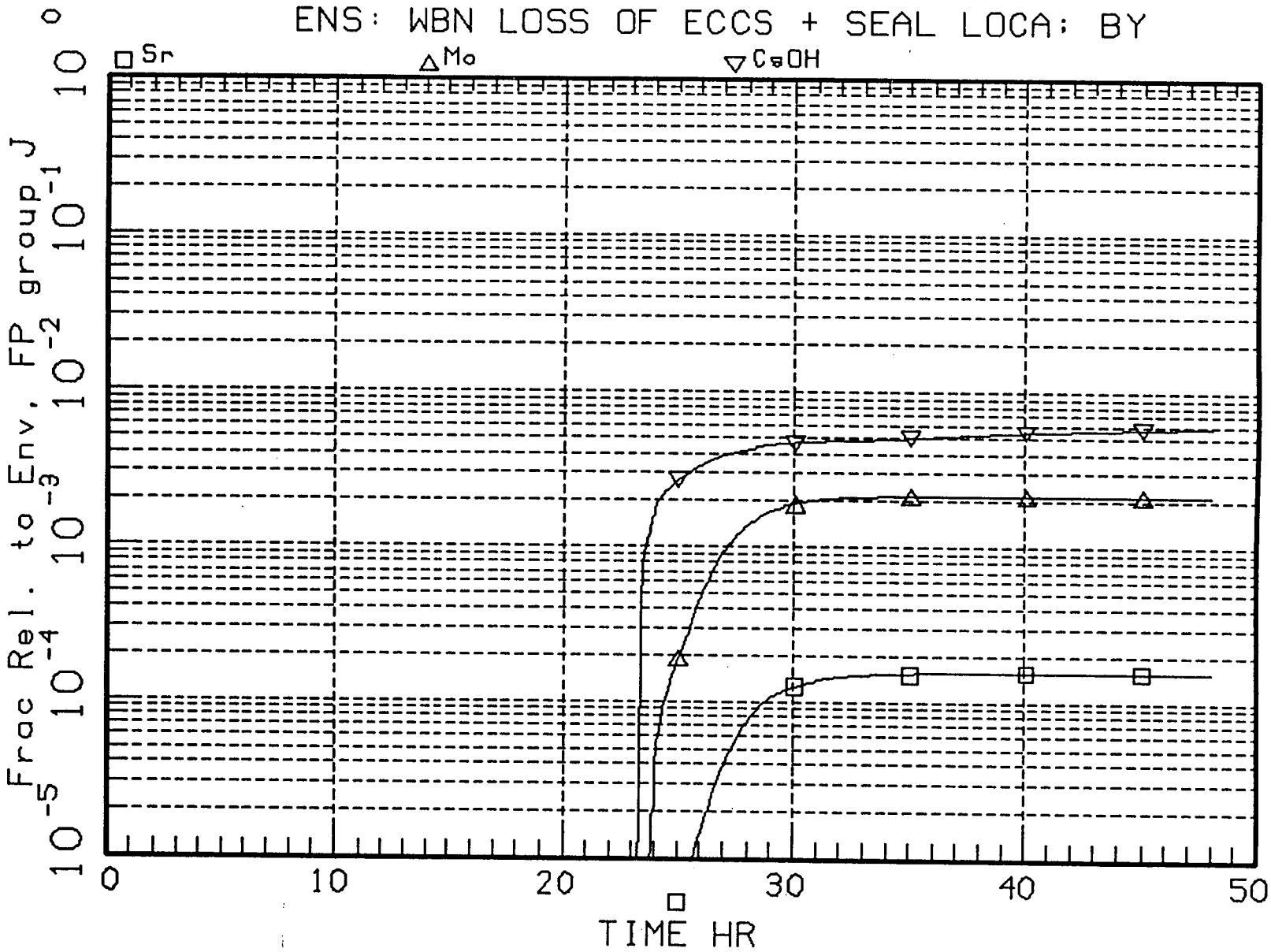

Figure 4.7-55. Fission Product Release from the Auxiliary Building in Case ENS - Groups 4, 5, 6

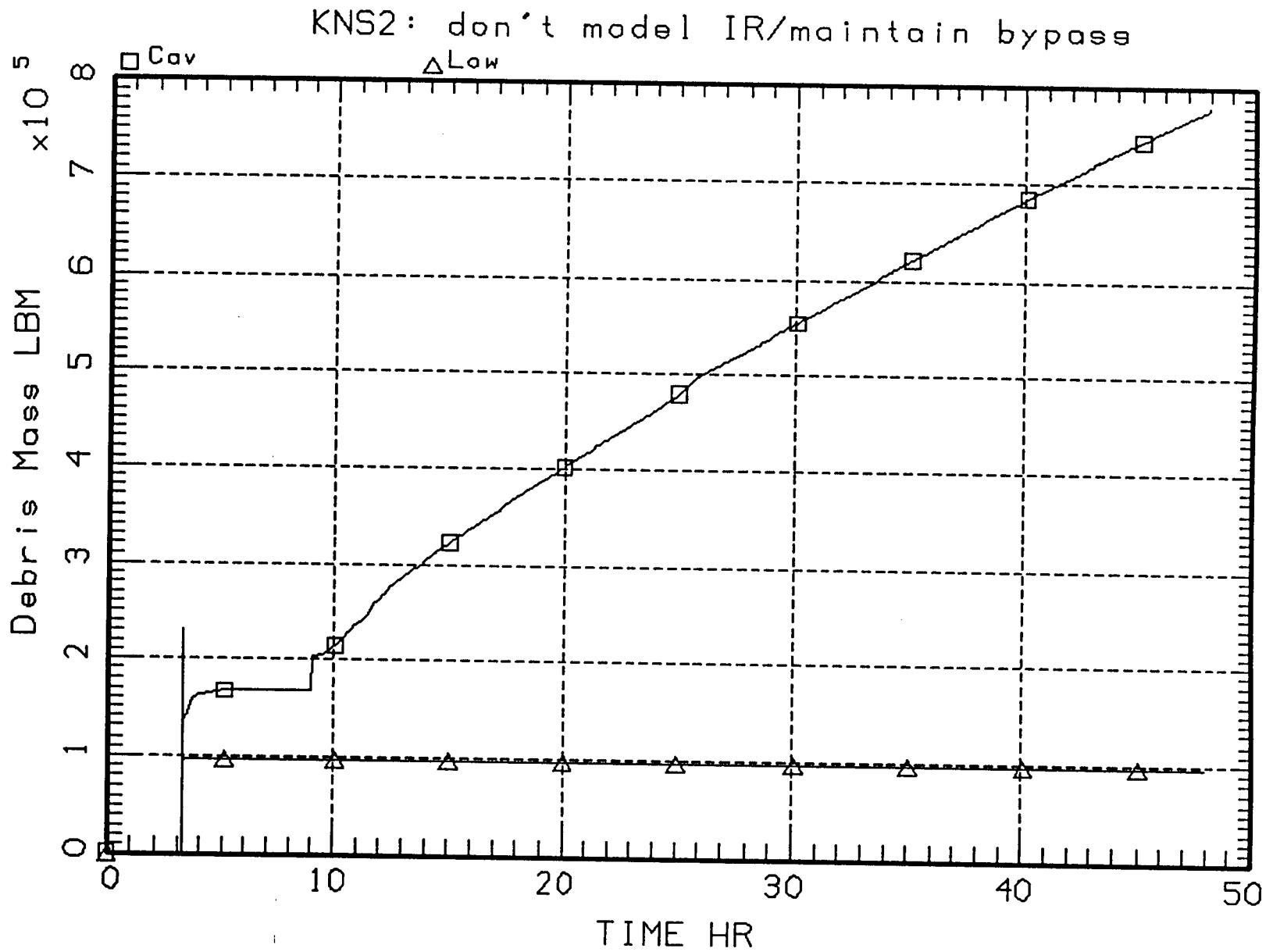

Figure 4.7-56. Debris Mass in Containment in Case KNS

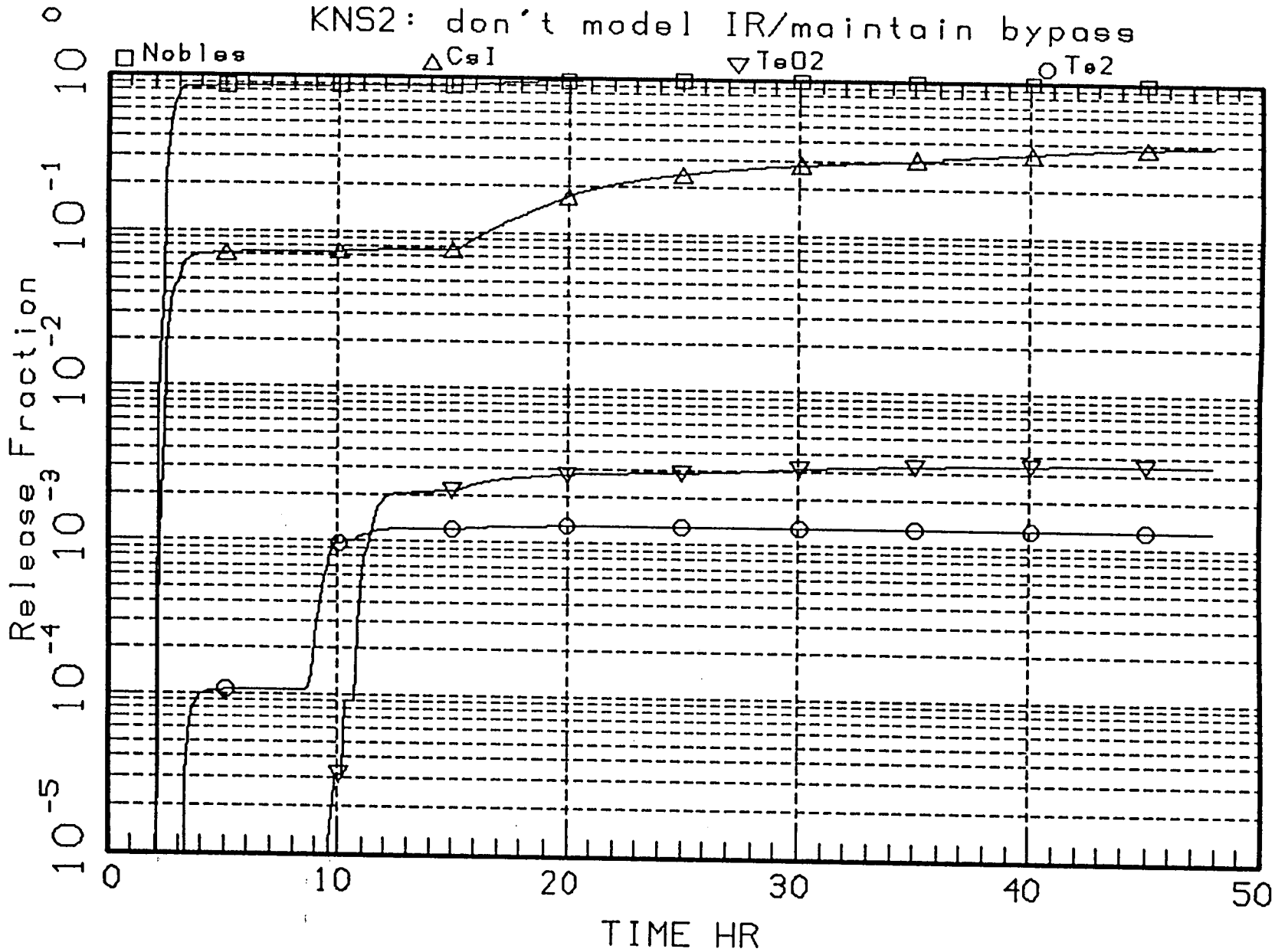

Figure 4.7-57. Fission Product Release to the Auxiliary Building in Case KNS

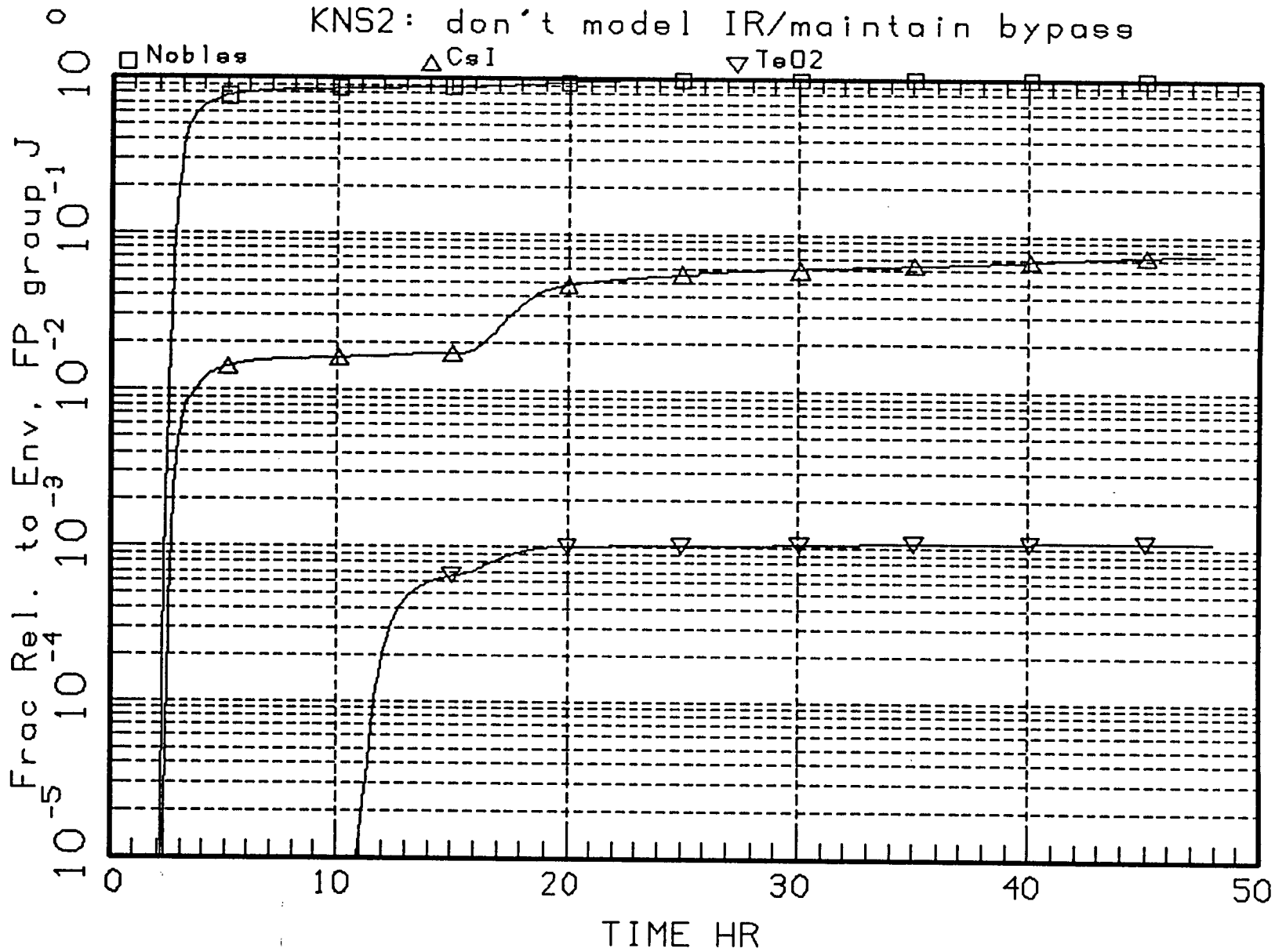

Figure 4.7-58. Fission Product Release from Auxiliary Building in Case KNS - Groups 1, 2, 3

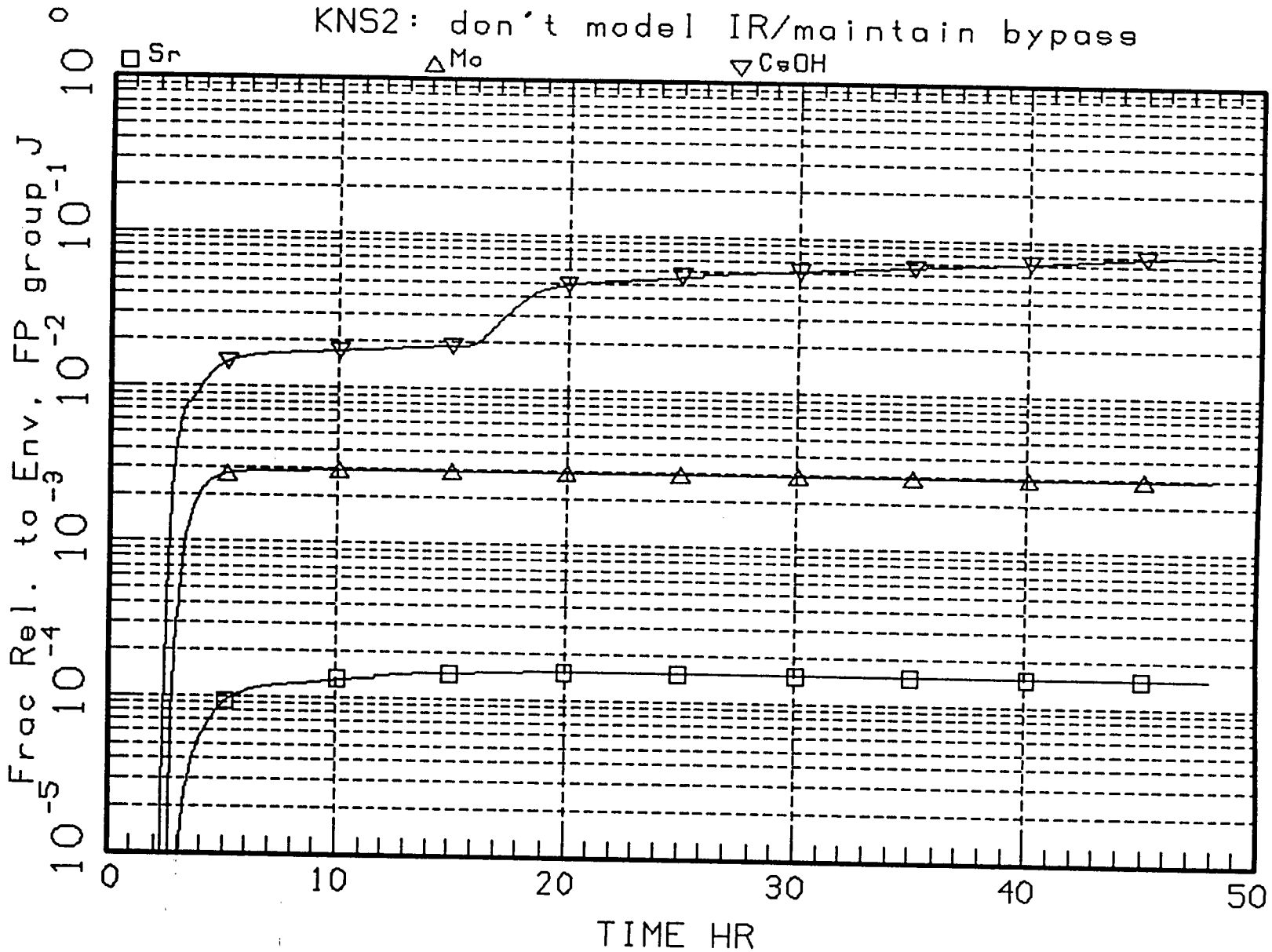

Figure 4.7-59. Fission Product Release from Auxiliary Building in Case KNS - Groups 4, 5, 6

4.8 CONTAINMENT EVENT TREE QUANTIFICATION

4.8.1 DESCRIPTION OF CONTAINMENT EVENT TREE QUANTIFICATION PROCESS

This section addresses the quantification of the Watts Bar containment event tree (CET). The CET quantification process includes the determination of top event split fraction values, the combination of these split fractions to determine conditional frequencies for each of the tree sequences, the assignment of each CET sequence to a release category, and the summation of all CET sequences for each release category. With the exception of the determination of CET top event split fractions, this effort is all accomplished automatically with the Event Tree Analysis module of the RISKMAN program (Reference 4.8-1). The RISKMAN Event Tree Analysis module requires as input (1) a description of the top events in the tree, (2) the logic defining the structure of the tree, (3) set of rules for assigning specific split fractions to account for dependencies on initiating events or prior top events in the tree, (4) a table of split fraction values, and (5) a set of rules governing the assignment of CET sequences to each release category. The structure and logic of the Watts Bar containment event tree were discussed in Section 4.5.

Wherever possible, CET split fraction values were based on plant-specific analysis [Modular Accident Analysis Program (MAAP)] (Reference 4.8-2) or extracted directly from Reference 4.8-3. However, a certain degree of engineering judgment is required for quantification of some split fractions. For the most part, this engineering judgment is based on the extensive Level 2 work that has been performed or reviewed by the Level 2 analyst team.

The results reported in Reference 4.8-3 for Sequoyah reflect certain actions that go beyond the scope of existing operating procedures and available thermal-hydraulic analysis for Watts Bar. In general, these actions tend to mitigate the consequences of certain accident initiators, and therefore to ignore them at this time is somewhat conservative. Credit for operator actions beyond the time of core uncovery has been included in the quantification of the Watts Bar CET, where such operations are clearly identified in existing emergency procedures. No credit is given for innovative recovery actions or recovery of systems that do not actuate automatically when AC power is recovered.

The entry state to the Level 2 analysis has been defined as uncovery of the top of the active fuel (UTAF) to be consistent with the NUREG/CR-4551 (Reference 4.8-3) definition. Significant core damage will not occur until a significant fraction of the core is uncovered. In the recovery analysis performed in Level 1, the time window for recovery is based on the expected time to core uncovery.

Hydrogen-related issues substantially complicate the process of quantifying the CETs in ice condenser probabilistic risk assessments (PRA). Ice condenser plants are sensitive to the treatment of combustion since they have a relatively low design pressure, small containment volume, and since the containment atmosphere downstream of the ice condenser is not steam-inerted in nearly all situations in which ice still remains. The treatment of hydrogen issues in the CET is made generally more difficult than in other pressurized water reactor (PWR) designs because (1) hydrogen concentrations are strong functions of position; (2) the behavior is greatly affected by the availability of air return fans and ignitors; and (3) phenomenological uncertainties in hydrogen production and combustion rates are large.

Some perspective on the hydrogen issue can be obtained by examining the results of the NUREG/CR-4551 analysis for Sequoyah. As described in Reference 4.8-3, hydrogen phenomena contributed little to the overall risk in accident sequences when air return fans and ignitors are operational. One qualification should be offered to this generalization: a few percent of such sequences that progressed to core damage were determined to result in early containment failure due to the combined effects of heating of the atmosphere and hydrogen burn in direct containment heating (DCH) events. DCH phenomena are driven strongly by the assumptions made on debris fragmentation and debris transport out of the lower compartment and somewhat less by uncertainties in combustion phenomena. This is not necessarily the case in large, dry containments in which there are sizeable uncertainties associated with the viability of steam inerting at the high temperatures reached during the event. Since this latter effect is not relevant for ice condenser containments, this narrow aspect of hydrogen phenomena is not considered in this report. Work sponsored by the U.S. Nuclear Regulatory Commission (NRC) in this area is continuing; Reference 4.8-4 contains the results of analyses (using the CONTAIN code) of possible plant back-fits to reduce the risk of DCH.

Sequences with neither air return fans nor ignitors are typified by station blackout (SBO) sequences. Hydrogen burns were an important contributor to the risk of these sequences in Reference 4.8-3. Of the SBO sequences that progressed to vessel failure with an intact containment, 12% resulted in early containment failure; approximately half of these were due to high pressure events (DCH combined with hydrogen burns). The other half (i.e., approximately 6%) were contributed by sequences that were depressurized prior to vessel failure (e.g., due to induced rupture of the hot leg or surge line) and the containment failed due to burning of hydrogen released prior to and coincident with vessel failure. Late failures of containment due to combustion of hydrogen and carbon monoxide produced both during core degradation and concrete attack occurred in 15% of the SBO cases and in a negligible fraction of the other sequences.

In this analysis, the treatment of hydrogen burns (other than those associated with high pressure melt ejection) is based solely on results generated with MAAP. The probability of containment failure at vessel breach due to high pressure melt ejection (HPME) is evaluated using the load data generated in Reference 4.8-3.

There are several major differences between the analysis reported here and that performed for Sequoyah in Reference 4.8-3. These differences are discussed in the next section.

4.8.1.1 Major Differences between NUREG/CR-4551 and the Watts Bar IPE Level 2 Analysis

The major differences between the NUREG/CR-4551 and Watts Bar IPE Level 2 analysis are as follows:

- **Core Damage Arrest.** The results reported in Reference 4.8-3 for Sequoyah take substantial credit for the arrest of core damage before vessel breach. Arresting the core damage process requires that emergency core cooling system (ECCS) injection be restored and that the damage has not progressed to the point at which the damaged core is no longer in a coolable geometry.

It is noted in Reference 4.8-3 that recovery of injection is due primarily to two events. For cases in which AC power is lost, it may be possible to recover injection when AC power is restored. Several considerations in this regard should be noted. First, prior to core damage, it is likely that the operator will have placed the ECCS pumps in a pull-to-lock configuration (Watts Bar Emergency Contingency Actions ECA-0.0, "Loss of All AC Power," Step 7). Thus, operator intervention is required to recover the ECCS once AC power is restored. Once core damage has occurred, despite the lack of specific procedural guidance, it is likely that the operator will perform the necessary actions to restore coolant flow. Finally, the window of time between the beginning of core damage and vessel breach is usually much shorter than the elapsed time up to the point where core damage begins. Thus, for many sequences, if AC power has not been recovered by the time that core damage begins, it is not likely that it will be recovered in the time window between the inception of core damage and vessel breach.

For other types of accidents, the ECCS may be operating, but the reactor coolant system (RCS) pressure is so high that it prevents injection into the vessel. A break in the RCS of sufficient size to allow the RCS to depressurize to levels that would facilitate ECCS injection would likely arrest the core degradation process and prevent vessel breach. Reference 4.8-3 notes that there are five means for depressurizing the RCS after UTAF:

1. Pressurizer Power-Operated Relief Valves (PORV) or Safety Relief Valves (SRV) Stick Open

2. Temperature-Induced Reactor Coolant Pump (RCP) Seal Failure

3. Deliberate Opening of the PORVs by the Operators

4. Temperature-Induced Steam Generator Tube Rupture (SGTR)

5. Temperature-Induced Hot Leg or Surge Line Failure

The combined effect of the above considerations is such that the mean values (Reference 4.8-3, Figure S.2) for the conditional probabilities of core damage arrest prior to vessel breach are approximately 0.42 for LOSP events, 0.17 for anticipated transient without scram (ATWS) events, 0.37 for loss of coolant accident (LOCA) events, and 0.79 for transients. There is some evidence [Reference 4.8-3 (APET Question No. 26)] that, for LOCAs, some of the recovery probability results from refined success criteria.

Operator depressurization before core uncovery is addressed in the plant model. For events in which AC power is available, Function Restoration Guideline FR-C.1, "Inadequate Core Cooling," is entered when core exit thermocouples indicate that the temperature is greater than 1,200°F. Step 24 of FR-C.1 instructs the operator to start RCPs if core exit thermocouples indicate 1,200°F or more, and if all available RCPs are running and exit thermocouple readings remain at 1,200°F or more, to open pressurizer PORVs and block valves to depressurize the RCS. Operators are specifically precluded from entering FR-C.1 if there is no AC power.

Except for the deliberate operation of PORVs by the operators, all of the above means for RCS depressurization following UTAF are explicitly addressed in the Watts Bar CET. These events are used in the context of altering the RCS pressure at the time of vessel breach from what it was at UTAF.

As a result of the detailed thermal-hydraulic analyses performed for representative sequences for key plant damage states, it was shown that some of the Level 1 success criteria were too conservative, and, in fact, some of the accident sequences did not result in core uncovery. These sequences were treated as core damage arrested sequences in the Level 2 analysis.

- **Recovery of Containment Systems.** The recovery of containment air return fans (ARF) and/or containment sprays after the onset of core damage has not been addressed for this submittal. These actions will be considered in the accident management phase of the examination process. Actuation of containment sprays and hydrogen ignitors* following loss of AC power requires an explicit action by the operators. Assuming no random failures of the ARFs, they would initiate automatically** if a Phase B condition were present when AC power was restored.

4.8.1.2 Hydrogen Phenomena

It is clear from the NUREG/CR-4551 (Reference 4.8-3) results that the treatment of hydrogen phenomena can potentially have a large impact on Level 2 results. The aspects of the problem that must be considered include:

- The quantity of hydrogen (and carbon monoxide if concrete attack occurs) generated.
- The hydrogen concentrations throughout the containment.
- The effectiveness of the ignitor system when it is available.
- The likelihood of deflagrations in SBO sequences.
- The likelihood of deflagration-detonation transition (DDT) and the consequences of such an event.
- The pressure rise that occurs due to a deflagration.

Because of the importance of hydrogen to the containment response of ice condenser plants, each of these considerations is addressed briefly in the sections that follow. The focus here is primarily on the treatment of the hydrogen from in-vessel sources. There are several reasons for this. First, in many sequences, the core debris will be quenched, and no ex-vessel source of hydrogen or carbon monoxide will exist. For cases with such a source, we shall nearly always be concerned with sequences in which concrete attack occurs in the reactor cavity. In such cases, if the cavity has become dry (coolable debris

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*Hydrogen ignitors are not initiated automatically. Ignitors are energized by the operators.
**Following a 10-minute time delay.

assumption), it is likely that the hydrogen source term will be mitigated by "recombination" of the combustible gases with oxygen that is brought into the reactor cavity by natural circulation (Reference 4.8-5). Furthermore, in many such cases, ice depletion will have occurred, which will increase the steam concentration and tend to inert the containment. Oxygen may also have been depleted below the 5% level, which will also tend to inert the containment. Finally, while cases in which "recombination" does not occur should be considered (References 4.8-6 and 4.8-7), such sequences will usually pose a threat to containment integrity at a relatively late point in the sequence compared to the threat posed by the in-vessel source; this should lessen their contribution to risk.

4.8.1.2.1 Hydrogen Source Term

The MAAP code has been used to provide insights into the various sequences and to gain an overall perspective on the possible outcomes of the various plant damage states in the Watts Bar IPE. If proper allowance is made for the various uncertainties and shortcomings associated with the MAAP models, MAAP results can be very helpful in discerning the timing of key events and for estimating the fission product source terms. Hydrogen MAAP can also be very helpful in illuminating the likelihood of containment-threatening combustion events in the various time frames of interest.

With this in mind, it is useful to first consider whether MAAP-calculated hydrogen and carbon monoxide source terms are reasonable. As discussed in Reference 4.8-6, if the MAAP "blockage" model is deactivated, MAAP results for in-vessel hydrogen production appear to reasonably track the results of more detailed codes such as MELPROG and MELCOR.

As a point of reference, the medians of the NUREG/CR-4551 aggregate curves for in-vessel hydrogen production range from 30% to about 45% (Figure 5-6 in Reference 4.8-3), with the higher values corresponding to high pressure sequences. This overlaps nicely the typical range of hydrogen production computed by the MAAP no-blockage model. For example, scoping calculations made with the Watts Bar parameter file have computed the following values of in-vessel hydrogen production, expressed as fractions of the total core zirconium inventory:

1. Large LOCA: 30%.
2. Medium LOCA: 30%.
3. Small LOCA: 35%.
4. SBO without induced rupture: 40%.
5. SBO with induced rupture: 43%.

With best estimate values of input parameters, it is rare to obtain hydrogen production corresponding to the reaction of more than about 55% of the zirconium inventory from MAAP. For this reason, unless we perform sensitivity calculations (e.g., on the MAAP eutectic melting temperature input), we will not typically test the "tails" of the NUREG/CR-4551 distributions for in-vessel hydrogen generation, which are quite long. Nevertheless, use of MAAP to guide our deliberations on the likelihood of the various CET end states would appear to be reasonable from the standpoint of hydrogen production.

While not considered in detail, it is believed that the MAAP concrete attack model (Reference 4.8-2) produces reasonable values for both the magnitude and the rate of

hydrogen and carbon monoxide production. It is perhaps worth noting in this regard that, given sufficient time, the MAAP model generates essentially unlimited amounts of combustible gases due to continuous addition of rebar to the melt.

4.8.1.2.2 Hydrogen Concentration in Containment

The possibility of a hydrogen deflagration or detonation at any point in the containment is strongly influenced by the concentrations of combustible gases (hydrogen and, after vessel failure, carbon monoxide), oxygen, and inertants. For steam concentrations above about 55%, hydrogen burns are precluded, except, at very high temperatures. Temperatures sufficient to prevent steam inerting from being effective are postulated, during DCH events or if concrete attack is occurring in the reactor cavity. Oxygen concentrations lower than 5% are believed to also prevent combustion. On the other hand, for steam fraction of at least 20%, hydrogen concentrations greater than roughly 13% give rise to the possibility that deflagration-detonation transition may occur (Reference 4.8-8). This would cause high localized pressurization, which may damage key equipment or, in areas adjacent to the containment shell, possibly result in loss of containment integrity.

As will be discussed in more detail below, the ARFs can at nearly all points in the accident sequence keep the containment in a well-mixed condition. This conclusion is supported by MAAP calculations, the work cited in NUREG/CR-4551, and HECTR calculations for Sequoyah (Reference 4.8-9). The evaluation of gas concentrations in an ice condenser plant when ARFs are not operational is much more difficult than in a large, dry containment due to the effect of steam condensation in the ice condenser and the fact that natural circulation is impeded by the ice condenser lower plenum doors, the intermediate deck doors, the ARF dampers, etc.

The expert elicitation process in NUREG/CR-4551 attempted to quantify the time-dependent concentrations of the various gases using a limited set of CONTAIN, HECTR, and MARCH calculations. This resulted in a rather complicated set of various conditions being defined for the Sequoyah APET, which are not easy to comprehend. In an attempt to provide some additional insight into the expected behavior, some MAAP calculations were performed as part of this evaluation. The observed behavior is described below. While MAAP certainly represents a coarse model of the containment for natural circulation processes, the qualitative behavior of the model is believed to be reasonable.

- **Small LOCA with Burns Inhibited and Fans Available.** This sequence is comparable to a base case small LOCA with failure of ECCS in the recirculation mode except that burns were inhibited to better observe internode differences in hydrogen concentration. As expected, with fans available, the containment was very well mixed except for somewhat higher steam concentrations in the lower compartment (which receives the steam from the break). The lower compartment was not steam inerted, however.

  It has been noted that steam condensation on passive heat sinks tend to result in hydrogen stratification (Reference 4.8-10). It is noteworthy that in this, as in all the other cases, steam condensation on the upper compartment wall is negligible until ice melt and only about 0.5 kg/sec thereafter. This is not surprising in view of the construction of the containment wall (steel shell separated by a large gap from the shield building), and indicates that the upper compartment should remain

relatively homogeneous, at least at elevations above the ice condenser upper plenum, even if air return fans are not operating. The conclusion that the containment will be well-mixed if the ARFs are available from the start is consistent with NUREG/CR-4551 (e.g., see APET Question 31). In fact, NUREG/CR-4551 assigned an 83% likelihood that ARFs could homogenize the containment prior to ignition even if they were only recovered late in an SBO.

- **Small LOCA with No Fans and No Ignitors Available.** In this sequence, burns were inhibited, and, additionally, it was assumed that the ARFs were unavailable. As a result, the containment displayed very large concentration differences. For example, the hydrogen concentration in the ice condenser peaks at about 25% just after core damage begins, and then rapidly declines to the low teens. Both values are within the range in which DDT is considered possible in the ice condenser. In the lower compartment, on the other hand, the steam concentration was high, near but often below the assumed inerting limit of 55%. Hydrogen concentration in the upper compartment, which is of particular importance for assessing pressure rise because of its large volume, rose to about 10%, where it remained until ice melt. This is above the flammability limit for global combustion. Steam concentrations in the upper compartment and the ice condenser were very low, as expected. In this regard, it should be pointed out that the ice condenser is treated as a single, relatively large volume in MAAP, and, thus, peak hydrogen concentrations there may be understated.

- **Small LOCA with No Fans but Ignitors Available.** In view of the high hydrogen concentrations observed in the previous sequence, it was decided to run a similar sequence but to allow the ignitors to function. The results obtained are, of course, sensitive to the modeling of the ignitors. While this is traditionally a subject of some controversy, the new model currently used in MAAP 3.0B appears to be reasonably mechanistic and has been compared quite favorably to experiment (Reference 4.8-11).

  The activation of the ignitors in this case with no ARFs had a substantial benefit in reducing peak hydrogen concentrations. The hydrogen concentration in the ice condenser peaked at 8%, probably because the ignitors in the lower compartment were effective. Hydrogen concentrations in the lower compartment peaked at about 6%, which is about the lower limit for horizontal burn propagation, and reached only 4% to 5% in the upper compartment and upper plenum. Changes in sequence definition might worsen these results by causing more persistent steam-inerting of the lower compartment; the ignitors in the upper portions of the containment and the dead-end compartments would still be effective.

- **Small LOCA, No Fans, and Ignitors Available Everywhere Except in the Lower Compartment.** Motivated by the results of the previous run, the same calculation was repeated; however, this time, no ignitors were assumed to function in the lower compartment. This gave results intermediate between the two cases just discussed: peak hydrogen concentration in the ice condenser reached 12% in this case and then dropped to the 5% to 7% range. Part of the reason for the improvement relative to the no ignitor case is the fact that global burns were still allowed in the lower compartment, and a series of these did occur. Steam fractions were in the 30% to 45% range in the lower compartment during the time frame of

interest, and so the region was not inerted. A code change would be necessary to completely prevent burns in the lower compartment but still allow them elsewhere; this was considered beyond the scope of this study, and in any event, burns would be expected under the conditions calculated.

- **Station Blackout Sequence with Induced Hot Leg Rupture.** Roughly speaking, this sequence would be expected to pose about the largest potential for early containment failure due to hydrogen burns for several reasons. Obviously, the key factor is that neither ARFs nor ignitors will be available. In addition, hydrogen source terms are somewhat higher than for the lower pressure sequences. Finally, if it is assumed that induced rupture occurs, a large quantity of hydrogen is released at one time while plenty of ice is still available to condense the steam. This would also occur in an SBO without hot leg rupture, and, indeed, such a sequence gave similar results. In any event, SBOs with hot leg rupture are currently thought to be more likely than those without.

  In this sequence, the hydrogen concentration in the ice condenser peaks at about 45% soon after the rupture, and then declines rapidly to the low teens. The hydrogen concentration in the upper compartment is in the 12% range after the rupture. In the lower compartment, the steam concentration is about 90% after failure of the quench tank, slowly drops to 30% as air is convected from the upper compartment, rises again to 90% after hot leg rupture, and then declines until vessel failure. Thus, after the large increase in ice condenser hydrogen concentration, internode flows appear to be relatively effective in mixing the hydrogen concentrations in the containment. As mentioned below, this result is subject to various uncertainties, notably the behavior of the ice condenser doors under low-flow conditions.

- **Transient with Ignitors and Air Return Fans.** To better explore the effects of rapid release of hydrogen into the containment, in this sequence, it was assumed that main and auxiliary feedwater were lost and that feed and bleed was not successful. It was further assumed that induced rupture would not occur. The primary system failed at high pressure, rapidly releasing a relatively large quantity of hydrogen into the containment.

  A very narrow spike in hydrogen concentration was observed in the ice condenser and lower compartment. The peak values achieved were 38% and 16%, respectively. The upper compartment never exceeded 6%. Once the blowdown was over, the combined effects of air return fans and ignitors very quickly reduced hydrogen concentrations in the containment to the 4% to 5% level, as expected from the flammability curves; this process took the longest in the ice condenser.

- **Transient with Ignitors but with Air Return Fans Inoperative.** One last sequence was run to study the effects of inoperative air return fans with ignitors available. Not surprisingly, the net effect was to widen the "spike" in hydrogen concentration in the ice condenser and lower compartment, and to produce peak values intermediate between the case with no ignitors and the case with both ignitors and air return fans. Otherwise, the results were not remarkable.

The conclusion that appears to be inevitable from these scoping calculations is that hydrogen concentrations sufficient to support DDT will be achieved in the ice condenser if neither fans nor ignitors are available. On the other hand, if air return fans are available, such concentrations would not be expected. With somewhat less assurance, we can draw the same conclusion if ignitors are available but ARFs are not.

4.8.1.2.3 Effectiveness of the Ignitor System

In NUREG/CR-4551, ignition was assured if ignitors were available and steam concentrations were below 60%. The latter condition is virtually guaranteed when ARFs are available. The end result is that the hydrogen from in-vessel sources will generally be burned at relatively low concentrations in all circumstances except perhaps when hydrogen is released so rapidly (e.g., in transients not involving induced ruptures, especially if direct containment heating occurs) that the ignitors are overwhelmed. This provides good assurance that containment failure pressures will not be approached. So, as noted above, when both ARFs and ignitors are available, there appears to be a general consensus that the threat posed by hydrogen burns is small in all but high pressure sequences.

There appears to be some question about the effectiveness of the ignitors in reducing hydrogen concentration in the ice condenser if ARFs are not available due to steam inerting in the lower compartment and the natural concentrating effect of the ice. If such sequences prove to be important, some additional MAAP calculations might shed some light on this issue. As discussed in References 4.8-4 and 4.8-7, when interpreting MAAP results for such sequences, it should also be noted the whole area of natural circulation in ice condenser containments is subject to uncertainty. Nevertheless, it is our current judgment that MAAP calculations of containment behavior with ignitors and no ARFs can be regarded as a reasonable statement of the best estimate containment response; this leads to the conclusion that hydrogen burns sufficient to fail containment are unlikely in most cases. This is moot if sequences with ignitors nearly always have operational ARFs. The answer to this question is a key input from the Level 1 evaluation.

4.8.1.2.4 Likelihood of Ignition with No Ignitors

The traditional MAAP base case treatment of hydrogen burns in the absence of ignitors but with AC power available has been to assume that ignition occurs whenever the conditions for global flammability exist. This position is qualitatively justified by the known, rapid drop in energy required to initiate a burn as the hydrogen concentrations increase (Reference 4.8-12), and is consistent with the experience of Three Mile Island where a burn occurred at about the lower limit of global flammability (about 8% hydrogen concentration). Although the same treatment is used for cases with no AC power, on the assumption that static electricity, DC power, etc., provides an ignition source, this situation is less certain.

In Reference 4.8-3, this question was taken up separately in the lower compartment, ice condenser, upper plenum, and upper compartment in APET Questions 48 through 51. In each case, the likelihood of ignition was assigned based on an assumed hydrogen and steam concentration. If ignitors were available and steam concentrations were less than 60%, ignition was assumed in all cases. The burn completeness was then assessed by using a formula from Wang (Reference 4.8-13) that involves the hydrogen fraction. If

ignitors were not available, the following assignments were made for the likelihood of ignition prior to vessel failure (a few additional cases that were considered in NUREG/CR-4551, mainly involving recovery of AC power during core degradation, have been omitted for conciseness):

- Lower Compartment:

  $H_2 < 5.5\%$ or $H_2O > 25\%$: 0

  $H_2 > 5.5\%$ and $H_2O < 25\%$ and AC Power: 1

  $H_2 > 5.5\%$ and $H_2O < 25\%$ and no AC Power: 0.15

  Given the expected gas concentrations, we conclude from these assignments that if no ARFs are available, we should take the likelihood of burns in the lower compartment as small or nil. If ARFs are available, burns prior to vessel failure are expected for most sequences.

- Ice Condenser Compartment:

  $H_2 < 5.5\%$ or $H_2O > 60\%$: 0

  $H_2 > 16\%$ and $H_2O < 60\%$ and AC Power: .197

  $11\% < H_2 < 16\%$ and $H_2O < 60\%$ and AC Power: .157

  $5.5\% < H_2 < 11\%$ and $H_2O < 60\%$ and AC Power: .123

  Combustion Occurs in Lower Compartment and ARFs: 1

  From this, it is concluded that the likelihood of burns in the ice condenser is small unless they propagate from the lower compartment. Given the previous assignments, burns are not expected unless ARFs are available.

- Upper Plenum Compartment:

  $H_2 < 5.5\%$ or $H_2O > 60\%$: 0

  $H_2 > 5.5\%$ and $H_2O < 25\%$ and AC Power: 1

  $H_2 > 16\%$ and $H_2O < 60\%$ and no AC Power: .347

  $11\% < H_2 < 16\%$ and $H_2O < 60\%$ and no AC Power: .257

  $5.5\% < H_2 < 11\%$ and $H_2O < 60\%$ and no AC Power: .178

  Combustion in Ice Condenser Occurs and ARFs: 1

- Upper Compartment:

  $H_2 < 5.5\%$ or $H_2O > 60\%$: 0

  $H_2 > 5.5\%$ and $H_2O < 25\%$ and AC Power: 1

  $H_2 > 16\%$ and $H_2O < 60\%$ and no AC Power: .097

  $11\% > H_2 < 16\%$ and $H_2O < 60\%$ and no AC Power: .092

  $5.5\% > H_2 < 11\%$ and $H_2O < 60\%$ and no AC Power: .083

  Combustion in Upper Plenum Occurs and ARFs: 1

  If ice exists and AC power is available, burns in the upper plenum and upper compartment are to be expected. If AC power is off, burns are not very likely, especially if one accepts the conclusions on upper plenum/upper compartment mixing drawn in Appendix 4A.

When comparing the NUREG-1150 approach to the MAAP default parameter treatment, it should first be recognized that MAAP does not explicitly model burns in the ice condenser. Assuming that no burns occur there represents 80% to 90% of the NUREG-1150 probability distributions but ignores the tail and the possibility of propagation from the lower compartment. For the other regions, the default MAAP treatment if AC power is available is consistent with the NRC approach as long as the steam concentration is less than 25%. This will always be the case in the upper plenum and upper compartment if ice is available (the most important time for hydrogen-related considerations). It is not clear why NUREG-1150 assumed that burns would not occur in the lower compartment when steam concentrations were greater than 25%; the reasoning appears to be that steam concentrations sufficient to inert would always occur if the ARFs were not operating.

For cases with no AC power, NUREG-1150 employs a complicated treatment that considers a range of hydrogen concentrations in the separate compartments of interest whenever steam fractions are below 25% (lower compartment) or 60% (elsewhere). In all cases, the likelihood of a burn is taken to be less than 50%. Rather than attempting to duplicate this treatment in the IPE, all burns were suppressed in some MAAP SBO sensitivity calculations. This confirmed that if burns were sufficiently delayed, especially in the presence of CCI, containment-threatening burns could occur. This was considered in the CET qualifications effort.

4.8.1.2.5 Likelihood of Deflagration-Detonation Transition

As noted above, quite high hydrogen concentrations can be produced in the ice condenser, at least for short periods of time. This gives rise to a concern that hydrogen burns might transition to detonations; this is apparently favored by the confined spaces, the many obstacles that promote turbulence, and the low steam concentration. On the other hand, as noted in the previous section, it is hard to imagine a readily available ignition source unless one postulates that a burn propagates from the lower compartment or initiates from friction during operation of the intermediate deck doors.

NUREG-1150 considered DDT in the ice condenser upper plenum as well as in the ice condenser itself. The report noted that the geometry was less conducive for detonations than the ice condenser, but the study ended up using the same probability distribution as in the ice condenser, the same median impulse (10.4 kPa-sec), but a lower failure criterion (12 kPa-sec versus 21.6 kPa-sec assigned to the ice condenser). At least one of the experts elicited in the study felt that detonations need not be considered in the upper plenum. Indeed, if one assumes that most of the very light upper doors are flung open early in the transient, which appears to be all but certain by the time that hydrogen is released from the primary system in large quantities, calculations of counter-current flow between the upper plenum and the upper compartment (see Appendix 4A) indicate that it will be very difficult to sustain detonable conditions in the upper plenum for any significant period. For these reasons, we do not consider it necessary to treat DDT in other than the ice condenser.

In NUREG/CR-4551, the likelihood of DDT in the ice condenser was assigned the following values (conditional on a deflagration in occurring in the ice condenser):

$H_2 > 21\%$: 0.72

$16\% < H_2 < 21\%$: 0.62

$14\% < H_2 < 16\%$: .453

$H_2 < 14\%$: 0

It is difficult to improve on the treatment on DDT used in NUREG/CR-4551. Therefore, the following approach is being used in this submittal:

- A hydrogen burn is assumed to occur in the ice condenser whenever a burn occurs in the lower compartment and the hydrogen concentration supports upward propagation. (The latter condition should nearly always be satisfied.)

  However, as noted in the previous section, the likelihood of a burn occurring in the lower compartment prior to vessel failure in sequences with no AC power is considered to be virtually nil because of high steam concentrations.

- If ARFs are operating, and many of the times when only ignitors are operating, the hydrogen concentration in the ice condenser should be below 14% and DDT need not be considered an important threat. As discussed above, the MAAP hydrogen concentrations are subject to many uncertainties. Nevertheless, it is hard to imagine hydrogen concentrations of this magnitude with ignitors operating.

- If neither ARFs nor ignitors are operating but AC power is available (this may be a very small fraction of the total CDF), DDT should be assessed using the NUREG/CR-4551 assignments. Containment failure, given DDT, is then considered in light of the estimated impulse and the failure criterion; based on NUREG-1150, containment failure is relatively unlikely even if DDT occurs; i.e., 0.1 was used for the containment failure probability, given DDT.

Based on this discussion, it has been concluded that DDT is unlikely to play a significant role in the results.

4.8.1.2.6 Containment Pressurization during Deflagrations

In a large, dry containment, gas concentrations are relatively uniform, and burns typically occur quickly enough that the event can be accurately handled by an adiabatic calculation. As a result, the pressure rise during deflagrations is not normally subject to large uncertainties and can, in fact, be computed fairly well by hand.

When quantifying the Sequoyah APET in NUREG/CR-4551, a similar calculation was performed in which the pressure was computed using an adiabatic, isochoric algorithm. Burn completeness, calculated with Wong's algorithm, is usually 100% in this calculation if ignitors are not present. An adjustment was made for expansion into nonparticipating containment volumes, and a 5% correction was applied to reflect heat loss to structures.

It appears that such a calculation is highly conservative in that it, unlike MAAP, does not consider how the gases expand into nonparticipating volumes. Insofar as failing containment is concerned, calculations involving burns in the upper compartment are usually of the most interest. The fan ducts that connect the upper compartment to the dead-end and annular compartments are only about 10 ft^2, and cannot keep the upper and lower regions of the containment at equal pressures. The estimated failure pressure of the ice condenser intermediate deck doors and lower plenum doors are 6 and 7 psid, respectively (Reference 4.8-14). Such pressures will be surpassed by a significant margin in global burns unless substantial flow area develops to relieve the pressure buildup in the upper compartment. Furthermore, Reference 4.8-4 states that once fully opened, it is believed that the inlet plenum doors will not reclose due to their "crushable hinges." This leads to the conclusion that failure of the ice condenser doors will inevitably occur for all upper compartment burns large enough to threaten containment integrity; i.e., those not involving local burns at ignitors.

If the gases do, indeed, flow back through the ice condenser, we would expect the effects of the burn to be greatly mitigated by the cooling of the gasses as they traverse the ice. A simple model described in Appendix 4B indicates that if half of the ice remains when the burn occurs, and if the flow from the upper compartment is assumed to flow relatively uniformly down the entire available cross section (the results are relatively insensitive to these assumptions as long as a channel is not formed that is completely devoid of ice), the cooling effect reduces the pressure rise by 25% or more, depending on the severity of the burn.

Most of the calculations performed by the NRC for ice condensers have used the HECTR code. Typical of these calculations are those documented in Reference 4.8-9. It is explained there that both sets of ice condenser doors are treated as one-way junctions, with only a small bypass area being modeled at the top. A number of sensitivity calculations were run for an S2D sequence. Interestingly enough, in one calculation (Case A.15), the doors were removed from the model entirely. In that case, the pressure rise from five deflagrations in the upper compartment ranged from about 75 to 120 kPa; in the same sequence with the doors modeled in such a way as to not allow back-flow, the pressure rise due to five burns over the same interval was from 100 to 210 kPa; i.e., an increase of 33% to 75%. It should be pointed out, however, that the door-removed

calculation benefited both from the cooling effect and the fact that the expansion of gasses into the lower containment regions was more effective. Unfortunately, Reference 4.8-9 did not report the pressure response in any but the upper compartment, so it is not possible to directly separate the two effects.

In the calculations performed for this report, the MAAP model, which credits backflow through the ice condenser for cases involving large upper compartment burns, was used.

4.8.1.2.7 Conclusions

The quantification of the Watts Bar CET considers the following:

- MAAP-calculated in-vessel hydrogen generation appears to be consistent with the median values defined in NUREG/CR-4551 and with the results of more detailed codes.

- With the air return fans operational, the containment generally stays well-mixed except perhaps during a short interval just after vessel failure. Thus, operation of the air return fans should prevent detonable conditions from arising.

- With neither air return fans nor ignitors operational, hydrogen concentrations in the ice condenser are above the lower limit for detonations in most sequences.

- With air return fans inoperative but with ignitors available, MAAP calculations indicate that concentrations are too low for detonations to occur unless hydrogen is released very rapidly into the containment as in transient sequences. However, these results are subject to uncertainties in both ignitor performance, and, more important, natural circulation flow rates.

- Using the NUREG/CR-4551 methodology, the likelihood of detonations in the ice condenser if no air return fans are operating is quite small due to the lack of an effective ignition source in either the ice condenser or the steam-laden lower compartment. If a detonation should occur anyway, the best estimate load will not cause containment failure. Detonations are not expected in the upper plenum of the ice condenser due to effective mixing with the upper compartment atmosphere. Detonations are also not expected if air return fans are operating.

- Except perhaps for high pressure sequences in which the hydrogen is released very rapidly at vessel failure, ignitors should prevent containment-threatening pressurization from hydrogen burns. For high pressure sequences, the containment loading at vessel failure must consider the effect of rapid hydrogen burns, augmented in some cases by direct heating of the containment atmosphere and by additional hydrogen production due to debris fragmentation.

- The likelihood of combustible gas ignition if ignitors are not available appears to be treated in a reasonable manner in NUREG/CR-4551. From this treatment, it can be concluded that:

  - Lower compartment burns are not expected unless air return fans are available. If they are, burns are expected to occur there. For cases with no

air return fans, it is therefore conservative and reasonable to neglect burns in the lower compartment.

- Burns in the ice condenser are not likely unless they propagate from the lower compartment. Thus, such burns are not expected unless air return fans are available. Since fans effectively mix the containment, it is acceptable to neglect the possibility of burns in the ice condenser in favor of burns in the upper compartment.

- If ice exists and AC power is available, burns are expected in the ice condenser upper plenum and in the upper compartment. If AC power is failed, burns are not likely but should be considered probabilistically due to the potential threat of upper compartment burns on containment failure.

- To calculate the pressure rise accurately due to large deflagrations (i.e., in the absence of ignitors or at the time of vessel failure in high pressure sequences), the failure of the intermediate deck doors must be considered. This will allow backflow through the ice condenser, and the cooling of the burned gases by the ice provides a substantial mitigation in the pressure rise.

4.8.2 QUANTIFICATION OF CET SPLIT FRACTIONS

Tables 4.8-1 and 4.8-2 define the split fraction macros used in the Watts Bar CET quantification process and summarize the numerical values of the CET top event split fractions for generalized sets of plant damage state parameters and pathways through the CET, the RISKMAN logic for assignment of these split fractions, and the basis for each split fraction. A general discussion of the quantification of each top event in the CET is provided in the remainder of this section.

- **Top Event 1 — Containment Not Bypassed Prior to Core Damage (BY).** Containment bypass prior to core damage results from events such as interfacing systems LOCAs, containment isolation failures leading to containment bypass (e.g., failure to isolate an RCP seal return line), and steam generator tube ruptures (as initiating events*). For any such sequence, Top Event 1 (BY) is assigned a failure fraction of 1.0. All other sequences are assigned a failure fraction of 0.0; i.e., no bypass is involved.

- **Top Event 2 — Bypass Prior to Core Damage is Small (LB).** If the bypass representing the failure branch of Top Event 1 (BY) is large, the failure branch for this top event is assigned a value of 1.0; otherwise, the split fraction is assigned a value of 0.0. From a size standpoint, the rupture of a single steam generator tube is treated as a small bypass. However, the source term associated with such bypasses could be very significant.

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*Steam generator tube failures induced by high temperature gases and superheated steam are assumed to affect more than a single tube and are therefore classified as large bypasses for this IPE submittal.

- **Top Event 3 — Core Damage Arrested Prior to Vessel Breach (CV).** This top event was included in the Watts Bar CET to address the likelihood of in-vessel recovery of a degraded core after core damage is initiated, given that recovery prior to the onset of core damage has not been successful. However, detailed thermal-hydraulic analysis of the highest ranking representative sequence for some of the Watts Bar key plant damage states (KPDS) (BCI, FCI, LCI, and LNIYA) indicate that Level 1 success criteria and/or modeling assumptions were too conservative, and for these sequences, core damage (i.e., core uncovery) did not occur. For these KPDSs, sequences that were similar to the representative sequence (and thus did not represent core damage) were identified, and the split fraction for core damage arrest Top Event 3 (CV) was set equal to the fraction of sequences within that KPDS that did go to vessel breach. The original representative sequence in KPDS BCI was initiated by a medium LOCA with failure of high pressure recirculation but successful secondary-side depressurization and cooldown. The top-ranking sequence (5.61×10^{-7} per reactor-year) represents approximately 10% of the KPDS frequency. MAAP analysis of this sequence clearly indicated no core damage. Furthermore, an examination of similar sequences indicated that 23% of the KPDS frequency would be "recovered" in this manner. Of the remaining sequences in this KPDS, there are other sequences (e.g., those initiated by a large LOCA with all systems available except the accumulators) that may also be shown to be "recovered." Although additional "recovery" may be possible, the split fraction for Top Event 3 (CV) for KPDS BCI was assigned a value of 0.77.

  A similar evaluation was necessary for KPDS FCI. The original representative sequence for this KPDS was a small LOCA with failure of high pressure recirculation but with secondary depressurization and cooldown available. MAAP analysis of this sequence also indicated no core damage. An examination of the sequences in KPDS FCI indicated that 32% of the sequences were similar to the representative sequence. Thus, the split fraction for Top Event 3 (CV) was assigned a value of 0.68 for KPDS FCI.

  The original representative sequence in KPDS LCI represents a scenario with the bleed and feed function available but with only one PORV. MAAP analysis of this scenario also indicates the prevention of core damage. By a similar process, the split fraction for Top Event 3 (CV) was assigned a value of 0.23 for this KPDS.

  When KPDS LNI was subdivided into LNIYA and LNIYN, the representative sequence for LNIYA was also shown to have no core damage. Since the frequency of LNIYA was already below a value of 1×10^{-6} per reactor-year, the split fraction for Top Event 3 (CV) was assigned a value of 0.0 for this KPDS.

  For core damage arrest, the principal accident scenarios of interest are those involving station blackout. It should be noted, however, that SBO is not as important for Watts Bar as in other plants. The time windows available for recovery of AC electrical power prior to core damage for station blackout sequences with and without the operation of emergency feedwater are discussed in Section 3.3.3 and Reference 4.8-3. Station blackout sequences without operation of emergency feedwater (TMLB') have the shortest time available for recovery of electrical power and therefore would benefit the most from any additional time

available to recover a degraded core. Typically, core uncovery for such sequences begins at about 2.0 hours, and the limit for in-vessel recovery occurs approximately 0.5 hours later. Thus, the additional time window for recovery after UTAF is small in such cases. Thus, recovery of AC power after the inception of core damage but prior to vessel breach is not addressed in this study.

The Level 2 team of analysts is aware of certain industry analysis and experiments that indicate the possibility of preventing vessel breach by flooding the reactor cavity above the bottom of the reactor vessel lower head. As noted in Section 4.1.2.1, particular attention was paid to the lower head area of the reactor vessel during the containment walkdown. While flooding above the bottom head is certainly possible, it was observed that seals are installed around the instrument tubes to inhibit gas flow through the insulation gaps leading to the reactor vessel. These seals would also limit the amount of water that could reach the vessel and, thus, the amount of in-vessel debris cooling. The amount of water that could penetrate the Watts Bar reactor vessel insulation and the effect of "steam binding," should water reach the vessel, are unknown at this time. Because of the observed seals, the lack of plant-specific data, and the large uncertainties associated with this type of damage arrest, no credit for ex-vessel cooling has been taken in the IPE submittal. Since many of the Watts Bar core damage scenarios involve cavity flooding prior to vessel breach, this possible mode of preventing vessel breach will be reassessed as additional information becomes available and current uncertainties are reduced.

- **Top Event 4 — Pressurizer PORVs and Safety Valves Reclose after Cycling Open (LS).** This top event addresses the potential for failure of a pressurizer PORV or SRV in the open position due to frequent cycling during severe accidents in which the RCS pressure "hovers" at the setpoint pressure. It also addresses failure of the PORV to close prior to core damage. For this latter case, as determined in Level 1, the failure path of this top event is assigned a value of 1.0.

  Because the PORVs are not challenged when RCS pressure is less than or equal to 2,000 psia, induced failures of the PORV or SRV can only occur when RCS pressure is at the system setpoint. Once core damage begins, the PORVs and SRVs will experience temperatures higher than those encountered during normal operation; thus, it is likely that the failure-to-close probability at these elevated temperatures will be significantly higher than that at normal conditions. Furthermore, the PORV or SRV is expected to cycle open-closed a number of times during these types of severe accidents. Thus, the likelihood that the PORVs or SRVs will fail to open is relatively high, although the blowdown area associated with such failures is very uncertain. Reference 4.8-3 (APET Question No. 17) assumes that the probability of a PORV or SRV sticking open following core damage is 0.5 for events in which the RCS pressure is at the system setpoint during the in-vessel accident progression. No induced PORV or SRV failures are predicted for RCS pressures less than the system setpoint pressure. An independent assessment of this failure probability is well beyond the scope of this assessment. Therefore, the value reported in Reference 4.8-3 has been adopted for Watts Bar.

- **Top Event 5 — Reactor Coolant Pump Seal Cooling Available (SP).** Given that conditions (no seal injection or thermal barrier cooling) for an RCP seal LOCA exist as determined in Level 1, the failure branch of this top event is assigned a value of 1.0. Conditions for seal failure are characterized by the sequences representing the KPDS. The size of the RCP seal LOCA (including the case in which no seal degradation occurs) is addressed in Top Event 12 (RP), given that the failure path for this top event is taken.

- **Top Event 6 — No Induced Steam Generator Tube Rupture (IS).** The Sequoyah containment performance analysis reported in Reference 4.8-3 indicated that induced steam generator tube rupture was only a concern when the reactor coolant system was at a very high pressure (near the pressurizer relief valve setpoint) and the steam generators are dry. Analysis of this event for Seabrook (Reference 4.8-15) confirm this conclusion. If a sustained flow of feedwater is supplied to the steam generators, the tubes will be maintained well below any failure criteria and will likely maintain RCS pressures well below the PORV setpoints. Fast station blackout (TMLB') sequences are typical of the sequences that fall into the category of concern. For such sequences, a failure fraction of 0.014 (see Sequoyah APET Question 20, Reference 4.8-3) is used in this study. This value represents the mean of the aggregate of the distributions provided by the experts for NUREG/CR-4551. For all other sequences, the failure fraction is assumed to be 0.

- **Top Event 7 — No Induced RCS Hot Leg or Surge Line Failure (IP).** Temperature-induced failures of the RCS are possible only if the RCS pressure is relatively high; e.g., at the pressurizer PORV setpoint. Such failures compete with induced steam generator tube ruptures and vessel breach. The determination of the probability of hot leg or surge line failure requires that a time-dependent thermal creep rupture analysis be performed simultaneously for these components and the steam generator tubes. The predicted time of failure for these components must be compared to the time of reactor vessel failure. The time-dependent local temperature environment for each of these components is extremely uncertain, and the mode of reactor vessel failure is equally uncertain.

  In the discussion for Sequoyah APET Question No. 21 (Reference 4.8-3), it is noted that a temperature-induced break of the hot leg or surge line was judged to be not credible when RCS pressure is below 2,000 psia. Thus, the most likely sequences involving temperature-induced failure of the hot leg or surge line are those associated with the fast SBO events (TMLB'). For such events (high RCS pressure and no steam generator cooling), the Sequoyah APET mean value for RCS pressure at the system setpoint of 0.768 is used for the failure branch of this CET top event.

- **Top Event 8 — No Hydrogen Burn Prior to Vessel Breach (HO).** Each KPDS was analyzed with MAAP for the behavior of hydrogen throughout the sequence representing these KPDSs. Only three KPDSs (LNIYC, ENIYB, and ENIYN) indicated no burn prior to vessel breach (steam inerted and/or insufficient hydrogen produced). A split fraction of 0 was assigned to this top event for these KPDSs. For all other KPDSs, the split fraction was assigned a value of 1.0.

- **Top Event 9 — No Loss of Ice Condenser Function Prior to Vessel Breach (ICE).** Level 1 analysis concluded that loss of ice condenser function prior to core uncovery was extremely unlikely. Therefore, there was no core damage frequency in plant damage states in which the ice condenser is failed.

  Several KPDSs that were examined by MAAP indicated that the ice would be depleted prior to vessel breach. These KPDSs were HCI and LNIYC (provided that an induced failure of the hot leg occurred prior to vessel breach). A split fraction of 1.0 was assigned to this top event (via the ICBYP macro) for these KPDSs. A split fraction of 0 was assigned to all other KPDSs.

- **Top Event 10 — No Containment Failure Prior to Vessel Breach (CI).** Preexisting leaks, both large and small, are considered in the Level 1 model and treated as an unisolated containment. Containment isolation failures can be both large (e.g., purge lines) and small; e.g., seal return lines. For all sequences involving containment isolation failure, the split fraction for Top Event 10 (C1) is assigned a value of 1.0. Such sequences in which the containment is unisolated at the time of core damage (e.g., PDSs ending in S) are ultimately mapped to a release category that accounts for the fact that the containment is "open" prior to vessel breach.

  The other possibilities for failure of the containment prior to vessel breach arise from early hydrogen burns and/or overpressurization by steam (see Figure 4.8-1). Of particular concern is the case in which a large amount of hydrogen is generated in-vessel and then suddenly released from the RCS following an induced failure of the hot leg or surge line shortly before vessel breach. For nearly all sequences analyzed by MAAP, hydrogen burns that occurred prior to vessel breach occurred at low hydrogen concentrations and were no threat to the containment. There were several cases, however, in which induced failures of the hot leg suddenly released large quantities of hydrogen into the lower compartment. Such sequences rapidly increase the hydrogen concentrations in the lower compartment and, should a burn be initiated, it is possible that it would propagate into the ice condenser and transition to a detonation (DDT).

  NUREG-1150 addressed the likelihood of DDT in the ice condenser, given that a deflagration had initiated there. As a function of the hydrogen concentration, the following probabilities were assigned:

  - $H_2 > 21\%$: 0.72
  - $16\% < H_2 < 21\%$: 0.62
  - $14\% < H_2 < 16\%$: 0.45

  For cases with the air return fan and ignitor systems operational, hydrogen concentrations greater than 14% are not expected unless the RCS fails at high pressure. For such cases, the release rate of hydrogen "overwhelms" these systems, and hydrogen concentrations can exceed 40% for a short time. This is most likely to happen in sequences involving a large induced rupture of the hot leg or surge line, so such sequences deserve special consideration.

In NUREG-1150, deflagrations are most likely to be initiated in the ice condenser by having them propagate from the lower compartment. In fact, it appears that a deflagration was always assumed to occur in the ice condenser in NUREG-1150 if conditions in the ice condenser allowed and a deflagration was initiated in the lower compartment. A deflagration was always assumed to occur in the lower compartment if the ignitors were operational and the steam concentration was less than 60%. If no AC power was available and the steam concentration was greater than 25%, burns were assumed not to occur in the lower compartment.

Three induced rupture cases are considered using the NUREG-1150 "rules": (1) an SBO, (2) a case with AC power but failed air return fans, and (3) a case with air return fans working. In an SBO, the lower compartment should always be inerted since steam concentrations will be greater than the 25% criterion. There will thus be no chance of a deflagration propagating into the ice condenser from below. Whether the NUREG-1150 steam concentration criterion is applicable to the period just after induced rupture, when the gas temperatures increase rapidly in the lower compartment (see Figure 4.8-2) can be questioned, but the oxygen fraction is also predicted to be extremely low at that time. Therefore, the only way that DDT seems to be possible in SBOs is if a burn occurs in the upper compartment and either an intermediate deck door is stuck open or the upper compartment burn is of such a magnitude that the doors fail and allow the burn to propagate into the ice condenser from above. Based on MAAP results, this appears unlikely; i.e., hydrogen concentrations in the upper compartment are low (less than 5%) until the spike in the ice condenser hydrogen concentration has been abated by natural circulation in the containment.

Transients with air return fans not working are similar to SBO sequences. The chance of local, small magnitude burns in the upper compartment is larger because of the ignitor availability, but such burns would not be expected to propagate downward into the ice condenser because of the low hydrogen concentration. Burns would still not be expected in the lower compartment due to steam inerting. Figures 4.8-3 and 4.8-4 illustrate the inerting of the lower compartment.

If air return fans are operational, detonable concentrations should not build up in the ice condenser except for sequences, such as transients with an induced rupture, that involve a sudden release of hydrogen. As shown in Figures 4.8-5 through 4.8-7, there is indeed a very short interval just after the break occurs in which the hydrogen concentration is reaching potentially detonable levels in the ice condenser just as the steam and oxygen concentrations in the lower compartment are rendering this volume inert. The duration of the window in which a burn could occur in the lower compartment and detonable concentrations existed in the ice condenser would appear to be very short. Later, the air return fans begin to bring oxygen back into the lower compartment. During this phase, there appears to be a significant interval during which the hydrogen concentration is above 14% in the ice condenser and the lower compartment is deinerted; however, the hydrogen concentrations have also dropped so far in the lower compartment that a burn would not be expected. Thus, again we conclude that the chance of DDT appears to be small.

Finally, even if DDT did occur in the ice condenser, NUREG-1150 concluded that there would be a relatively small chance that it would cause failure of the containment shell. The median impulse from a detonation was estimated to be only half the value required to induce failure.

The probability of DDT in the ice condenser prior to vessel breach and the probability of containment failure, given DDT in the ice condenser, are expected to be very low. Detailed calculations of both phenomena are difficult and require extensive analysis. Based on the knowledge that DDT conditions are extremely unlikely, a conservative treatment of containment failure due to DDT has been adapted for this study. This treatment is depicted graphically in Figure 4.8-8. Hydrogen concentrations are expected to exceed 14% in the ice condenser prior to vessel breach only for induced failures of the hot leg. Given that this event occurs [i.e., the failure branch of Top Event 7 (IPE)], the probability of containment failure due to hydrogen deflagrations/DDT is assigned a value of 0.072.

- **Top Event 11 — No Large Containment Failure Prior to Vessel Breach (L1).** The split fraction for this top event is assigned a value of 1.0 if a large isolation failure or DDT in the ice condenser caused containment failure and a value of 0 for all other failures at Top Event 10 (C1).

  As small leaks in the containment are assumed not to impact significantly the early response of the containment, sequences with small containment failures at Top Event 10 (C1) are propagated through the CET as though no failure existed. Specific release categories were identified for Watts Bar to account for the possible increased source terms due to small leaks prior to vessel breach.

- **Top Event 12 — RCS Pressure at Vessel Breach (RP).** This top event has four branches, each of which coincides with one of the pressure ranges defined for the PDSs. The values for the branching fractions for this top event depend on the RCS pressure at UTAF as well as the success or failure of Top Events 4 (LS), 5 (SP), and 7 (IP) in the containment event tree. Failure of Top Event 7 (IP) is assumed to guarantee that the RCS pressure will be low (less than 200 psia) at the time of vessel breach. In addition, if the RCS pressure is low (e.g., large and medium LOCAs) at the onset of core damage, it is also assumed to be low at vessel breach. Thus, for low pressure at UTAF or failure of Top Event 7 (IP), the various branches for RP are assigned the following values:

Branch	Branching Fraction	Split Fraction
Low (< 200 psia)	1.0	RPW
Intermediate (> 200 psia; < 600 psia)	0.0	RPX
High (> 600 psia; < 2,000 psia)	0.0	RPY
System (> 2,000 psia)	0.0	RPZ

Induced failures of the PORVs/SRVs occur when they are repeatedly challenged when the RCS is at system pressure and high temperature. Reference 4.8-3 (Case 2 of APET Question No. 22) assigns induced PORV failures to low pressure with a conditional probability of 0.8, with the remainder going to intermediate

pressure. However, there is considerable uncertainty regarding the leak area associated with an induced stuck-open PORV. To compensate somewhat for this uncertainty, the branching fractions selected for this case (induced PORV or SRV failure with no other breach in the RCS) are as follows:

Branch	Branching Fraction	Split Fraction
Low (< 200 psia)	0.25	RPS
Intermediate (> 200 psia; < 600 psia)	0.5	RPT
High (> 600 psia; < 2,000 psia)	0.25	RPU
System (> 2,000 psia)	0.0	RPV

For the case in which a PORV sticks open prior to core uncovery and an RCP seal LOCA occurs, the APET values cited below are used to determine the pressure range at vessel breach:

Branch	Branching Fraction	Split Fraction
Low (< 200 psia)	0.632	RPA
Intermediate (> 200 psia; < 600 psia)	0.368	RPB
High (>600 psia; <2,000 psia)	0.0	RPC
System (> 2,000 psia)	0.0	RPD

For sequences in which RCP seal LOCAs [failure of Top Event 5 (SP)] are the only breach in the RCS, the following branching fractions are assumed:

Branch	Branching Fraction	Split Fraction
Low (< 200 psia)	0.005	RPO
Intermediate (> 200 psia; < 600 psia)	0.535	RPP
High (> 600 psia; < 2,000 psia)	0.17	RPQ
System (> 2,000 psia)	0.29	RPR

The above branching fractions for seal LOCAs are based on the seal leak probability distribution reported in Reference 4.8-16. The probability that seals will not degrade is 0.29, and in the absence of no other breach in the RCS, the vessel pressure will be at the system setpoint at the time of vessel breach. Seal leaks with a total leakage of 1,440 gpm are classified as S1-sized events, leading to low RCS pressure at the time of vessel breach. Such leaks have been assigned a probability of 0.005. Seal leaks with a total leakage of 750 gpm are treated as S2-sized leaks, and are assigned to the intermediate RCS pressure at the time of vessel breach. These size leaks are predicted to be the most probable (0.535) of all seal leaks. All other RCP seal leaks are treated as S3-sized leaks, and are assigned to the high RCS pressure range at the time of vessel breach. The combined probability of the S3-sized seal leaks is 0.17.

- **Top Event 13 — High Pressure Melt Ejection Avoided (ME).** This top event differentiates between those events involving pressurized ejection of the debris from the vessel and those involving pour-type melts or gross failure of the bottom head. The basis for quantification of this top event is the opinion of the NUREG-1150 In-Vessel Expert Panel (Sequoyah APET Question No. 65, Reference 4.8-3). The pressurized ejection mode of failure requires that the RCS be at pressures greater than 200 psia (Reference 4.8-3). For the pour failure mode, gravity is the driving force of debris expulsion from the vessel. The bottom head failure mode can occur at any pressure and involves a failure of a substantial portion of the vessel bottom head. As noted in Reference 4.8-3, bottom head failure at high pressure has effects similar to HPME; while at low pressure, it has effects similar to pour-type melts. Whether HPME occurs dictates whether DCH can occur and the extent of hydrogen burning at vessel breach.

- **Top Event 14 — Containment Failure at Vessel Breach (C2).** Containment failure at (or shortly after) vessel breach is based on the fault tree depicted in Figure 4.8-9, and includes in-vessel steam explosions, overpressurization of the containment, and the "rocket" mode of failure.

  An independent investigation of the probability that an in-vessel steam explosion will fail the Watts Bar containment (alpha-mode) is beyond the scope of this IPE submittal. Accordingly, since the Watts Bar plant is nearly identical to the Sequoyah plant, the failure fractions assigned to this mode of failure are taken directly from Reference 4.8-3 (APET Question No. 64). For RCS pressures greater than 200 psia, the failure fraction is assigned a value of 0.0008, and for RCS pressures less than 200 psia, the failure fraction is assigned a value of 0.008. It is assumed that an alpha-mode failure results in a large containment failure.

  The contribution to containment failure due to overpressure at vessel breach has been determined using a probabilistic model based on the containment loads information provided in Reference 4.8-3. The approach used for this submittal is believed to be an upper bound assessment for Watts Bar because of the following:

  - MAAP pressurization results for Watts Bar based on default values are relatively low when compared with the Reference 4.8-3 distributions. Figure 4.8-10 compares the result of a MAAP case analyzed for Watts Bar with distributions used in Reference 4.8-3. Most of this difference is attributable to the assumption in the base-case calculations that only a small fraction of the debris dispersed during HPME is likely fragmented and thus contributes to DCH (see Section 4.7.1.2). Sensitivity calculators performed with complete fragmentation assumed predicted very high pressure rises, as expected.

  - Conservative use was made of the Reference 4.8-3 containment loads information. When the discretization of a parameter resulted in small differences relative to the overall range of results, the parameter was not discretized. Instead, the more conservative results were used.

  - Experiments performed in the Surtsey Test Facility (reported in Reference 4.8-17) indicate that debris "trapping" in containment

subcompartments, particularly the lower compartment, will limit the amount of heat that can be transferred from the debris to the gas in the containment and significantly reduce the peak containment pressure following vessel breach.

Resolution of the uncertainties associated with the loads at vessel breach due to HPME goes well beyond the scope of this submittal.

The model for the assessment of containment failure at vessel breach is quantified with PLG's STADIC4 program (Reference 4.8-18), which determines the probability of containment failure and, given that the containment fails, the conditional probability that the failure is large or small (benign). The probability of containment failure is assessed using the concept of "interference theory," depicted in Figure 4.8-11. In this concept, probability distributions for containment strength and imposed loading are defined and then sampled many times using Monte Carlo techniques to determine the interference between the two distributions. This interference is the probability that the imposed loading exceeds the containment strength. The failure probability distributions for the Watts Bar containments were discussed in Section 4.4. These containment failure distributions are displayed graphically in Figure 4.8-12.

The imposed loading on the containment at the time of vessel breach is composed of the sum of the baseline pressure immediately prior to vessel breach plus the pressure rise in the containment at the time of vessel breach. The distributions for baseline pressures used in this analysis are based on MAAP analyses performed for Watts Bar and are summarized in Table 4.8-3. The STADIC model is depicted in Figure 4.8-13.

The pressure rise at vessel breach is determined using the trees shown in Figures 4.8-14 through 4.8-17. For high pressure melt ejections, the pressure rise represents the combined effects of blowdown, hydrogen burning, direct containment heating, and ex-vessel steam explosion. For RCS pressures at vessel breach that are greater than 200 psia, the NUREG/CR-4551 evaluation of Sequoyah pressure rise at vessel breach is dependent on the hole size, the fraction of the core ejected, whether ice remains in the ice condenser, and whether there is water in the reactor cavity. In addition, for RCS pressures at vessel breach that are less than 1,000 psia, the NUREG/CR-4551 evaluation of Sequoyah pressure rise at vessel breach is dependent on the fraction of hydrogen released before vessel breach that remains unburned in the containment.

The probability distribution for the fraction of the core ejected was taken directly from the generic PWR analysis (Reference 4.8-19). The aggregate distribution of the experts is shown in Figure 4.8-18.

The size of the hole in the reactor vessel (after ablation) is based on information from Sequoyah APET Top Event Question No. 72 (Reference 4.8-3). For HPME, this question was sampled zero-one. It was concluded that the probability of a small hole in the vessel when it fails in the HPME mode was 0.9. This information was input to the Watts Bar STADIC model in the form of a discrete distribution (double-delta function). For pour and gross bottom head failures, reactor vessel

hole size is always taken to be large. However, bottom head failures at high pressure have effects similar to HPME, and such failures at low pressure have effects similar to pour failures. Thus, gross bottom head failures were not treated explicitly but, rather, were combined with one of the other two failure modes, depending on RCS pressure at the time of vessel breach.

A number of different cases were run with the STADIC Monte Carlo model to reflect the RCS pressure at the time of vessel breach and various baseline pressures. For each Monte Carlo sample, the probability distributions for baseline pressure, reactor vessel hole size, fraction of core ejected (the spectrum of results were rebinned to high, medium, and small fractions), pressure rise at vessel breach, containment strength, and containment failure mode (large above ground versus large below ground) were sampled.

Depending on the RCS pressure, cavity flooding condition, ice condenser status, and the sampled results for reactor vessel hole size and core ejection fractions, the appropriate pressure rise based on Figures 4.8-14 through 4.8-17 was determined and added to the sampled baseline pressure to determine the peak pressure in the containment. Peak containment pressure was then compared to the sampled containment strength distributions to determine if the loading exceeded the strength of any containment failure mode. If so, it was also determined whether the containment failure was above ground or below ground. As noted in Section 4.4, three failure modes were considered for the Watts Bar containments, including two modes that produce large containment failures above ground (dome membrane and equipment hatch buckling), and one mode that produces a large containment failure below ground (basemat flexure). Failure of each of these failure modes is tracked separately. No small failure modes were considered because they were found to be extremely unlikely compared to the large failure modes.

Based on Reference 4.8-3, the rocket mode type of failure is assigned a value of 0.0065, which applies only when the RCS pressure is greater than 400 psia at the time of vessel breach. This is based on a probability of rocket mode failure of 0.05 (from Sequoyah APET Question 70, Reference 4.8-3), given a gross bottom head vessel failure, which is assigned a value of 0.13 following Sequoyah APET Question 65 (Reference 4.8-3). Since the Watts Bar plants are nearly identical to Sequoyah, these values are appropriate to use here.

The results of this quantification of Top Events 14 (C2) and 15 (L2) for various cases are summarized in Table 4.8-4. The results shown in Table 4.8-4 include the effects of the alpha-mode and the rocket mode of failure where appropriate.

The FORTRAN listing of the SAMPLE subroutine used in STADIC4 for this assessment is provided in Reference 4.8-20.

- **Top Event 15 — No Large Containment Failure at Vessel Breach (L2).** Given that the containment fails at vessel breach, a determination of the size of the containment failure (i.e., small or benign versus large) must be made. Rocket mode and alpha mode failures of the vessel are assumed to rupture the containment; i.e., cause a large failure. For the overpressurization component of containment failure at vessel breach, the conditional frequency of the three containment failure modes

was assessed with the STADIC4 program. No small modes of overpressurization failure were considered because they were found to be extremely unlikely compared to the large failure modes. The results of this assessment are summarized in Table 4.8-4.

- **Top Event 16 — No Direct Impingement of Debris on Seal Table Wall (DI).** This top event addresses the possibility of containment failure due to direct contact cf dispersed debris with the containment wall. For such a failure to occur, the debris must be forcibly ejected from the cavity via the inclined instrument tunnel and a failed seal table. The seal table is assumed to fail as a result of thermal attack by the debris as well as the loads created by pressurization of the cavity. The geometric details of this pathway and the seal table area are provided in Section 4.1. As noted in Reference 4.8-3, the probability of such failures depends primarily on the RCS pressure at the time of vessel breach and the fraction of the core that is ejected at that time. The NUREG/CR-4551 estimates for the fraction of core ejected are based on the probability distribution shown in Figure 4.8-18. Distributions for the fraction of core ejected at vessel breach that is "diverted to the in-core instrumentation room" were also provided (by Sandia staff). Distributions were developed for various combinations of RCS pressure at vessel breach and the amount of core ejected. The distributions discussed previously were combined to determine the mass of core debris dispersed through the seal table. The probability of containment failure was assessed by comparing the mass dispersed through the seal table with another set of distributions (estimated by SNL staff) giving the probability of containment failure as a function of the mass.

  Direct application of the NUREG/CR-4551 Sequoyah APET information for this containment failure mode is extremely difficult. Given the uncertainties associated with core melt progression and debris dispersal, an independent assessment of this containment failure mode is considered to be well beyond the scope of this IPE submittal. The MAAP program currently has no models to address this concern.

  Conservative estimates of the probability of containment failure due to direct impingement were determined for two general cases: (1) RCS pressure greater than 600 psia at vessel breach, and (2) RCS pressure in the range of 200 to 600 psia at vessel breach. No containment failure is assumed for RCS pressures below 200 psia, as HPME is not expected to occur at such pressures. The estimated failure probabilities are based on the mean fraction of core released at vessel breach that is diverted to the seal table room (APET Question No. 68), the fraction of the core ejected at vessel breach (Figure 4.8-18), and the conditional frequencies of containment failure given as a function of debris mass diverted to the seal table room (APET Question No. 78). These data were combined using the STADIC program to calculate the conditional frequency of containment failure due to direct impingement. The corresponding split fractions are: (1) 0.332 for RCS pressures greater than 600 psia at vessel breach, and (2) 0.243 for RCS pressures between 200 and 600 psia at vessel breach.

- **Top Event 17 — Heat Removal Available Immediately after Vessel Breach (X2).** This top event was included in the Watts Bar containment event tree to address the survivability of the containment heat removal function following vessel breach. No equipment qualification data are available, however, for exposure to substantial

aerosol loads and hydrogen burns. Survivability of the containment heat removal function following an early hydrogen burn is addressed in Top Event 22 (XE).

Containment heat removal after vessel breach is a consideration only if a large containment failure has not occurred and is provided by containment sprays and/or vessel injection in a recirculation mode.

As noted in APET Question No. 85, the mechanisms for failing these containment heat removal mechanisms include "clogging of the sumps by debris, direct damage to the piping by hydrogen burns, or dislocation of the piping." It was concluded that the threat due to such mechanisms was relatively low. The APET split fraction value of 0.05 has been adapted for this study whenever a hydrogen burn or HPME has occurred.

- **Top Event 18 — Debris Cooled (DBC).** The ability to cool the debris ex-vessel and to prevent concrete ablation is strongly dependent on the depth of the debris and on whether a sustained supply of water can be provided to the debris. The floor area of the reactor cavity is approximately 649 square feet. If all of the core zircaloy and UO_2 is released into and contained within the reactor cavity, the debris depth would be approximately 30 cm. This estimate assumes no debris porosity and no contribution to debris mass from the core support plate.

  Whether the debris is cooled, ex-vessel is predicated on whether the debris is dispersed from the cavity or a sustained supply of water quenches the debris, if it remains in the cavity. It is assumed that debris is cooled if it is dispersed from the cavity (i.e., HPME or EVSE). If it remains in the cavity and the cavity is totally flooded, it is also assumed coolable for the following reasons:

  — In Sequoyah, all likely accident sequences in which water is available in the cavity long-term will have a wet cavity at the time of vessel failure. The presence of water as the debris enters will enhance debris fragmentation and coolability.

  — Considerably less than the total core mass is expected to be molten at the time of vessel failure. Thus, we expect the initial debris depth to be well below than the 25 cm criterion suggested for debris coolability in Reference 4.8-21 and thus the initial debris pour is expected to be coolable.

  — Core material melting later and drainining into the cavity would do so at a slow rate, and can be expected to quench as it enters the reactor cavity.

- **Top Event 19 — No Early Hydrogen Burn (HE).** Any containment failure caused by a hydrogen burn within 4 hours of vessel breach is assumed to be an early containment failure. A 4-hour window for early containment failure was selected for this analysis to reflect a sufficient time to allow natural processes to deplete the airborne source term in the containment and thus minimize any early release and to initiate appropriate emergency actions. Therefore, Top Event 19 (HE) asks whether such burns occur in this time frame.

Whether a hydrogen burn occurs during this time frame is based entirely on MAAP results for the KPDS being assessed. A value of 1.0 is assigned to the split fraction if a burn occurred, and 0.0 if no burn occurred. In nearly all of the cases, the burn(s) occurred at relatively low hydrogen concentrations, and the pressure rise in the containment was relatively small. In some cases, the burn(s) occurred in the reactor cavity.

One situation of particular interest is when a large amount of hydrogen is released at vessel breach and there is no high pressure melt ejection; i.e., a pour-type melt (ME=S). This situation usually arises when there is no or little leakage from the RCS. For such cases, a treatment for DDT similar to that for induced failures of the hot leg has been adopted.

- **Top Event 20 — No Containment Failure due to Early Burn (CE).** Given that a hydrogen burn has occurred [i.e., the failure branch of Top Event 19 (HE)], this top event asks whether the containment fails as a result of this burn.

  As noted in the discussion for the previous top event, except for the possibility of DDT in the ice condenser, hydrogen burns that occur in the early period after vessel breach result in relatively low containment pressures. For the DDT case, however, Figure 4.8-1 is used to estimate the probability of containment failure.

- **Top Event 21 — No Large Containment Failure from Early Burn (LE).** All containment failures due to DDT are assumed to be large.

- **Top Event 22 — Containment Heat Removal Available after Early Burn (XE).** In the absence of applicable equipment qualification data for hydrogen burns, it assumed that if an early burn occurred, the conditional probability of losing the CHR function is as described in Top Event 17 (X2).

- **Top Event 23 — No Containment Failure due to Late Burn (CL).** If the debris remains in the reactor cavity and is not cooled, large amounts of hydrogen and carbon monoxide can be generated. Carbon monoxide would be produced during the decomposition of reactor cavity concrete. Hydrogen could be produced by oxidation of the following materials in the debris bed:

  — Metallic zircaloy from the core.
  — Steel from the reactor vessel and its internals.
  — Steel reinforcing bars in the cavity and lower compartment basemat.

  Thus, in addition to the hydrogen produced in-vessel and that was not burned prior to, at, or within 4 hours of vessel breach, substantial quantities of hydrogen can be produced ex-vessel from the above sources.

  If electrical power and ignitors are continuously available prior to and during this time period, many small burns would occur, none of which would challenge the containment. If electrical power is not available, the containment would be steam inerted, and no burns are likely unless electrical power and sprays were recovered. If ignitors and air return fans have operated continuously since the start of the accident, then ignition is expected whenever a flammable concentration is reached.

Burns that occur at the lower limit of flammability do not pose a threat to the Watts Bar containments. The only burns that appear capable of challenging the Watts Bar containment are those that occur when the power is recovered after the onset of CCI. As noted earlier in this section, the current study does not address recovery of electrical power after the onset of severe core damage. Recovery of electrical power and containment sprays would condense the steam that had previously deinerted the containment atmosphere. If, during the deinerting process, the steam condenses rapidly and ignition is delayed, hydrogen burns at high concentrations could possibly occur. The operation of the air return fans would tend to mix the containment atmosphere.

For high pressure melt ejections, the debris ejected at vessel breach will be dispersed to the lower compartment of the containment where it is easily cooled, thereby precluding concrete attack and the production of significant quantities of hydrogen and carbon monoxide. In this case only, the hydrogen remaining from in-vessel generation and oxidation shortly after vessel breach will be available for late burns.

If the debris remains within the reactor cavity and is not cooled, large amounts of hydrogen and carbon monoxide can be generated. Because of the high gas temperatures in the reactor cavity, most of this hydrogen is expected to "recombine" in the cavity or burn as it egresses the cavity. Sustained recombination requires a continuous supply of oxygen to the cavity. Combustion of the hydrogen as it egresses the cavity requires that the atmosphere in the "receiver" compartment be non-inerted.

There is sufficient oxygen (approximately 1,690 lbm-moles) initially in the Watts Bar containment to burn approximately 7,000 lbm of hydrogen.

The only late burns capable of challenging the Watts Bar containment appear to be those in which large quantities of hydrogen were released into the containment, and this hydrogen was not burned at vessel breach or within 4 hours of vessel breach. If containment heat removal is not available, the containment can remain inerted for long periods of time. Eventually, however, sufficient steam condensation might occur to de-inert the atmosphere. When electrical power is not available, ignition is considered to be a stochastic phenomena (see Reference 4.8-3).

MAAP results indicate that for most of the KPDSs, there are no late burns capable of failing the containment. From these KPDs, the split fraction for this top event is assigned a value of 0. Three KPDSs (ENIYB, ENIYN, and GNIYN) involve ignitor unavailability and there exists the possibility of delayed ignitors upon recovery of AC power. For these three KPDSs, it was conservatively assumed that the recovery of AC power causes a delayed ignition and the accompanying burn fails the containment.

- **Top Event 24 — No Large, Late Containment Failure due to Late Burn (LL).** Late failures caused by late burns are assumed to cause large containment failures.

- **Top Event 25 — Long-Term Containment Heat Removal (XLT).** It is assumed that a late burn of combustible gases will fail the CHR function in the same manner as Top Events 17 (X2) and 22 (XE).

- **Top Event 26 — No Long-Term Overpressurization Containment Failure (CLT).** If no other containment failures have occurred and the debris is being cooled, the containment may ultimately fail due to a buildup of noncondensible gases generated during core-concrete interaction (CCI), unless there is some means for containment heat removal. (If containment heat removal is available, it is assumed that basemat melt-through occurs before long-term overpressurization. Basemat melt-through is treated in Top Event 28.) If the containment failed previously, it is assumed that even a small failure will be large enough to preclude any pressure increase that might otherwise result from the buildup of noncondensible gases. This top event considers whether the containment fails within 48 hours of the start of the accident. It is likely that within this time frame measures can be taken to mitigate or recover from the accident.

  The strength of the Watts Bar containment was discussed in Section 4.4 in terms of failure probability distributions for various failure modes. These distributions differ with different temperature conditions. For a defined set of temperature conditions, when pressure increases slowly, the methodology of Reference 4.8-22 can be used to calculate the probability that the containment fails at a certain pressure and in a certain failure mode, given that it did not fail at a lower pressure. Figures 4.8-19 through 4.8-22 show the cumulative failure probability distributions for the most important containment failure modes at room temperature, 300°F, 400°F, and 500°F, respectively, Three failure modes were considered, including two that produce large above ground failures (dome membrane, equipment hatch buckling), and a large subsoil failure mode (basemat flexure). The total cumulative failure probability is also shown at each temperature. Figure 4.8-23 shows that, at a given pressure, the total cumulative failure probability for the Watts Bar containment tends to increase with temperature.

  The split fraction for long-term overpressurization is determined for each representative KPDS by comparing MAAP results (pressure and temperature versus time) with the probability distributions (strength versus temperature) for the various containment failure modes. For example, containment pressure versus time (from MAAP) is shown in Figure 4.8-24) for KPDS GNIYA. Projecting beyond the assumed failure pressure of 135 psia, at 39.5 hours the pressure would reach 149.2 psia (134.5 psig), which is the pressure at which the cumulative probability of the failure would reach 0.999 if the containment temperature was 400°F throughout the transient (see Figure 4.8-21). Using this data is conservative, since MAAP predicts that containment temperatures remain below 400°F throughout the transient. Thus, the cumulative probability that the containment fails within 48 hours is 1.0 for KPDS GNIYA. Recovery within this time frame is likely. The cumulative probability that the containment fails at 24 hours is 0.0022 (from Figure 4.8-21), since at that time the containment pressure is 64 psia (49.3 psig) (from Figure 4.8-24). Table 4.8-5 shows the split fractions for containment failure due to long-term overpressurization for the KPDSs.

- **Top Event 27 — No Large, Long Term Containment Failure (LLT).** None of the three containment failure modes considered in Top Event 26 is small containment failure (leak). Thus, for Watts Bar, the conditional probability is 1.0 that a long-term containment failure is large. Table 4.8-5 shows the split fraction for a large containment failure due to long-term overpressurization for each KPDS that is subject to such long-term containment failure.

- **Top Event 28 — No Basemat Penetration (BI).** Basemat melt-through is defined as penetration of the basemat. There is somewhat of a race between the basemat melt-through and late overpressure containment failure modes. If the debris is cooled, no melt-through of the basemat occurs. Basemat melt-through is likely in the long term, if the debris is not cooled.

  In this analysis, basemat melt-through is assumed to be prevented if Top Event 18 (DBC) is successful. Conversely, if Top Event 18 (DBC) is failed, basemat melt-through is assumed to be inevitable.

- **Top Event 29 — Sprays Operate after Large, Early Containment Failure (SO).** This top event was included in the Watts Bar containment event tree to highlight the impact that continued spray operation might have on source terms following a large, early containment failure. However, except for large containment failures solely due to failure to isolate the containment, it is conservatively assumed that all large, early containment failures fail the sprays.

4.8.3 CET SPLIT FRACTION ASSIGNMENT LOGIC

The assignment of CET top event split fractions to the appropriate CET branch is accomplished with logic rules based on previous top event (both Level 1 and Level 2) successes, bypasses, and failures. The actual process is performed automatically within the RISKMAN Event Tree Analysis module by the Split Fraction Assignment Rules file. Tables 4.8-1 and 4.8-2 summarize these rules.

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TABLE 4.8-1 DESCRIPTION OF MACROS USED IN WATTS BAR CONTAINMENT EVENT TREE

MACRO-ID	BASIS	CET LOGIC	DESCRIPTION
RCSPSYS	LEVEL 1	-	KPDSs WITH RCS PRESSURE AT SYSTEM SETPOINT (>2000PSI) AT UTAF (INCLUDES LCI, LNIYA, LNIYC, KNSYA, KNSYC, KNI)
RCSPHIGH	LEVEL 1	-	KPDSs WITH 600PSI < RCS PRESSURE AT UTAF < 2000PSI (INCLUDES ENIYA, ENIYB, ENIYN, FNI, HNI, EIB, FCI, FGI, ENB, HGI, EGI, ENSYA, ENSYB, ENSYC, ENSYN, GNIYA, GNIYN)
RCSPINT	LEVEL 1	-	KPDSs WITH 200PSI < RCS PRESSURE AT UTAF < 600PSI (NO KPDSs WERE IDENTIFIED)
RCSPLOW	LEVEL 1	-	KPDSs WITH RCS PRESSURE AT UTAF < 200PSI (INCLUDES BCI, HCI)
SPRAYS	LEVEL 1	-	KPDSs WITH CONTAINMENT SPRAY INJECTION AND RECIRCULATION AVAILABLE (INCLUDES FCI, LCI, BCI, HCI)
PSPRAY	LEVEL 1	-	KPDSs WITH CONTAINMENT SPRAY INJECTION AVAILABLE BUT NOT SPRAY RECIRCULATION (INCLUDES FGI, EGI, FNI, HNI, HGI, KNI, ENIYA, ENIYN, ENIYB)
NOSPRAY	LEVEL 1/CET	DI = F + SPECIFIED KPDSs	KPDSs WITH NO CONTAINMENT SPRAYS AVAILABLE (INCLUDES KNSYA, KNSYC, ENB, ENSYA, ENSYB, ENSYC, ENSYN, GNIYA,GNIYN, LNIYA, LNIYC)
CHR	LEVEL 1	-	KPDSs WITH CONTAINMENT HEAT REMOVAL AVAILABLE (INCLUDES FCI, LCI, BCI, HCI)
ISOFAILS	LEVEL 1	-	KPDSs WITH CONTAINMENT NOT ISOLATED AT UTAF. SMALL LINE FAILED (INCLUDES KNSYA, KNSYC)
ISOFAILL	LEVEL 1	-	KPDSs WITH CONTAINMENT NOT ISOLATED AT UTAF. LARGE LINE FAILED (NO KPDSs WERE IDENTIFIED)
SBYP	LEVEL 1	-	KPDSs WITH CONTAINMENT BYPASSED DURING CORE DAMAGE. BYPASS IS SMALL. (INCLUDES EIB, ENB, ENSYA, ENSYB, ENSYC, ENSYN)
LBYP	LEVEL 1	-	KPDSs WITH CONTAINMENT BYPASSED DURING CORE DAMAGE. BYPASS IS LARGE. (INCLUDES ATV)
CONISOL	LEVEL 1	-(ISOFAILS + ISOFAILL + SBYP + LBYP)	KPDSs WITH CONTAINMENT ISOLATED AND NOT BYPASSED AT UTAF
SEALOC	LEVEL 1	-	KPDSs WITH NO RCP SEAL INJECTION OR THERMAL BARRIER COOLING-CONDITIONS FOR SEAL LOCA EXIST. (INCLUDES FNI, HNI, FGI, ENIYA, ENIYB, ENIYN, GNIYA, GNIYN, ENSYA, ENSYB, ENSYC, ENSYN)
PORVFL	LEVEL 1	-	KPDSs WITH STUCK OPEN PORV OR SRV (INCLUDES HNI, HGI)

TABLE 4.8-1 DESCRIPTION OF MACROS USED IN WATTS BAR CONTAINMENT EVENT TREE

MACRO-ID	BASIS	CET LOGIC	DESCRIPTION
COOLDOWN	LEVEL 1	-	KPDSs WITH SUSTAINED AUXILIARY FEEDWATER/COOLDOWN (INCLUDES ENIYA, ENIYB, ENIYN, FNI, FCI, FGI, EGI, ENSYA, ENSYB, ENSYC, ENSYN)
CAVFLD	LEVEL 1	-	KPDSs WITH REACTOR CAVITY FLOODING PRIOR TO VESSEL BREACH (INCLUDES FNI, FGI, HNI, HGI, HCI, ENIYA, ENIYB, ENIYN)
QUENCH	LEVEL 1	-	KPDSs WITH CORE DEBRIS QUENCH IN REACTOR CAVITY (INCLUDES FNI, FGI, HNI, HGI, HCI, FCI, ENIYA, ENIYB, ENIYN, LNIYC, LCI)
ICBYP	LEVEL 1/CET	(IP=F * INIT =LNIYC) + OTHER KPDSs	KPDSs WITH ICE CONDENSERS FAILED, MELTED, OR BYPASSED EARLY. (INCLUDES LNIYC (when no induced hot leg or surge line rupture), HGI, HCI, FCI)
ARFFAIL	LEVEL 1	-	KPDSs WITH AIR RETURN FANS FAILED EARLY (INCLUDES ENIYN, ENSYC, ENSYN, GNIYN, KNSYC, LNIYC)
NOIGN	LEVEL 1	-	KPDSs WITH HYDROGEN IGNITORS NOT AVAILABLE (INCLUDES ENIYB, ENIYN, GNIYN, ENSYB, ENSYN)
EVSE	LEVEL1/CET	CAVFLD* (ME=S+RP=LOW)	EX-VESSEL STEAM EXPLOSION OCCURS
DDT1	CET	IP=F	DEFLAGRATION-DETONATION TRANSITION OCCURS PRIOR TO VESSEL BREACH
DDT2	CET	RP=SYS*ME=S	DEFLAGRATION-DETONATION TRANSITION OCCURS AT OR SHORTLY AFTER VESSEL BREACH
EARLY	CET	C1=F + C2=F + CE=F + DI=F	CONTAINMENT FAILED EARLY
ELARGE	CET	L1=F + L2=F + LE=F + DI=F	EARLY CONTAINMENT FAILURE IS LARGE
LATE	CET	(C1=S+C1=B) * (C2=S+C2=B) * (CE=S+CE=B) * (CL=F+(CL=S+ CL=B) * CLT=F)	CONTAINMENT DOES NOT FAIL EARLY BUT FAILS LATE
LLARGE	CET	LL=F + LLT=F	LATE CONTAINMENT FAILURE IS LARGE

TABLE 4.8-1 DESCRIPTION OF MACROS USED IN WATTS BAR CONTAINMENT EVENT TREE

MACRO-ID	BASIS	CET LOGIC	DESCRIPTION
SMALL	CET	(C1 = F*L1 = S) + (C2 = F*L2 = S) + (CE = F*LE = S) + (CL = F*LL = S) + (CLT = F*LLT = S)	CONTAINMENT SHELL FAILURE IS SMALL
NOSHELL	CET	(C1 = S + C1 = B) * (C2 = S + C2 = B) * (CE = S + CE = B) * (CL = S + CL = B) * (CLT = S + CLT = B) * (DI = S + DI = B)	NO FAILURE OF THE CONTAINMENT EXCEPT FOR BASEMAT MELT-THROUGH
NOFAIL	CET	NOSHELL * (BI = S + BI = B)	NO FAILURE OF THE CONTAINMENT
BMMT	CET	NOSHELL *BI = F	BASEMAT PENETRATION ONLY

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
1. Containment Not Bypassed Prior to Core Damage [BY]	BYV	1.00	LBYP	MACRO for KPDSs with large bypass prior to core damage
	BYC	1.00	INIT =ENS	KPDS with containment isolation failure leading to seal return line bypass
	BYB	1.00	SBYP	MACRO for KPDSs with small bypass prior to core damage
	BYA	0.00	-(SBYP +LBYP)	No bypass defined in Level 1
	BY1	1.00	1.0	Default value
2. No Large Bypass Prior to Core Damage [LB]	LBV	1.00	LBYP	MACRO includes only large bypasses prior to core damage
	LBC	0.00	INIT =ENS	Containment isolation failure leads to small seal return line bypass
	LBB	0.00	SBYP	MACRO includes only small bypasses prior to core damage
	LB1	1.00	1.0	Default value
3. Core Damage Arrested Prior to Vessel Breach [CV]	CVY	0.00	INIT= LNIYA	Sequences in KPDS LNIYA (bleed and feed successful with one PORV) are not predicted to go to core damage
	CVL	0.23	INIT= LCI	Sequences in KPDS LCI that have bleed and feed with one PORV were shown by MAAP analysis to not go to core damage
	CVB	0.68	INIT= FCI	Sequences in KPDS FCI that have small LOCA with SG cooldown and LP recirculation were shown by MAAP analysis to not go to core damage
	CVA	0.77	INIT= BCI	Sequences in KPDS BCI that have medium LOCA with SG depressurization and LP recirculation were shown by MAAP analysis to not go to core damage

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	CVC	1.00	-(INIT = BCI + INIT = FCI + INIT = LCI + INIT = LNIYA)	Most accident sequences reflect a relatively short period of time between UTAF and vessel breach. Potential for recovery after UTAF is not addressed in this study except as noted above.
	CV1	1.00	1	Default value
4. No induced PORV or Safety Relief Valve Failure [LS]	LSO	1.00	PORVFL	MACRO indicating stuck open PORV or SRV prior to core damage
	LSS	0.50	RCSPSYS * (-COOLDOWN)	MACROs indicating RCS pressure at system setpoint at UTAF with no sustained AFW/Cooldown. Split fraction value based on Sequoyah APET Question No. 17, NUREG/CR-4551
	LSL	0.00	-RCSPSYS	MACRO is not true (i.e., no induced PORV or SRV failure occurs during core degradation at RCS pressure less than 2000 psia.)
	LS1	1.00	1	Default value
5. Reactor Coolant Pump Seal Cooling Available[SP]	SPB	1.00	SEALOC	MACRO indicating that conditions for RCP seal LOCA exist (i.e., no seal injection and no thermal barrier cooling).
	SPA	0.00	-SEALOC	Seal cooling available
	SP1	1.00	1	Default value
6. No Induced Steam Generator Tube Rupture [IS]	ISS	0.018	RCSPSYS * LS=S * (-COOLDOWN)	RCS Pressure > 2000 psia at UTAF, and No induced PORV or SRV failure and no sustained AFW/cooldown. Split Fraction taken from NUREG/CR-4551 (Sequoyah APET Question No. 20)
	ISL	0.00	-(RCSPSYS) + (RCSPSYS * LS=F)	Induced SGTR possible only if RCS pressure is at or near PORV setpoint during core degradation.

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	IS1	1.00	1	Default value
7. No Induced RCS Hot Leg or Surge Line Rupture [IP]	IPS	0.768	RCSPSYS * LS=S * IS=S * (-COOLDOWN)	RCS Pressure > 2000 psia at UTAF, and no induced PORV or SRV failure, and no induced steam generator tube rupture, and no sustained AFW/cooldown.Split Fraction taken from NUREG/CR-4551 (Sequoyah APET Question No. 21)
	IPL	0.00	-(RCSPSYS) + RCSPSYS * (LS=F + IS=F)	Induced Hot Leg or surge line failure possible only if RCS pressure remains at or near PORV setpoint during core degradation
	IP1	1.00	1	Default value
8. No Hydrogen Burn Prior to Vessel Breach [H0]	H0B	1.00	IP= F * INIT=LNIYC + INIT=HNI + INIT=EGI + INIT=ENIYA + INIT=GNIYA + INIT=GNIYN + INIT=FNI + INIT=FGI + INIT=HGI + INIT=BCI + INIT=HCI + INIT=FCI + INIT=LCI + INIT=LNIYA	KPDSs with hydrogen burn prior to vessel breach

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	H0N	0.00	-IP=F * INIT=LNIYC + INIT=ENIYB + INIT=ENIYN + INIT=KNSYA + INIT=KNSYC + INIT=KNI	KPDSs with no hydrogen burn prior to vessel breach
	H01	1.00	1	Default value
9. No Loss of Ice Condenser Function Prior to Vessel Breach [ICE]	ICEH	0.79	INIT = HNI	MAAP analysis shows that sequences in KPDS HNI that have seal LOCA but small leakage rates do not lose ice condenser function prior to vessel breach
	ICEB	1.00	ICBYP	MACRO for KPDSs with early loss of ice condenser function.
	ICEA	0.00	-(ICBYP + INIT =HNI)	Ice condenser remains functional prior to vessel breach.
	ICE1	1.00	1.0	Default value
10. No Containment Failure Prior to Vessel Breach [C1]	C1L	1.00	ISOFAILL * -DDT1	Large containment isolation failure
	C1S	1.00	ISOFAILS * -DDT1	Small containment isolation failure
	C1T	0.072	DDT1	Conditional probability of containment failure given DDT prior to vessel breach

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	C1D	0.00	INIT=ENIYA + INIT=GNIYA + INIT=GNIYN + INIT=HNI + INIT=EGI + INIT=FNI + INIT=HCI + INIT=FCI + INIT=LCI + INIT=BCI + INIT=HGI + INIT=FGI + INIT=LNIYC	KPDSs with hydrogen burn but no containment failure prior to vessel breach
	C1A	0.00	CONISOL * CV=S	No containment failure because no vessel breach
	C1B	0.00	CONISOL * H0=S	No containment failure because no hydrogen burn
	C1N	0.00	-ARFFAIL * -NOIGN	Air return fans and hydrogen ignitors available
	C11	1.00	1.0	Default value
11. No Large Containment Failure Prior to Vessel Breach [L1]	L1L	1.00	ISOFAILL * -DDT1	Guaranteed large failure if ISOFAILL is TRUE when no DDT
	L1S	0.00	ISOFAILS * -DDT1	If ISOFAILS is true when no DDT, only small isolation failures possible. (No other failures prior to vessel breach except isolation failures.)
	L1T	1.00	DDT1	Large containment failure assumed for DDT prior to vessel breach.
	L11	1.00	1.0	Default value

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
12. RCS Pressure at Vessel Breach [RP]	RPZ	0.00	(RCSPLOW + IP=F + COOLDOWN) * RP=SYS	If RCS pressure low at inception of core damage (indicating a large or medium LOCA) or there is a thermally induced failure of the hot leg or surge line or there is sustained AFW/cooldown, RCS pressure will be low at vessel breach.
①	RPY	0.00	(RCSPLOW + IP=F + COOLDOWN) * RP=HIGH	Same as RPZ
	RPX	0.00	(RCSPLOW + IP=F + COOLDOWN) * RP=INTER	Same as RPZ
	RPW	1.00	(RCSPLOW + IP=F + COOLDOWN) * RP=LOW	Same as RPZ
	RPD	0.00	PORVFL * SP=F * RP=SYS	Stuck open PORV prior to UTAF and simultaneous RCP seal LOCA
	RPC	0.00	PORVFL * SP=F * RP=HIGH	Same as RPD
	RPB	0.368	PORVFL * SP=F * RP=INTER	Same as RPD (1.0 - .79 * .8)
	RPA	0.632	PORVFL * SP=F * RP=LOW	Same as RPD (.79 *.8)
	RPV	0.00	LS=F * SP=S * RP=SYS	Fraction of challenges assigned to "SYS" branch given a stuck open PORV and no other breaches in the RCS. Based on NUREG/CR-4551 (Seqoyah APET Question No. 25, Case 2)
	RPU	0.25	LS=F * SP=S * RP=HIGH	Same as RPV for "HIGH" branch

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	RPT	0.50	LS=F * SP=S * RP=INTER	Same as RPV for "INTER" branch
	RPS	0.25	LS=F * SP=S * RP=LOW	Same as RPV for "LOW" branch
	RPR	0.29	SP=F * RP=SYS	RCP seal LOCA. Split Fraction is probability that no seal degradation occurs.
	RPQ	0.17	SP=F * RP=HIGH	RCP seal LOCA. Split Fraction represents S3 sized leaks.
	RPP	0.535	SP=F * RP=INTER	RCP seal LOCA. Split Fraction represents S2 sized leaks.
	RPO	0.005	SP=F * RP=LOW	RCP seal LOCA. Split Fraction represents S1 sized leaks.
	RP17	1.00	RCSPSYS * RP=SYS	If RCS pressure is at the system setpoint at UTAF and there are no breaks in the RCS, the RCS will be at the system setpoint pressure at vessel breach.
	RP16	0.00	RCSPSYS * RP=HIGH	Same as RP17
	RP15	0.00	RCSPSYS * RP=INTER	Same as RP17
	RP14	0.00	RCSPSYS * RP=LOW	Same as RP17
	RP13	0.00	RCSPHIGH * RP=SYS	If RCS Pressure is in the 600-2000 psi range at UTAF and the RCS boundary is intact, it will remain in this range until vessel breach.
	RP12	1.00	RCSPHIGH * RP=HIGH	Same as RP13
	RP11	0.00	RCSPHIGH * RP=INTER	Same as RP13
	RP10	0.00	RCSPHIGH * RP=LOW	Same as RP13
	RP9	0.00	RCSPINT *RP=SYS	If RCS Pressure is in the 200-600 psi range at UTAF and the RCS boundary is intact, it will remain in this range until vessel breach.
	RP8	0.00	RCSPINT *RP=HIGH	Same as RP9

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	RP7	1.00	RCSPINT *RP=INTER	Same as RP9
	RP6	0.00	RCSPINT *RP=LOW	Same as RP9
	RP5	0.00	RCSPLOW * RP=SYS	If RCS Pressure is below 200 psi at UTAF and the RCS boundary is intact, it will remain in this range until vessel breach.
	RP4	0.00	RCSPLOW * RP=HIGH	Same as RP5
	RP3	0.00	RCSPLOW * RP=INTER	Same as RP5
	RP2	1.00	RCSPLOW * RP=LOW	Same as RP5
	RP1	1.00	1.0	Default value
① This is a "multi-state" branch. RP =SYS branch implies that RCS Pressure is at the PORV setpoint at vessel breach RP =HIGH branch implies that RCS Pressure is in the range 600-2000 psi at vessel breach RP =INTER branch implies that RCS Pressure is in the range 200-600 psi at vessel breach RP =LOW branch implies that RCS Pressure is less than 200 psi at vessel breach A failure fraction equal to 1.0 for any branch indicates that all of the frequency entering node RP is assigned to that particular branch.				
13. No High Pressure Melt Ejection [ME]	MES	0.93	RP=SYS	NUREG/CR-4551 (Sequoyah APET Question No. 35)
	MEH	0.73	RP=HIGH + RP=INTER	Same as MES
	MEL	0.00	RP=LOW	Same as MES
	ME1	1.00	1.0	Default value
14. No Containment Failure at Vessel Breach [C2]	C2S	0.072	ME=F * ICE=S * RP=SYS	STADIC Stress-strength interference model. RCS pressure at system setpoint, ice condensers functional, HPME at vessel breach.

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	C2R	0.336	ME=F * ICE=F * RP=SYS	STADIC model. RCS pressure at system setpoint, ice condensers not functional, HPME at vessel breach.
	C2P	0.058	ME=F * ICE=S * RP=HIGH	Same as C2S except RCS Pressure in the range 600-2000 psi at vessel breach.
	C2O	0.30	ME=F * ICE=F * RP=HIGH	Same as C2R except RCS Pressure in the range 600-2000 psi at vessel breach.
	C2M	1.60E-03	ME=F * ICE=S * H0=F * RP=INTER	Same as C2S except RCS Pressure in the range 200-600 psi at vessel breach.
	C2L	0.05	ME=F * ICE=F * H0=F * RP=INTER	Same as C2M except ice condensers not functional.
	C2J	0.082	ME=F * ICE=S * H0=S * RP=INTER	Same as C2M except no hydrogen burn.
	C2I	0.213	ME=F * ICE=F * H0=S * RP=INTER	Same as C2L except no hydrogen burn.
	C2A	0.008	RP=LOW * (-IP=F)	Alpha mode for low RCS pressure at vessel breach.
	C2EV	0.01	EVSE	Ex-vessel steam explosion, no HPME.
	C2NF	0.00	ME=S * (RP=INTER +RP=HIGH + RP=SYS) + RP=LOW	No failure for pour-type melt with no ex-vessel steam explosion. (Effect of hydrogen burns considered in Top Events HE, CE, LE.)

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	C21	1.00	1.0	Default value
15. No Large Containment Failure at Vessel Breach [L2]	L2S	1.00	ME=F * ICE=S * RP=SYS	STADIC Stress-strength interference model. RCS pressure at system setpoint, ice condensers functional, HPME at vessel breach.
	L2R	1.00	ME=F * ICE=F * RP=SYS	STADIC model. RCS pressure at system setpoint, ice condensers not functional, HPME at vessel breach.
	L2P	1.00	ME=F * ICE=S * RP=HIGH	Same as L2S except RCS Pressure in the range 600-2000 psi at vessel breach.
	L2O	1.00	ME=F * ICE=F * RP=HIGH	Same as L2R except RCS Pressure in the range 600-2000 psi at vessel breach.
	L2M	1.00	ME=F * ICE=S *H0=F * RP=INTER	Same as L2S except had hydrogen burn in containment prior to vessel breach, and RCS Pressure in the range 200-600 psi at vessel breach.
	L2L	1.00	ME=F * ICE=F *H0=F * RP=INTER	Same as L2M except ice condensers not functional.
	L2J	1.00	ME=F * ICE=S *H0=S * RP=INTER	Same as L2M except no hydrogen burn.
	L2I	1.00	ME=F * ICE=F *H0=S * RP=INTER	Same as L2L except no hydrogen burn.
	L2A	1.00	RP=LOW * (-IP=F)	Alpha mode for low RCS pressure at vessel breach is large.
	L2EV	1.00	EVSE	Ex-vessel steam explosion causes large containment failure.
	L21	1.00	1.0	Default value
16. No Direct Impingement on Seal Table Wall [DI]	DIH	0.332	ME=F * (RP=HIGH + RP=SYS)	HPME with RCS pressure > 600 psi at vessel breach

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	DII	0.243	ME=F * (RP=INTER)	HPME with RCS pressure in the range 200-600 psi at vessel breach
	DIL	0.00	ME=S + RP=LOW	No HPME
	DI1	1.00	1.0	Default value
17. Containment Heat Removal Available After Vessel Breach [X2]	X2C	1.00	INIT=HGI + INIT=EGI	KPDSs where CHR fails when containment spray recirculation fails
	X2F	1.00	-CHR	If CHR unavailable prior to core damage, assumed to remain unavailable.
	X2S	0.05	HO=F + ME=F	CHR may fail due to a hydrogen burn prior to vessel breach or due to HPME.
	X2I	0.00	CHR	If CHR unavailable prior to vessel breach, assumed to survive after vessel breach.
	X21	1.00	1.0	Default value
18. Debris Cooled [DBC]	DBCC	0.00	ME=F + (ME=S +RP=LOW) * QUENCH + EVSE	Debris is dispersed by HPME or by quenching or by an ex-vessel steam explosion.
	DBCN	1.00	RP=LOW + ME=S	Debris assumed to be trapped inside cavity for pour-type melt.
	DBC1	1.00	1.0	Default value

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
19. No Early Hydrogen Burn [HE]	HEB	1.00	INIT=GNIYA + INIT=GNIYN + INIT=EGI + INIT=FNI + INIT=FGI + INIT=HNI + INIT=KNSYA + INIT =KNSYC + INIT=FCI + INIT=HCI + INIT=LCI + INIT=BCI + INIT=ENIYA + INIT=ENIYB + INIT=ENIYN + INIT=LNIYC + INIT=KNI + INIT=HGI	KPDSs with hydrogen burn within 4 hours of vessel breach.
	HEN	0.00	INIT=NONE	KPDSs with no hydrogen burn within 4 hours of vessel breach.
	HE1	1.00	1.0	Default value
20. No Containment Failure Due to Early Burn [CE]	CET	0.072	DDT2	Conditional probability of containment failure given DDT at or shortly after vessel breach

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	CEB	0.00	INIT=GNIYA + INIT=GNIYN + INIT=EGI + INIT=FNI + INIT=FGI + INIT=HNI + INIT=KNSYA + INIT =KNSYC + INIT=FCI + INIT=HCI + INIT=LCI + INIT=BCI + INIT=ENIYA + INIT=ENIYB + INIT=ENIYN + INIT=LNIYC + INIT=KNI + INIT=HGI	KPDSs with no containment failure
	CE1	1.00	1.0	Default value
21. No Large Containment Failure Due to Early Burn [LE]	LET	1.00	DDT2	Assumes DDT causes large failure
	LE1	1.00	1.0	Default value
22. Containment Heat Removal Available After Early Burn [XE]	XEI	0.00	CHR * (-X2=F)	If CHR available and not failed after vessel breach, CHR assumed to remain available.
	XEF	1.00	-CHR + X2=F	If CHR previously unavailable, CHR assumed to remain unavailable.
	XES	0.05	HE=F	Probability that CHR fails due to hydrogen burn within four hours of vessel breach. Value based on Sequoyah APET Question No. 85, NUREG/CR-4551.
	XE1	1.00	1.0	Default value

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
23. No Containment Failure Due to Late Burn [CL]	CLA	1.00	INIT=GNIYN +INIT=ENIYB + INIT=ENIYN	Containment Failure assumed for KPDSs involving ignitor unavailable
	CLN	0.00	INIT=GNIYA + INIT=EGI + INIT=FNI + INIT=FGI + INIT=HNI + INIT=KNSYA + INIT =KNSYC + INIT=FCI + INIT=HCI + INIT=LCI + INIT=BCI + INIT=ENIYA + INIT=LNIYC + INIT=KNI + INIT=HGI	MAAP analysis
	CL1	1.00	1.0	Default value
24. No Large Containment Failure Due to Late Burn [LL]	LLA	1.00	INIT=GNIYN +INIT=ENIYB + INIT=ENIYN	Containment Failure assumed for KPDSs involving ignitor unavailable; Large failure assumed
	LL1	1.00	1.0	Default value
25. Long-term Containment Heat Removal Available [XLT]	XLTI	0.00	CHR * (-X2=F) * (-XE=F)	CHR available in the long term.
	XLTF	1.00	-CHR + X2=F + XE=F	CHR either failed initially or at vessel breach or due to an early burn. No CHR available for long term cooling.
	XLTS	0.05	CL=F * LL=S	Probability that CHR fails due to late burn when containment failure is small. Split fraction value is based on Sequoyah APET Question No. 85, NUREG/CR-4551.
	XLT1	1.00	1.0	Default value

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
26. No Long-term Overpressurization Containment Failure [CLT]	CLTS	0.00	CHR * QUENCH * (-X2=F) * (-XE=F) * (-XLT=F)	Long-term heat removal available, no condensibles produced.
	CLTD	0.016	INIT=ENIYA + INIT=ENIYB + INIT=ENIYN	Predicted failure fraction at 48 hours for KPDS ENIYA. Used also for ENIYB and ENIYN.
	CLTE	0.045	INIT=EGI	Predicted failure fraction at 48 hours for KPDS EGI.
	CLTF	0.860	INIT=FNI + INIT=FGI	Predicted failure fraction at 48 hours for KPDS FNI. Used also for FGI.
	CLTL	1.00	INIT=GNIYA + INIT=GNIYN + INIT=LNIYC + INIT=HNI + INIT=HGI + INIT=KNSYA + INIT=KNSYC + INIT=KNI	KPDSs where containment failure is ineveitible if no recovery, but does not occur within 24 hours.
	CLT2	0.00	INIT=NONE	KPDSs with no containment failure within 48 hours.
	CLT1	1.00	1.0	Default value
27. No Large, Long-term Containment Failure [LLT]	LLTD	1.00	INIT=ENIYA + INIT=ENIYB + INIT=ENIYN	Conditional probability of large containment failure at 48 hours for KPDS ENIYA. Used also for ENIYB, ENIYN.
	LLTE	1.00	INIT=EGI	Conditional probability of large containment failure at 48 hours for KPDS EGI.
	LLTF	1.00	INIT=FNI + INIT=FGI	Conditional probability of large containment failure at 48 hours for KPDS FNI. Used also for FGI.

TABLE 4.8-2 FAILURE FRACTIONS FOR WATTS BAR CONTAINMENT EVENT TREE

TOP EVENT	SPLIT FRACTION ID	FAILURE FRACTION	SPLIT FRACTION LOGIC	BASIS
	LLTK	1.00	INIT=KNI * IP=F	Asymptotic conditional probability of large containment failure within 48 hours when containment temperatures approach 500 Deg F.
	LLTG	1.00	INIT=GNIYA + INIT=GNIYN + INIT=HGI + INIT=KNSYA + INIT=KNSYC + (INIT=KNI * IP=S) + INIT=HNI + INIT=LNIYC	Asymptotic conditional probability of large containment failure within 48 hours when containment temperatures approach 400 Deg F.
	LLTL	1.00	INIT=NONE	Asymptotic conditional probability of large containment failure within 48 hours when containment temperatures approach 300 Deg F.
	LLT1	1.00	1.0	Default value
28. No Basemat Penetration [BI]	BIC	0.00	DBC=S	Debris cooled, no concrete attack.
	BIU	1.00	DBC=F	Basemat penetration assumed if debris not cooled.
	BI1	1.00	1.0	Default value
29. Sprays Operate After Large, Early Failure [SO]	SOA	0.00	ISOFAILL	Large containment isolation failure does not cause failure of the sprays.
	SOB	1.00	-ISOFAILL	Sprays fail for all other large containment failures except isolation failures.
	SO1	1.00	1.0	Default value

Table 4.8-3. Baseline Pressure Distribution Used in STADIC Model for Containment Failure at Vessel Breach

Condition	Baseline Pressure (psig)		Type of Distribution
	Median	94th Percentile	
Ice in Ice Condenser and/or Sprays Available	5.3	7.3	Lognormal
No Ice and No Sprays Available	10.3	11.3	Lognormal

Table 4.8-4 Split Fractions for Watts Bar Containment Failure at Vessel Breach

INITIAL CONDITIONS				PROBABILITIES OF						CORRESPONDING SPLIT FRACTIONS		
RCS PRESS @ VB (psia)	WATER IN REACTOR CAVITY	ICE IN ICE COND.	PRE EXISTING H2	LARGE FAILURE ABOVE GROUND	LARGE BELOW GROUND	SMALL FAILURE	ALPHA MODE	ROCKET MODE	NO CONT FAILURE	C2	L2	
>2000	Y	Y		0.054	0.053	ε(1)	8.0-04	6.5-03	0.886	0.114	1	
>2000	N	Y		0.033	0.032	ε	8.0-04	6.5-03	0.928	0.072	1	
>2000	N	N		0.222	0.106	ε	8.0-04	6.5-03	0.664	0.336	1	
>600,<2000	Y	Y		0.043	0.043	ε	8.0-04	6.5-03	0.906	0.094	1	
>600,<2000	N	Y		0.022	0.029	ε	8.0-04	6.5-03	0.942	0.058	1	
>600,<2000	N	N		0.196	0.097	ε	8.0-04	6.5-03	0.7	0.3	1	
>200,<600	Y	Y	LO	5.3-03	0.012	ε	8.0-04	0	0.982	0.018	1	
>200,<600	N	Y	LO	5.0-04	3.3-04	ε	8.0-04	0	0.998	1.6-03	1	
>200,<600	N	N	LO	0.016	0.034	ε	8.0-04	0	0.95	0.05	1	
>200,<600	Y	Y	HI	0.13	0.041	ε	8.0-04	0	0.828	0.172	1	
>200,<600	N	Y	HI	0.04	0.041	ε	8.0-04	0	0.918	0.082	1	
>200,<600	N	N	HI	0.169	0.044	ε	8.0-04	0	0.787	0.213	1	
<200	Y	Y	LO	0	1.7-04	ε	0.008	0	0.992	8.2-03	1	
<200	N	Y	LO	0	0	ε	0.008	0	0.992	8.0-03	1	
<200	Y	N	LO	1.7-04	1.0-03	ε	0.008	0	0.991	9.2-03	1	
<200	N	N	LO	0	0	ε	0.008	0	0.992	8.0-03	1	
<200	Y	Y	HI	0.175	0.025	ε	0.008	0	0.792	0.208	1	
<200	N	Y	HI	0.098	0.04	ε	0.008	0	0.854	0.146	1	
<200	Y	N	HI	0.185	0.021	ε	0.008	0	0.786	0.214	1	
<200	N	N	HI	0.18	0.024	ε	0.008	0	0.788	0.212	1	

NOTE 1: PROBABILITIES OF SMALL FAILURE MODES ARE INSIGNIFICANT RELATIVE TO LARGE FAILURE PROBABILITIES

Table 4.8-5 (Page 1 of 2). Split Fractions for Watts Bar CET Top Events 26 (CLT) and 27 (LLT)

KPDS	Failure Fractions		Comments
	CLT	LLT	
ENIYA	0.16	1.0	(T = 300°F).
ENIYB	0.16	1.0	Assume same as ENIYA.
ENIYN	0.16	1.0	Assume same as ENIYA.
FCI	CHR*	—	
FNI	.86	1.0	
LCI	CHR	—	
GNIYA	1.0	1.0	P_f = .999 @ 39.5 hours; P_f = .0022 @ 24 hours (T = 400°F)
GNIYN	1.0	1.0	Assume same as GNIYA.
BCI	CHR	—	
ENSYA	NR**	—	
ENSYB	NR	—	
ENSYC	NR	—	
ENSYN	NR	—	
EIB	NR	—	
HGI	1.0	1.0	P_f = .999 @ 20.2 hours (before 24 hours) (T = 400°F).
ENB	NR	—	
EGI	.045	1.0	
KNSYA	1.0	1.0	Assume same as KNSYC.
KNSYC	1.0	1.0	For IP = S(?) P_f = .999 @ 19.2 hours (before 24 hours) (T = 400°F).
KNI	1.0	1.0	If IP = F, P_f = .999 @ 43.5 hours; P_f = 2×10^{-4} @ 24 hours (T = 500°F). If IP = S, P_f = .999 @ 19.6 hours (before 24 hours); (T = 400°F).

*When containment heat removal (CHR) is available, basemat melt-through (BI) is assumed to occur before overpressurization due to condensibles (CLT).
**NR = Not required.

Table 4.8-5 (Page 2 of 2). Split Fractions for Watts Bar CET Top Events 26 (CLT) and 27 (LLT)

KPDS	Failure Fractions		Comments
	CLT	LLT	
FGI	.86	1.0	Assume same as FNI.
HNI	1.0	1.0	P_f = .999 @ 36.9 hours; P_f = .124 @ 24 hours (T = 400°F).
HCI	CHR	—	
LNIYA	NR	—	
LNIYC	1.0	1.0	If IP = S, P_f = .999 @ 34 hours; P_f = .144 @ 24 hours; (T = 400°F). If IP = F, P_f = .999 @ 19.4 hours (before 24 hours); (T = 400°F).
ATV	NR	—	

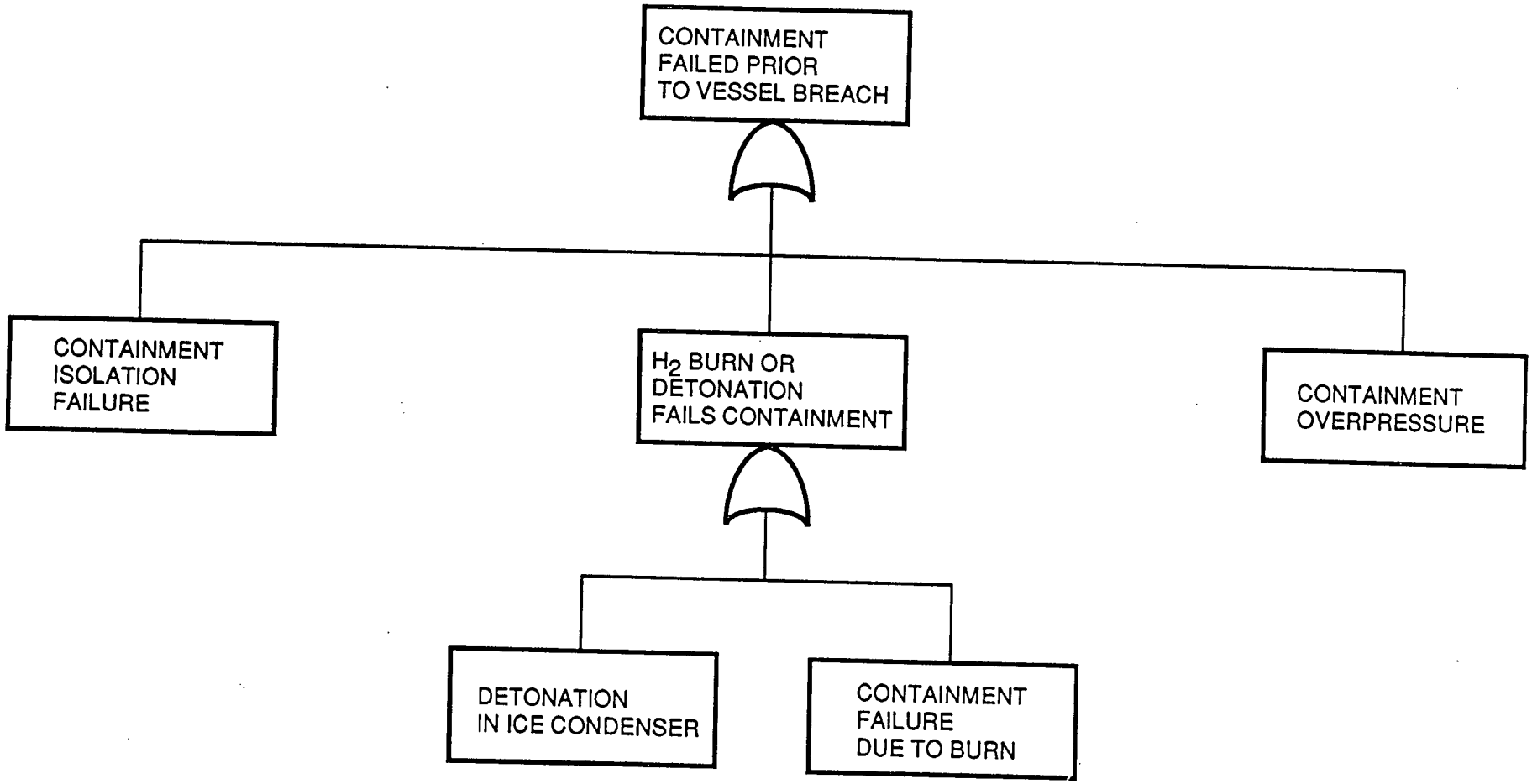


Figure 4.8-1. Fault Tree for Containment Failure Prior to Vessel Breach

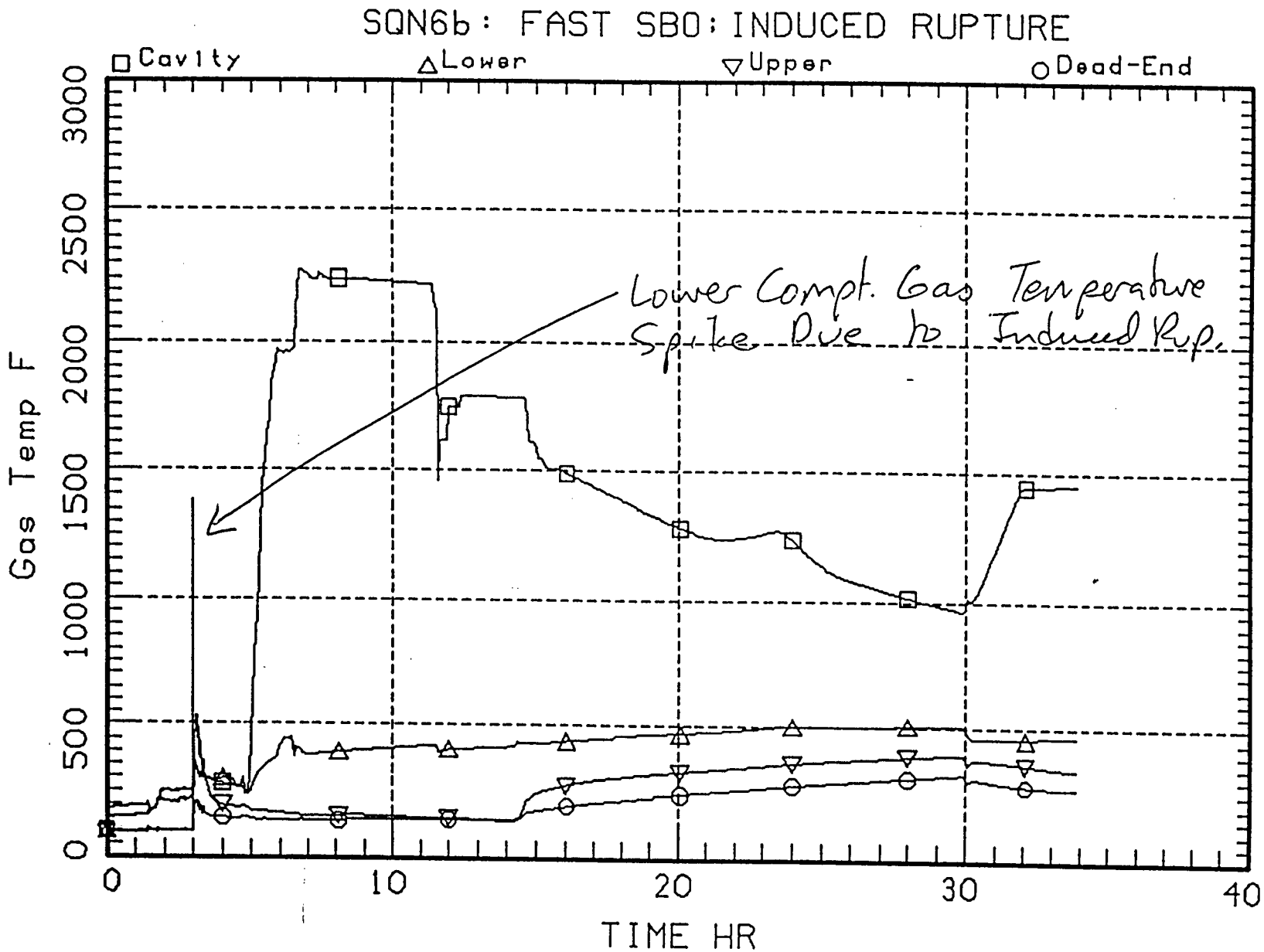


Figure 4.8-2. Spike in Lower Compartment Temperature Due to Induced Rupture

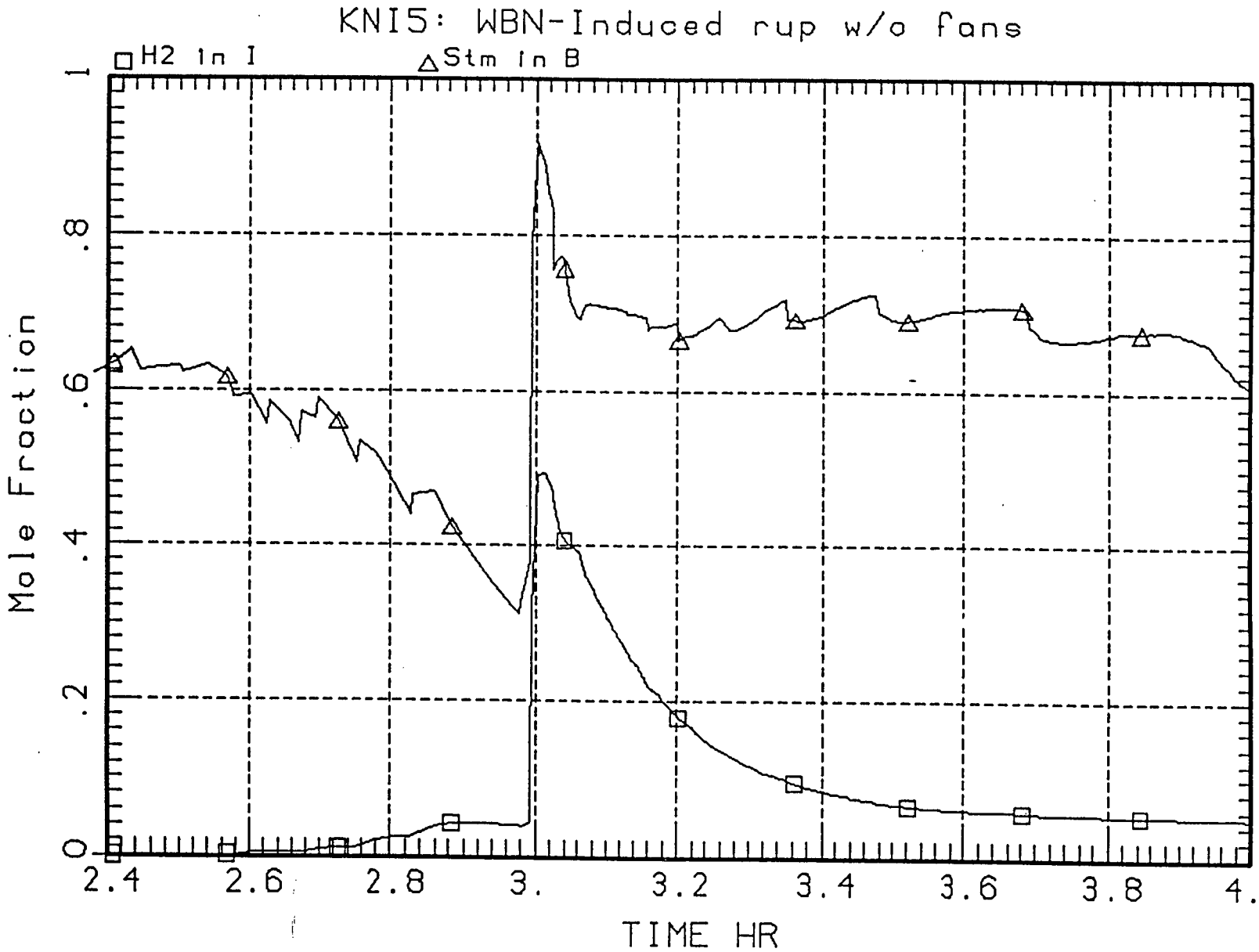


Figure 4.8-3. Inerting of Lower Compartment When ARFs are Off (H_2 and H_2O mole fractions)

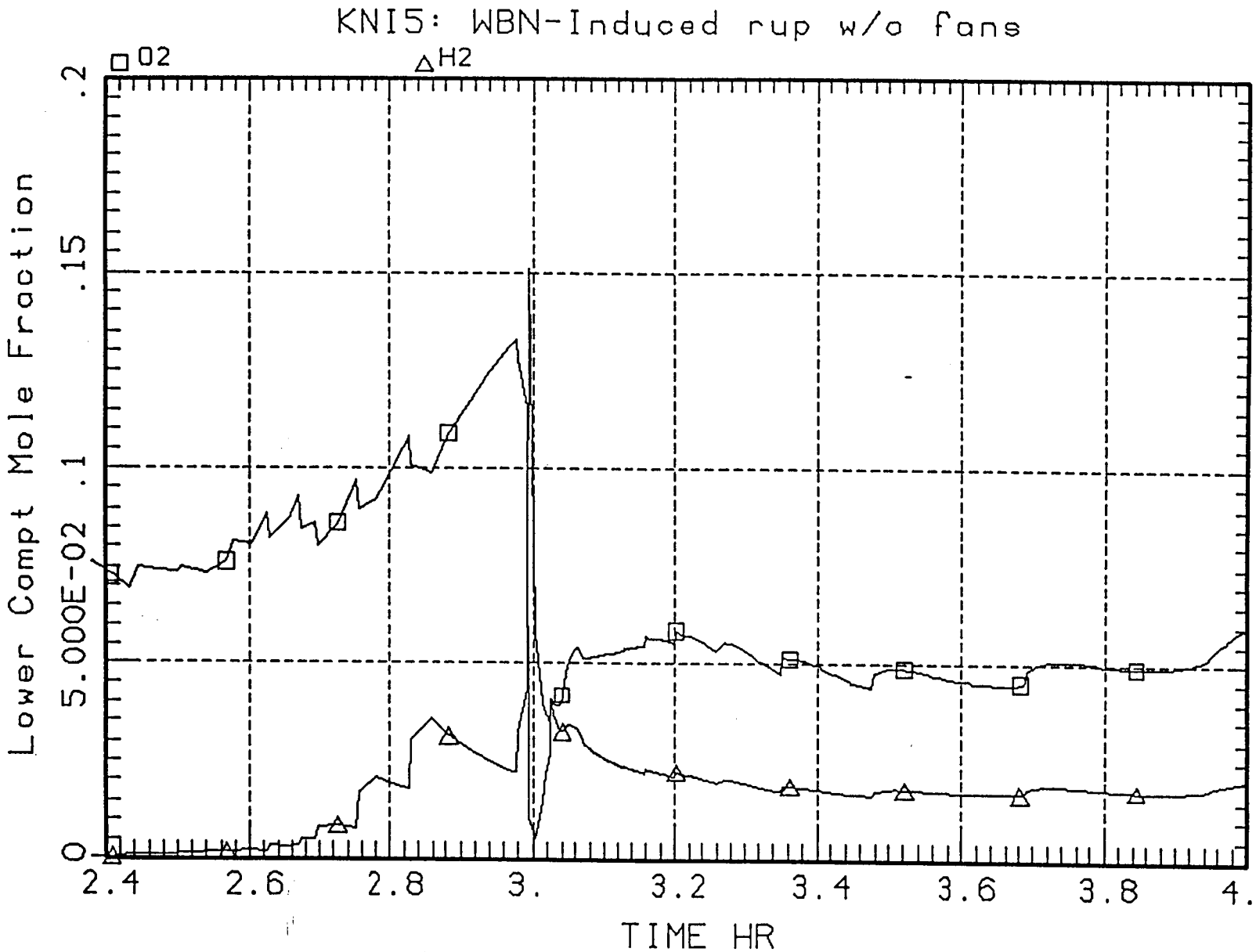


Figure 4.8-4. Inerting of Lower Compartment When ARFs are Off (O_2 and H_2 mole fractions)

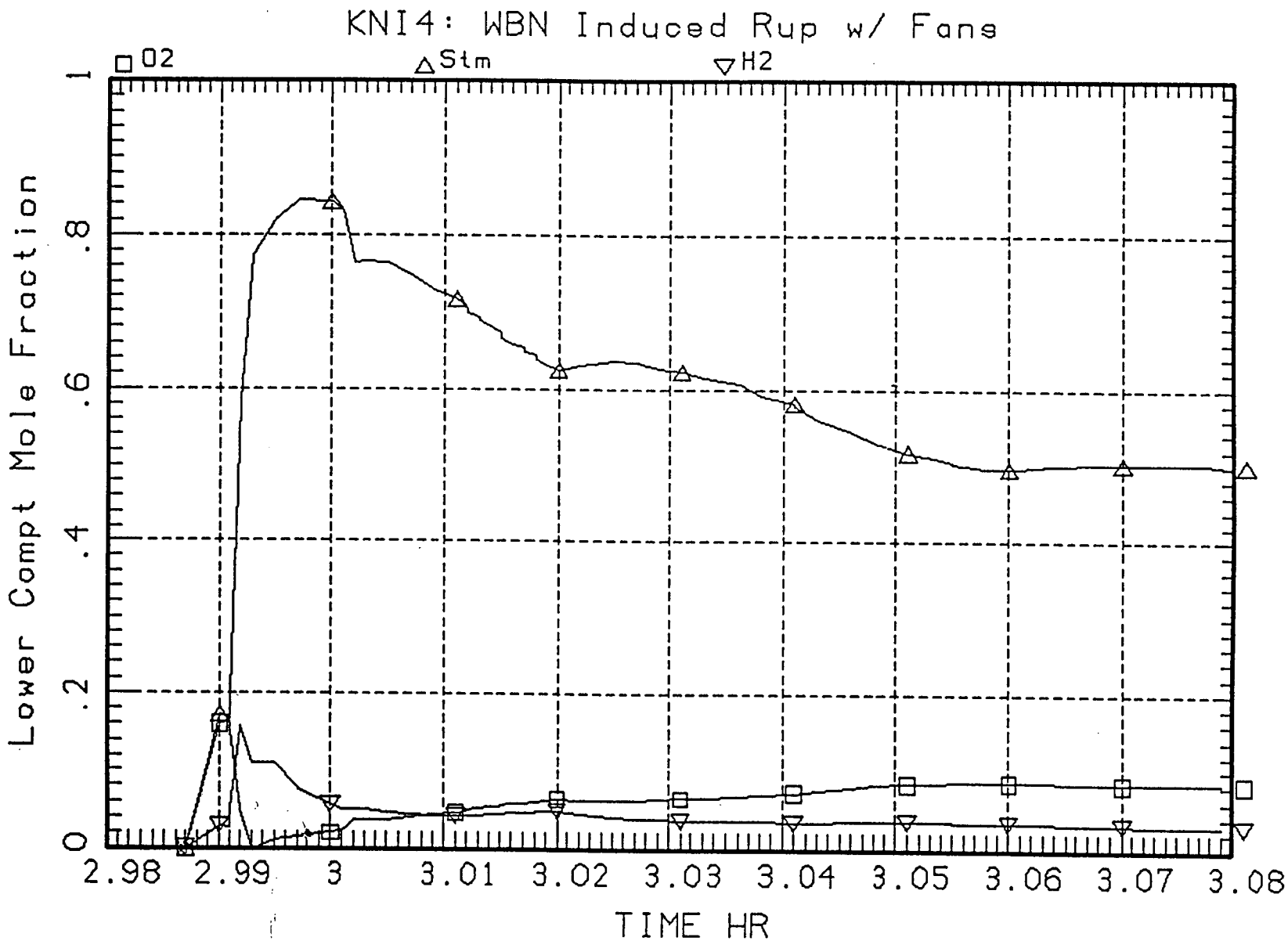


Figure 4.8-5. Postrupture Gas Concentrations with Fans On (O_2, H_2O, and H_2 mole fractions)

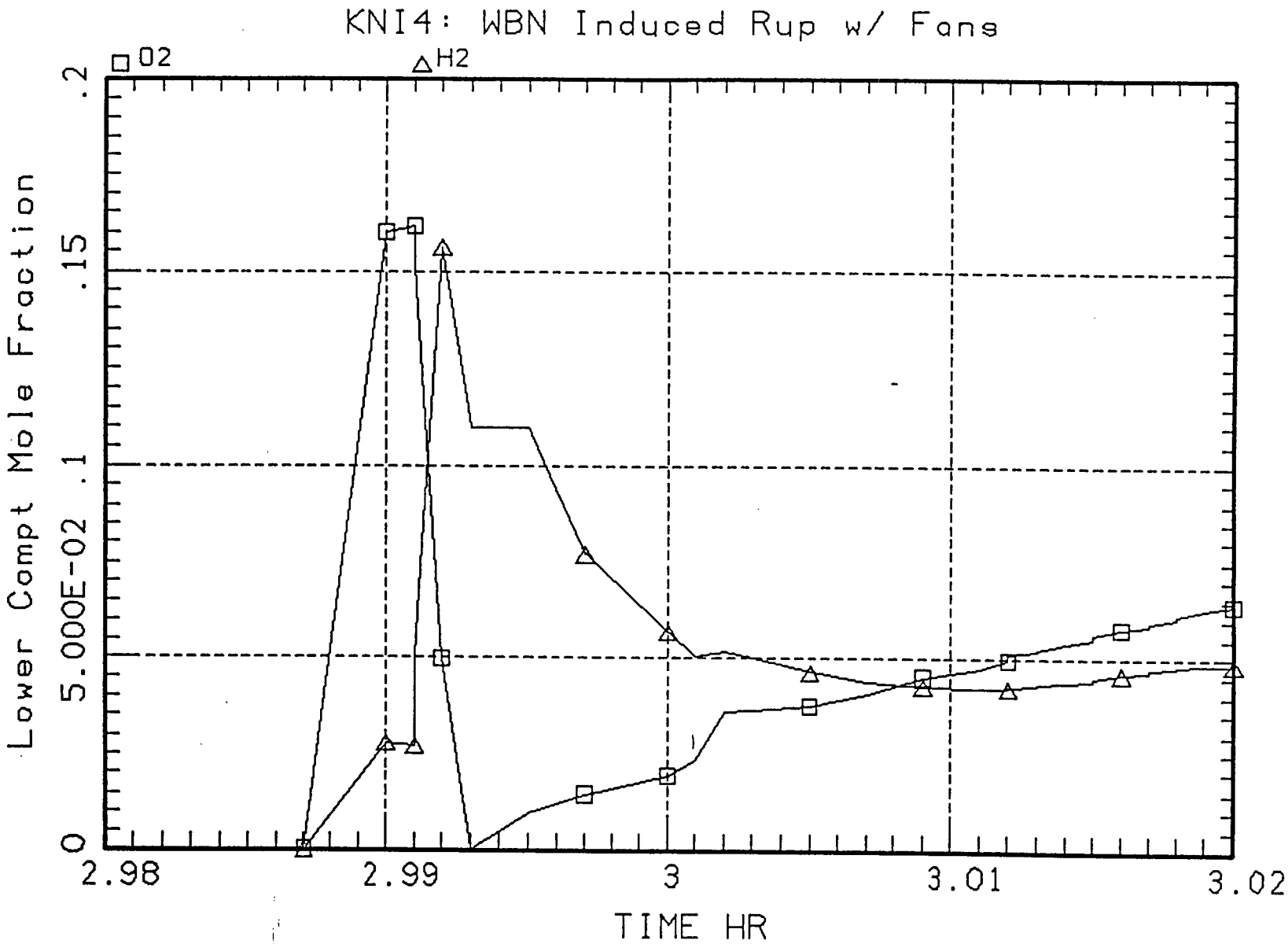


Figure 4.8-6. Postrupture Gas Concentrations with Fans On (O_2 and H_2 mole fractions)

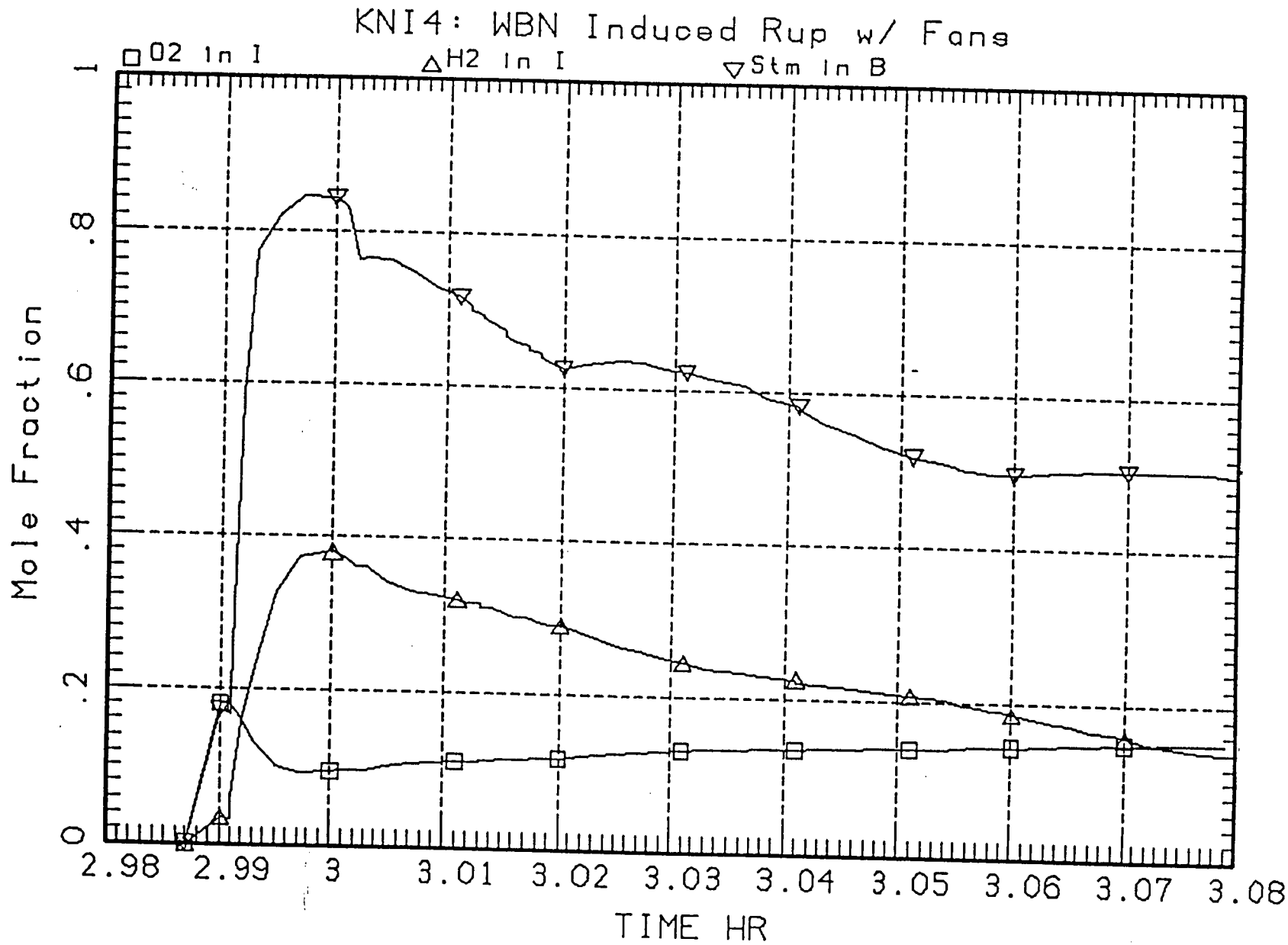


Figure 4.8-7. Postrupture Gas Concentrations with Fans On (O_2, H_2, and H_2O mole fractions)

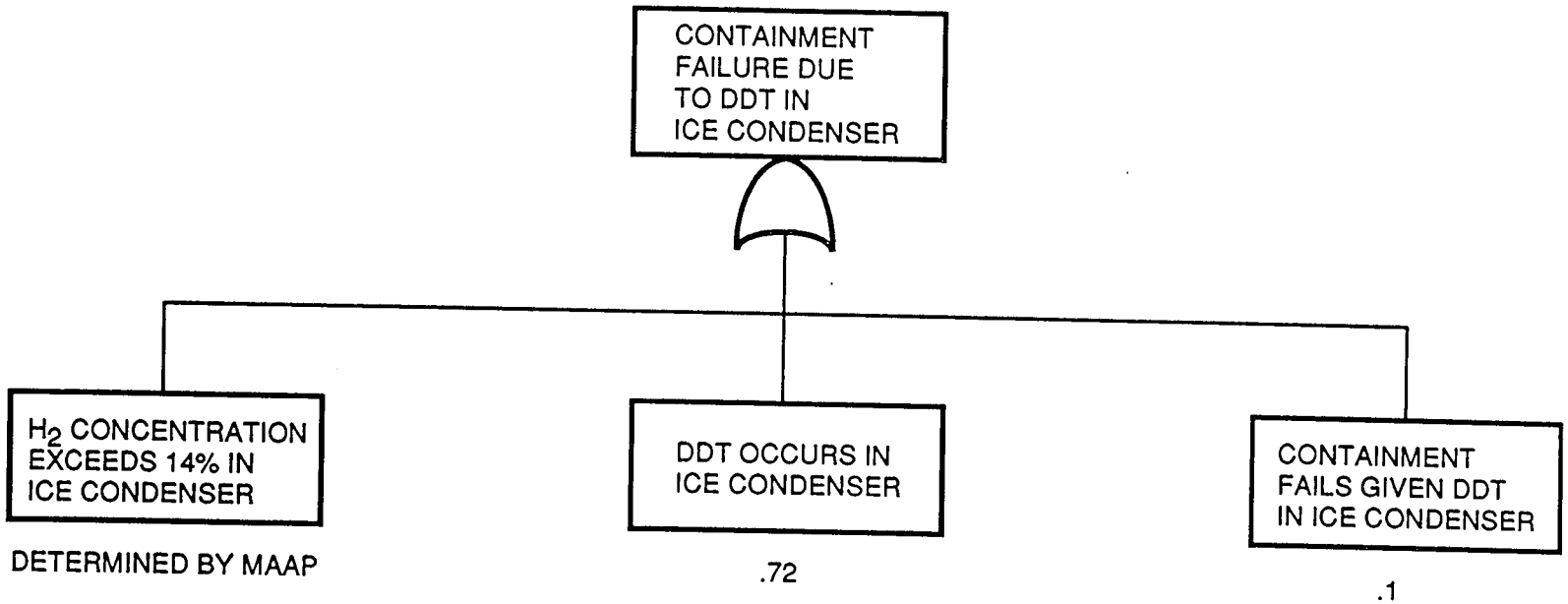


Figure 4.8-8. Fault Tree for Containment Failure Due to DDT in Ice Condenser

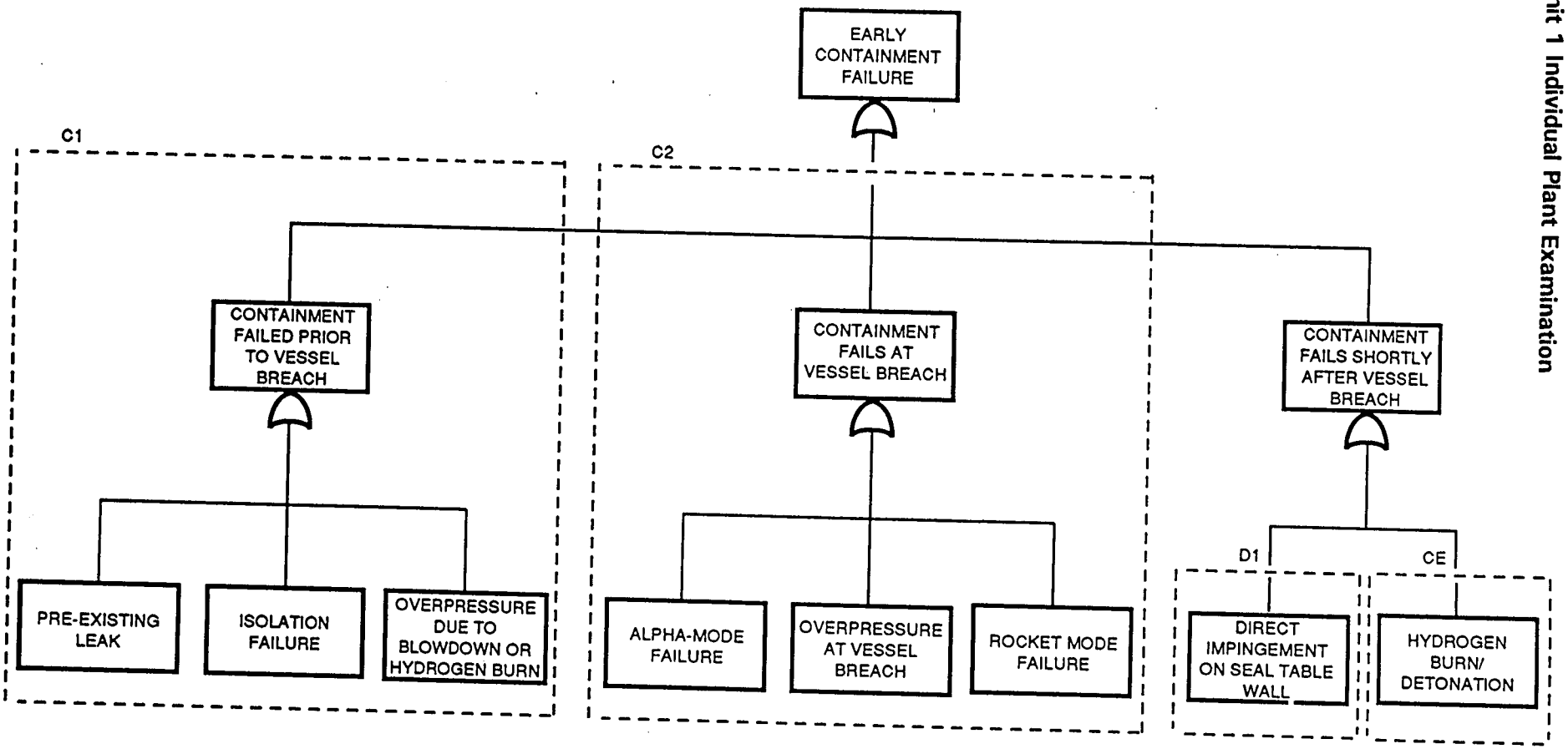


Figure 4.8-9. Fault Tree for Containment Failure at (or shortly after) Vessel Breach

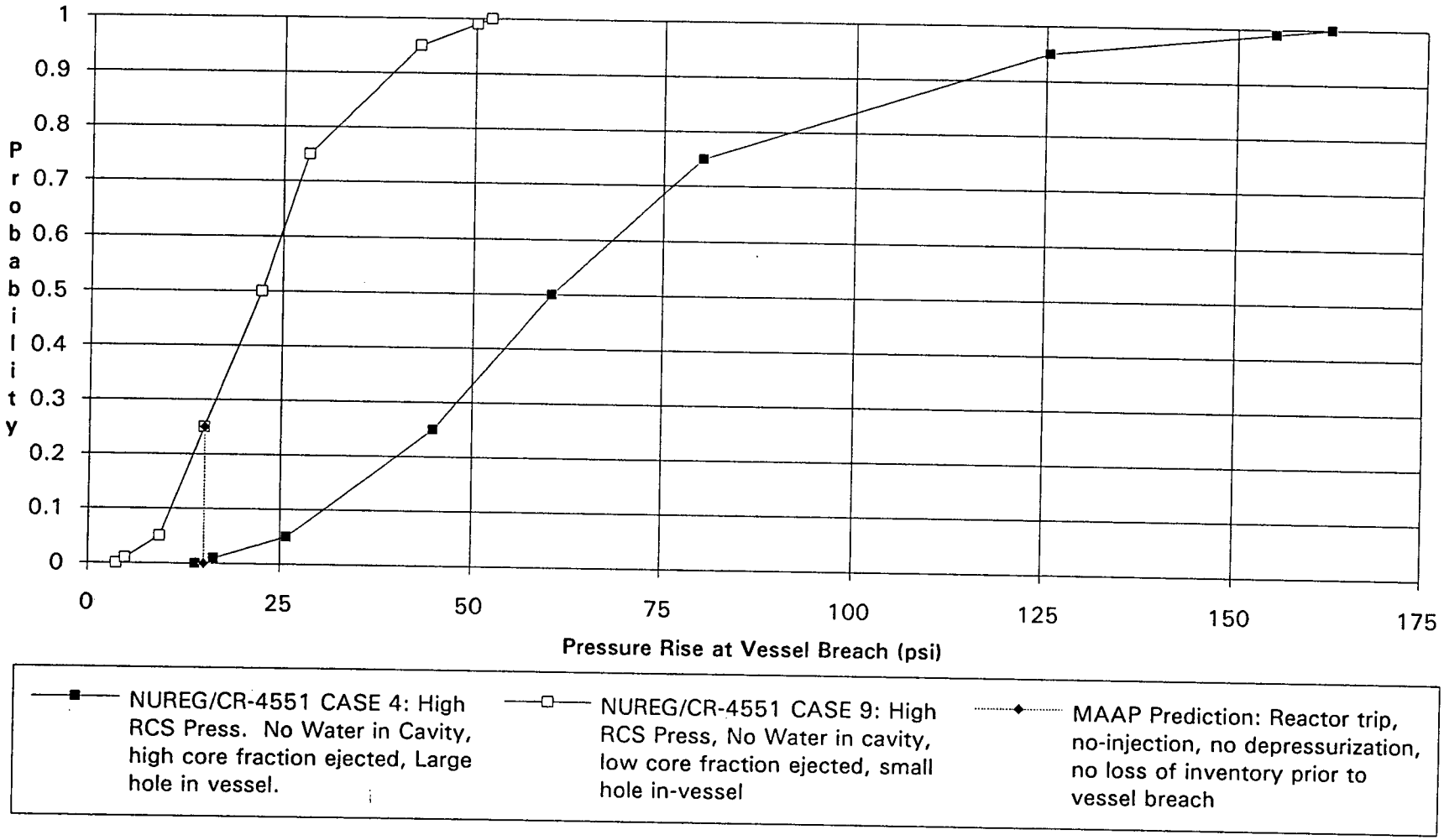


Figure 4.8-10. Comparison of MAAP DCH Predictions with NUREG/CR-4551 Distributions (Table 5-3 Volume 2, Part 2)

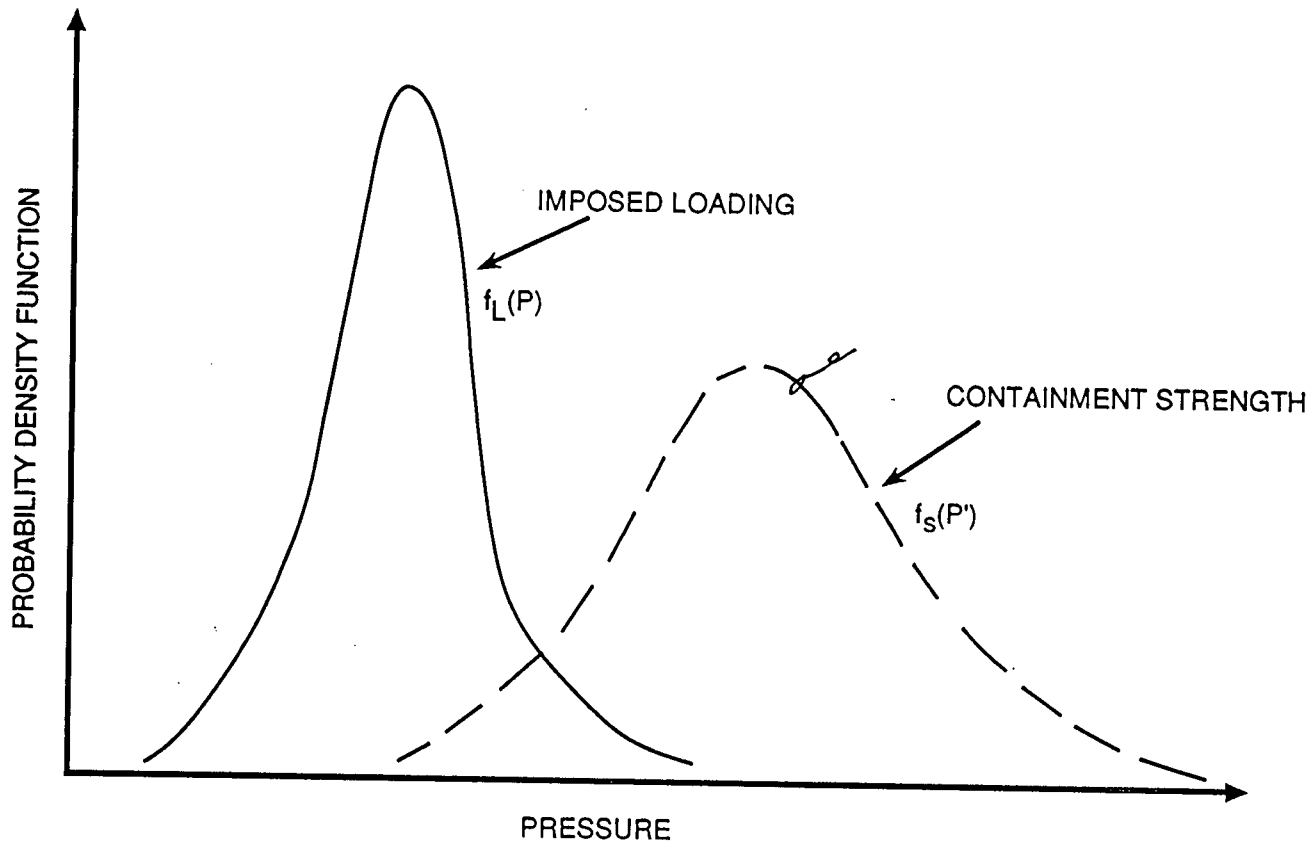


Figure 4.8-11. Stress-Strength Interference Theory

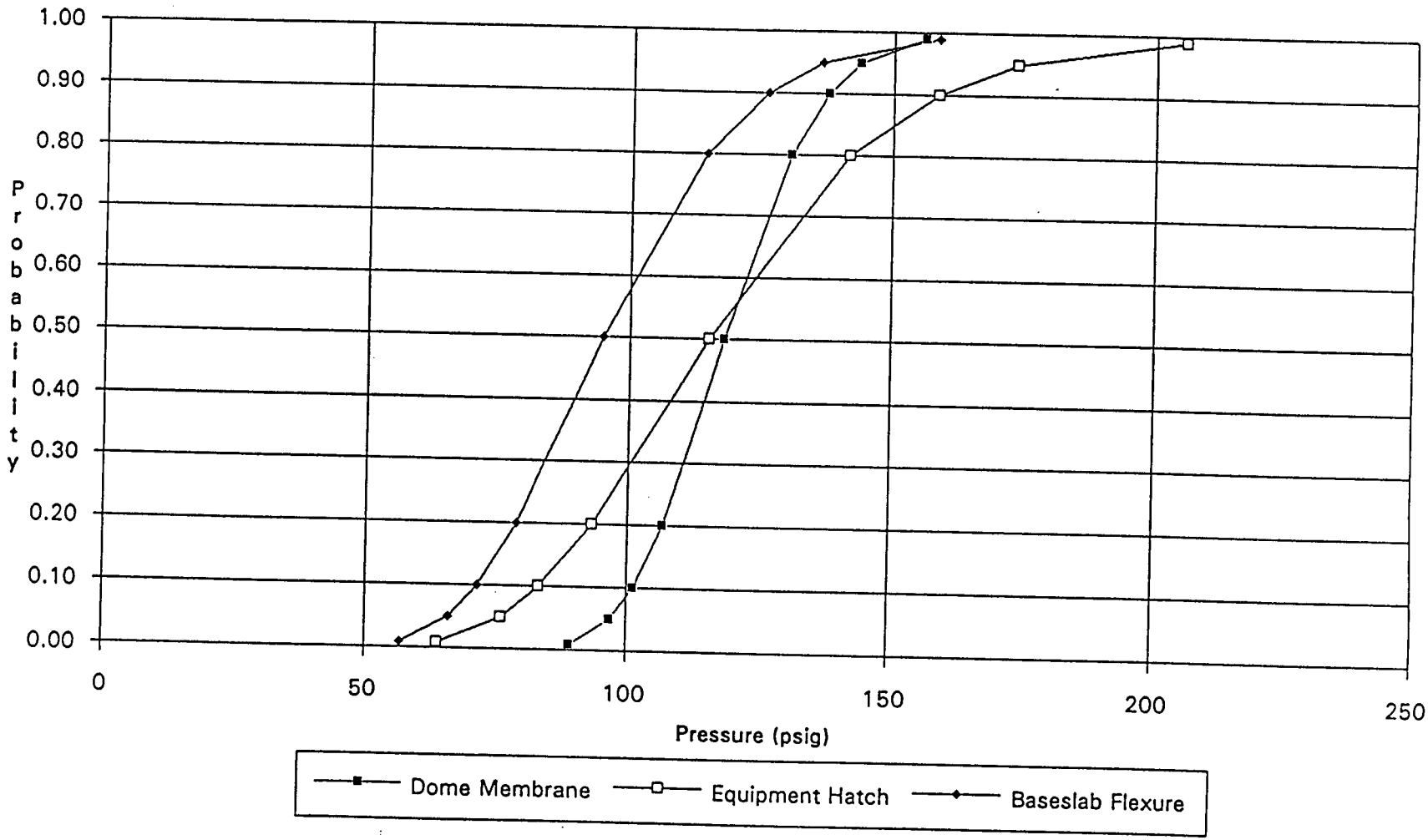


Figure 4.8-12. Cumulative Probability Distributions for Watts Bar Containment Failure Modes at 300°F

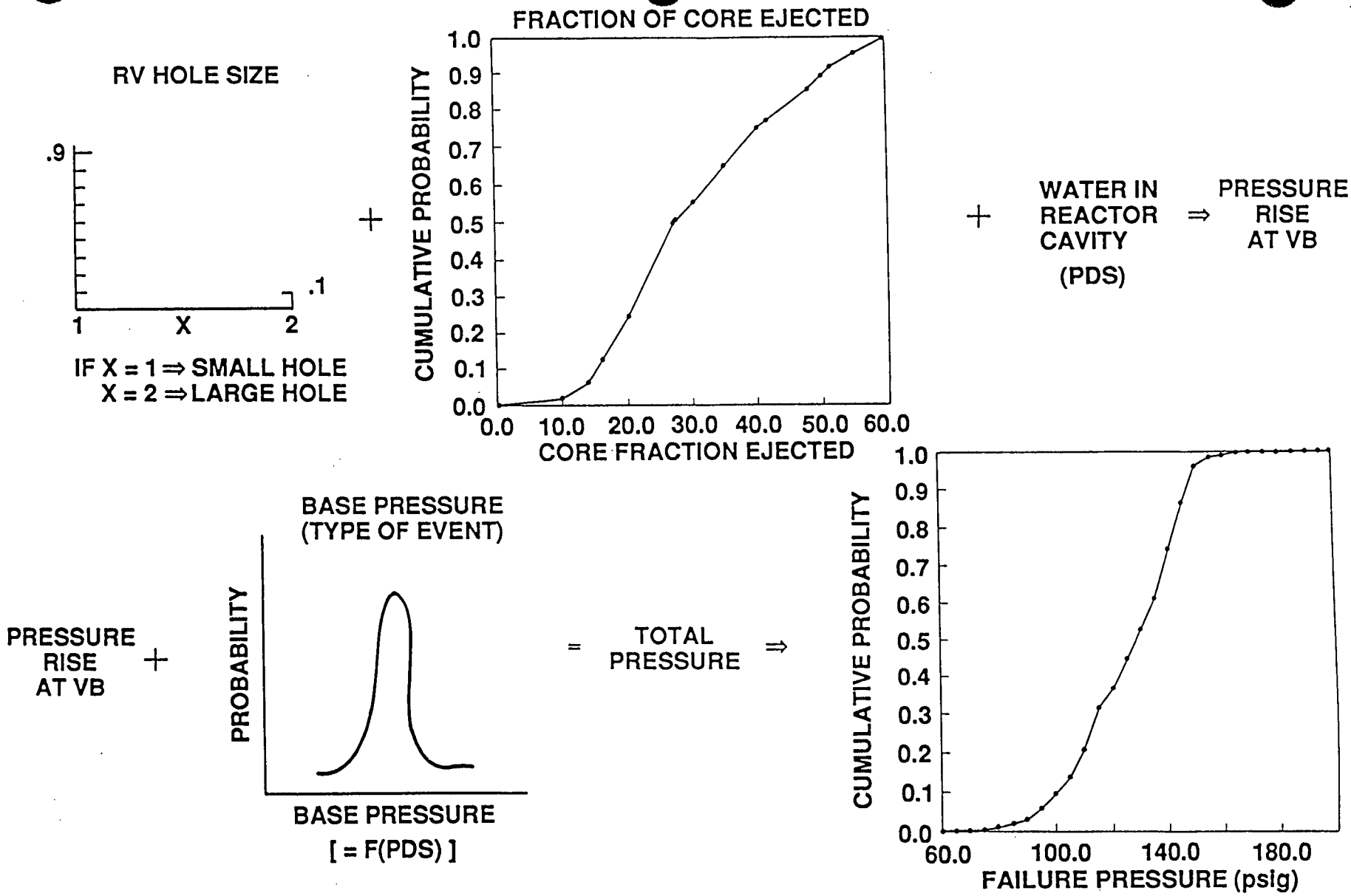


Figure 4.8-13. Containment Failure at Vessel Breach

RCS PRESS @VB	ICE IN ICE COND	WATER IN REAC CAV	PRE EXIST H2	MEDIAN PRESS INC @ VB (psi)	LP CURVE (TABLE 5-1)#
LOW <200 PSIA (OR POUR MELTS)	NO	NO	HI	10.9	8
			LO	9.1	7
		YES	HI	16.7	10
			LO	12.6	9
	YES	NO	HI	10.8	6
			LO	9.4	5
		YES	HI	15.2	4
			LO	11.5	3

From NUREG/CR-4551, Vol. 2, Rev 1, Part 2, Apr. 1991

Figure 4.8-14. Pressure Rise at Vessel Breach for Low RCS Pressure

RCS PRESS @VB	RV HOLE SIZE *	FRAC OF CORE EJEC	ICE IN ICE COND	WATER IN REAC CAV	PRE EXIST H2	MEDIAN PRESS INC @ VB (psi)**	LP CURVE (TABLE 5-1)#	IP CURVE (TABLE 5-2)#
INTER 200-600 PSIA	LARGE + >.4 sq m	HIGH >40%	NO	NO	HI	48.8	8	27
					LO	47.8	7	27
				YES	HI	-	-	-
					HI	-	-	-
			YES	NO	HI	35.3	6	15
					LO	34.6	5	15
				YES	HI	28.2	4	10
					LO	26.4	3	10
		MEDIUM 20-40%	NO	NO	HI	33.2	8	28
					LO	32.3	7	28
				YES	HI	-	-	-
					LO	-	-	-
			YES	NO	HI	28.4	6	16
					LO	27.8	5	16
				YES	HI	22.2	4	11
					LO	20.4	3	11
		LOW <20%	NO	NO	HI	21.6	8	29
					LO	20.7	7	29
				YES	HI	-	-	-
					LO	-	-	-
			YES	NO	HI	19.3	6	17
					LO	18.6	5	17
				YES	HI	17.8	4	12
					LO	15.9	3	12
	SMALL ++ < .4 sq m	HIGH >40%	NO	NO	HI	46.2	8	30
					LO	45.3	7	30
				YES	HI	-	-	-
					HI	-	-	-
			YES	NO	HI	28.9	6	21
					LO	28.3	5	21
				YES	HI	26.4	4	13
					LO	24.5	3	13
		MEDIUM 20-40%	NO	NO	HI	33.2	8	28
					LO	32.3	7	28
				YES	HI	-	-	-
					LO	-	-	-
			YES	NO	HI	23	6	22
					LO	22.3	5	22
				YES	HI	22.2	4	11
					LO	20.4	3	11
		LOW <20%	NO	NO	HI	21.6	8	29
					LO	20.7	7	29
				YES	HI	-	-	-
					LO	-	-	-
			YES	NO	HI	16.5	6	23
					LO	15.9	5	23
				YES	HI	17.8	4	12
					LO	15.9	3	12

* After Ablation
# From NUREG/CR-4551, Vol. 2, Rev 1, Part 2, Apr. 1991
** Average of Low and Intermediate pressure data, weighted equally
\+ Nominal Hole Size Taken to be 2.0 sq m
\+ + Nominal Hole Size Taken to be .1 sq m

Figure 4.8-15. Pressure Rise at Vessel Brech for Intermediate RCS Pressure

RCS PRESS @VB	RV HOLE SIZE *	FRAC OF CORE EJEC	ICE IN ICE COND	WATER IN REAC CAV	MEDIAN PRESS INC @VB (psi)**	HP CURVE (TABLE 5-3)#	IP CURVE (TABLE 5-2)#
HIGH 400-2000 PSIA	LARGE + >.4 sq m	HIGH >40%	NO	NO	87.9	10	27
				YES	-	-	-
			YES	NO	60	4	15
				YES	41.4	1	10
		MEDIUM 20-40%	NO	NO	58.5	11	28
				YES	-	-	-
			YES	NO	46.1	5	16
				YES	31.4	2	11
		LOW <20%	NO	NO	33.8	12	29
				YES	-	-	-
			YES	NO	27.7	6	17
				YES	21.4	3	12
	SMALL ++ < .4 sq m	HIGH >40%	NO	NO	84.8	10	30
				YES	-	-	-
			YES	NO	46.8	7	21
				YES	39.2	1	13
		MEDIUM 20-40%	NO	NO	58.5	11	28
				YES	-	-	-
			YES	NO	35.2	8	22
				YES	31.4	2	11
		LOW <20%	NO	NO	33.8	12	29
				YES	-	-	-
			YES	NO	22.3	9	23
				YES	21.4	3	12

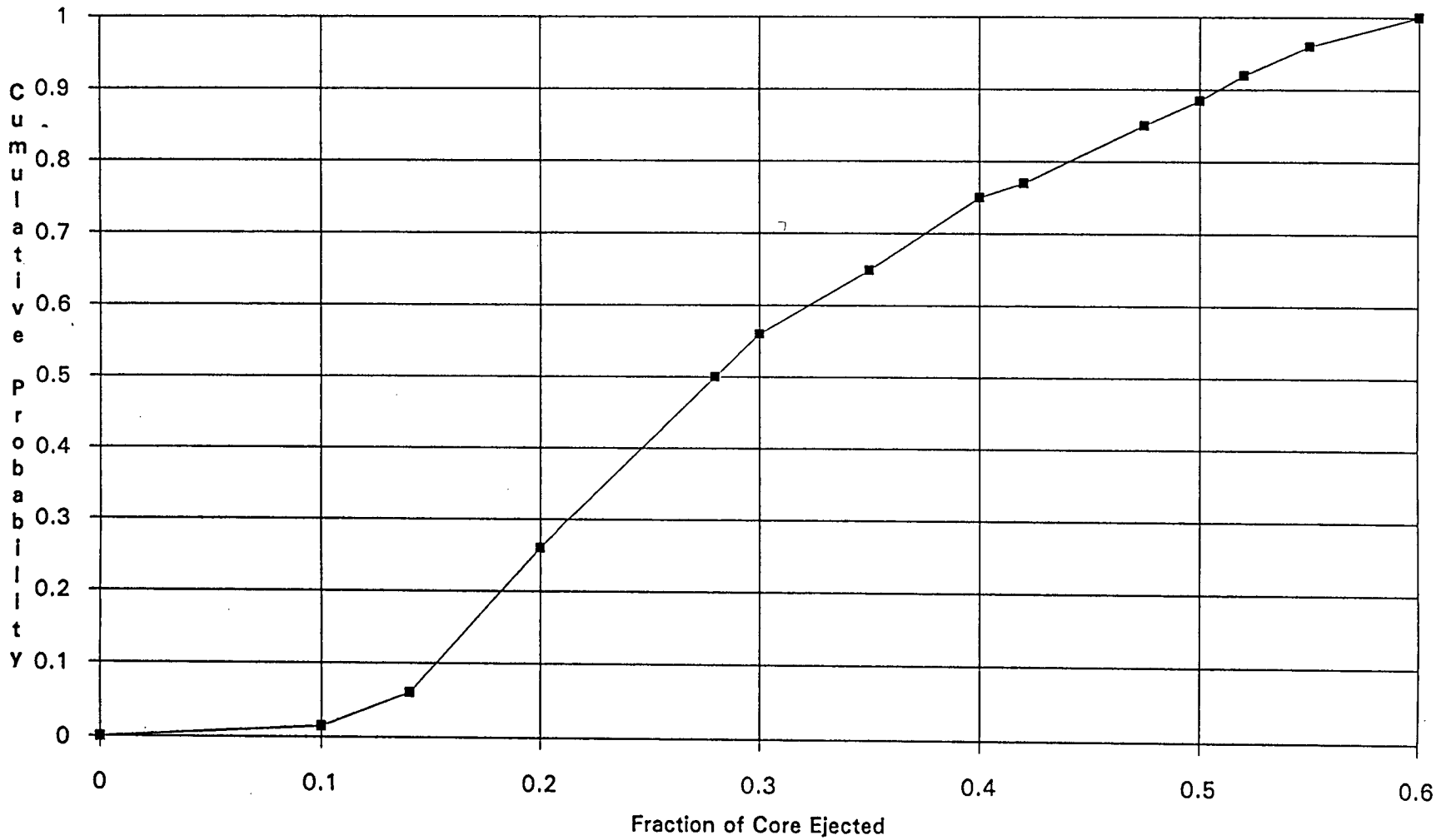
* After Ablation
# From NUREG/CR-4551, Vol. 2, Rev 1, Part 2, Apr. 1991
** Average of Intermediate and High pressure data, weighted 60/40 towards Intermediate Pressure data
\+ Nominal Hole Size Taken to be 2.0 sq m
\+ + Nominal Hole Size Taken to be .1 sq m

Figure 4.8-16. Pressure Rise at Vessel Breach for High RCS Pressure

RCS PRESS @VB	RV HOLE SIZE *	FRAC OF CORE EJEC	ICE IN ICE COND	WATER IN REAC CAV	MEDIAN PRESS INC @VB (psi)	HP CURVE (TABLE 5-3)#
OPP SET 2500 PSIA	LARGE + >.4 sq m	HIGH >40%	NO	NO	89.8	10
				YES	-	-
			YES	NO	60.3	4
				YES	41.7	1
		MEDIUM 20-40%	NO	NO	62.9	11
				YES	-	-
			YES	NO	46	5
				YES	34.6	2
		LOW <20%	NO	NO	36	12
				YES	-	-
			YES	NO	27.7	6
				YES	23	3
	SMALL + + < .4 sq m	HIGH >40%	NO	NO	89.8	10
				YES	-	-
			YES	NO	46.4	7
				YES	41.7	1
		MEDIUM 20-40%	NO	NO	62.9	11
				YES	-	-
			YES	NO	35.1	8
				YES	34.6	2
		LOW <20%	NO	NO	36	12
				YES	-	-
			YES	NO	22.3	9
				YES	23	3

* After Ablation
\# From NUREG/CR-4551, Vol. 2, Rev 1, Part 2, Apr. 1991
\+ Nominal Hole Size Taken to be 2.0 sq m
\+ + Nominal Hole Size Taken to be .1 sq m

Figure 4.8-17. Pressure Rise at Vessel Breach for RCS Pressure of System Setpoint



*NUREG/CR-4551, Vol. 2, In-Vessel Issue No. 6

Figure 4.8-18. Fraction of Core Ejected at Vessel Breach*

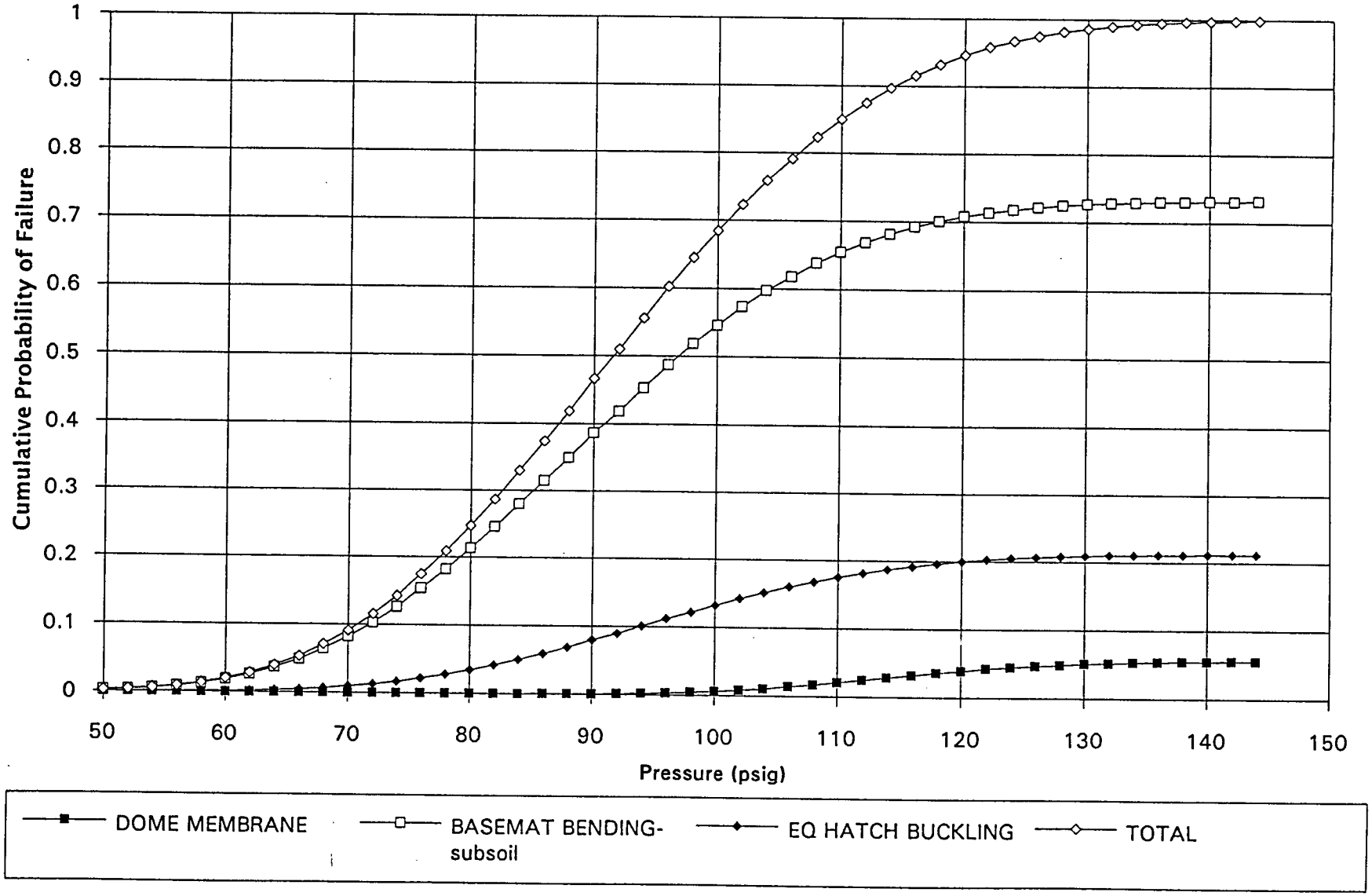


Figure 4.8-19. Cumulative Failure Probability of Watts Bar Containment: Slow Pressure Increase at Room Temperature

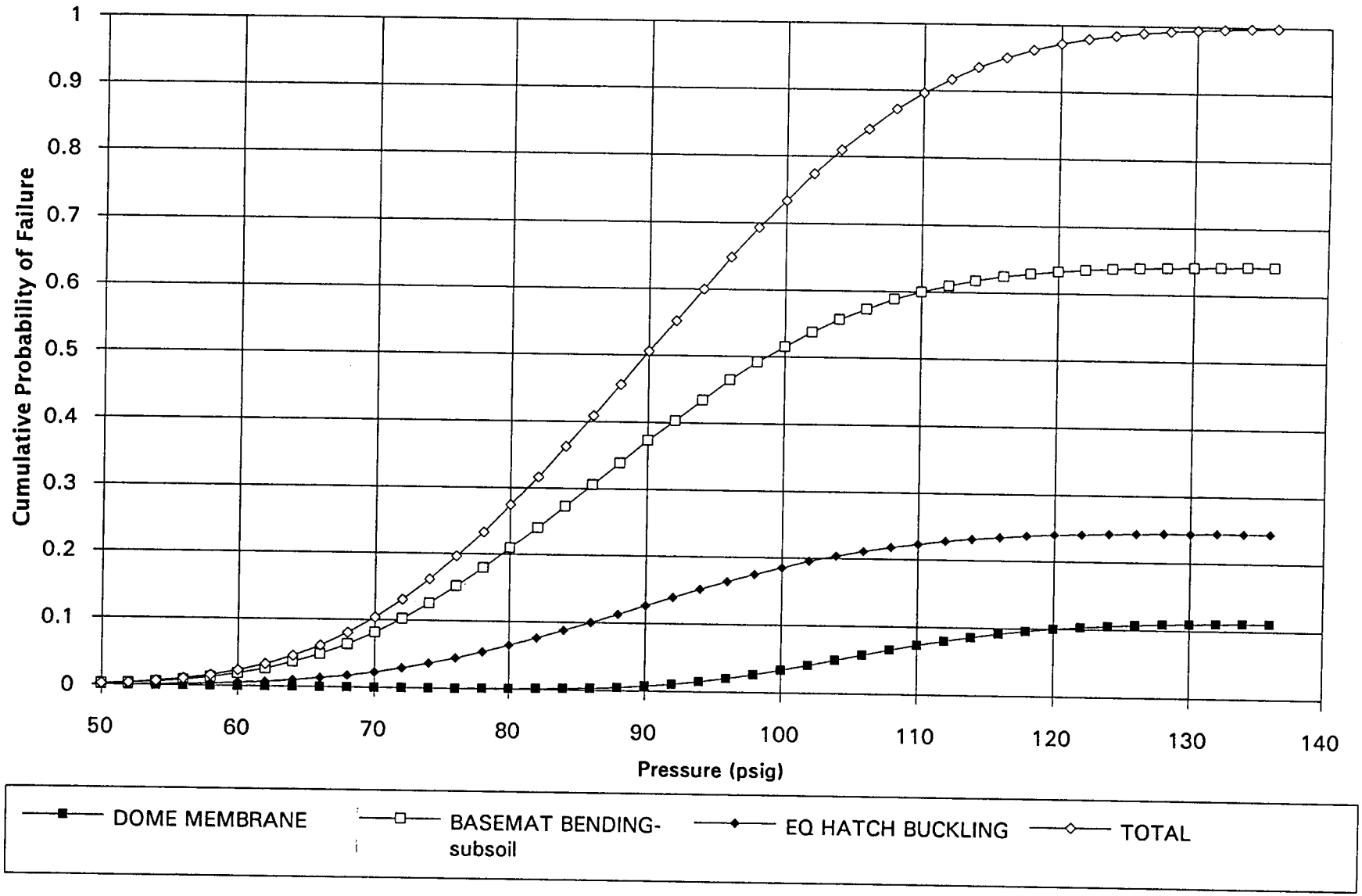


Figure 4.8-20. Cumulative Failure Probability of Watts Bar Containment: Slow Pressure Increase at 300°F

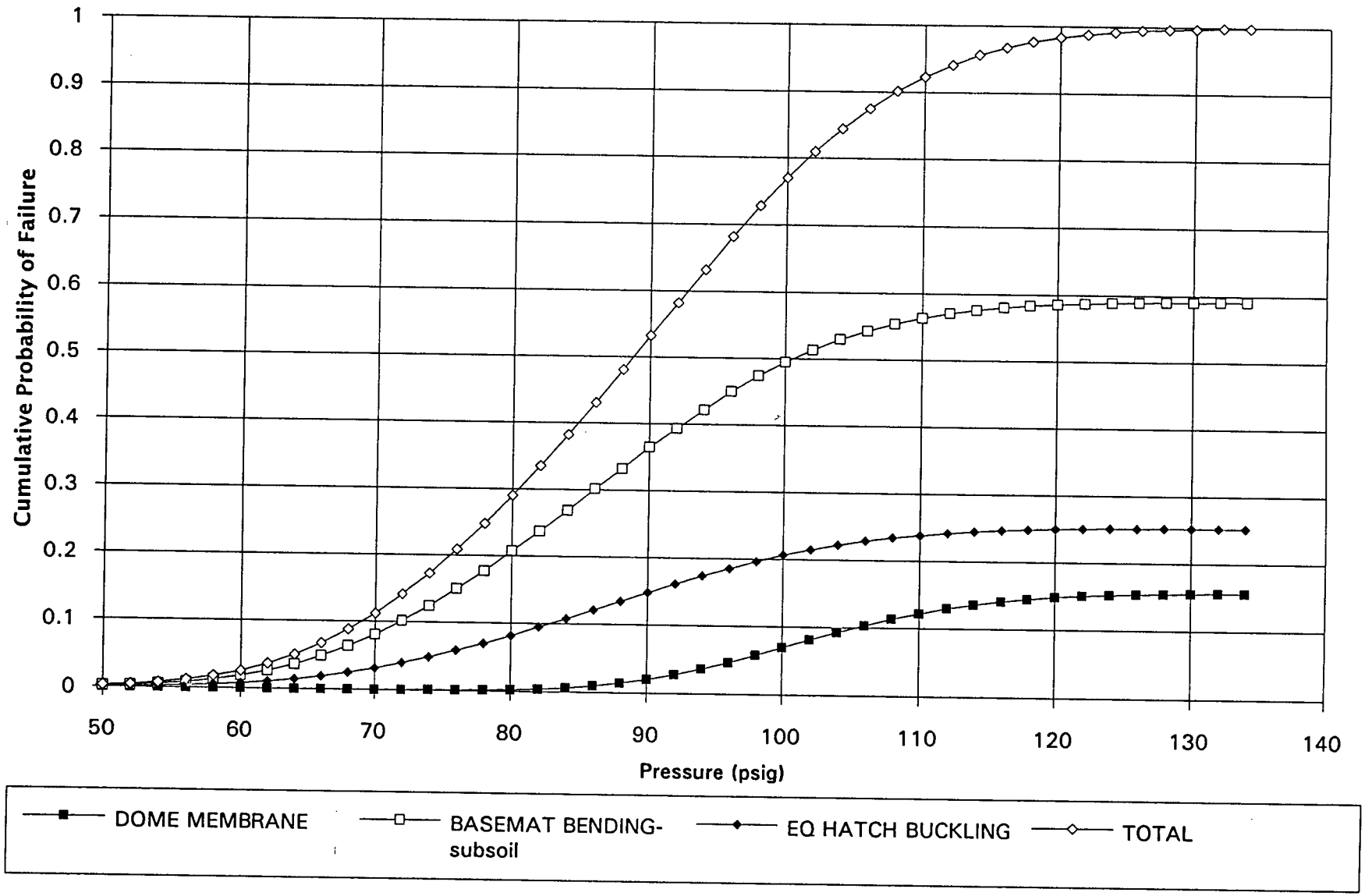


Figure 4.8-21. Cumulative Failure Probability of Watts Bar Containment: Slow Pressure Increase at 400°F

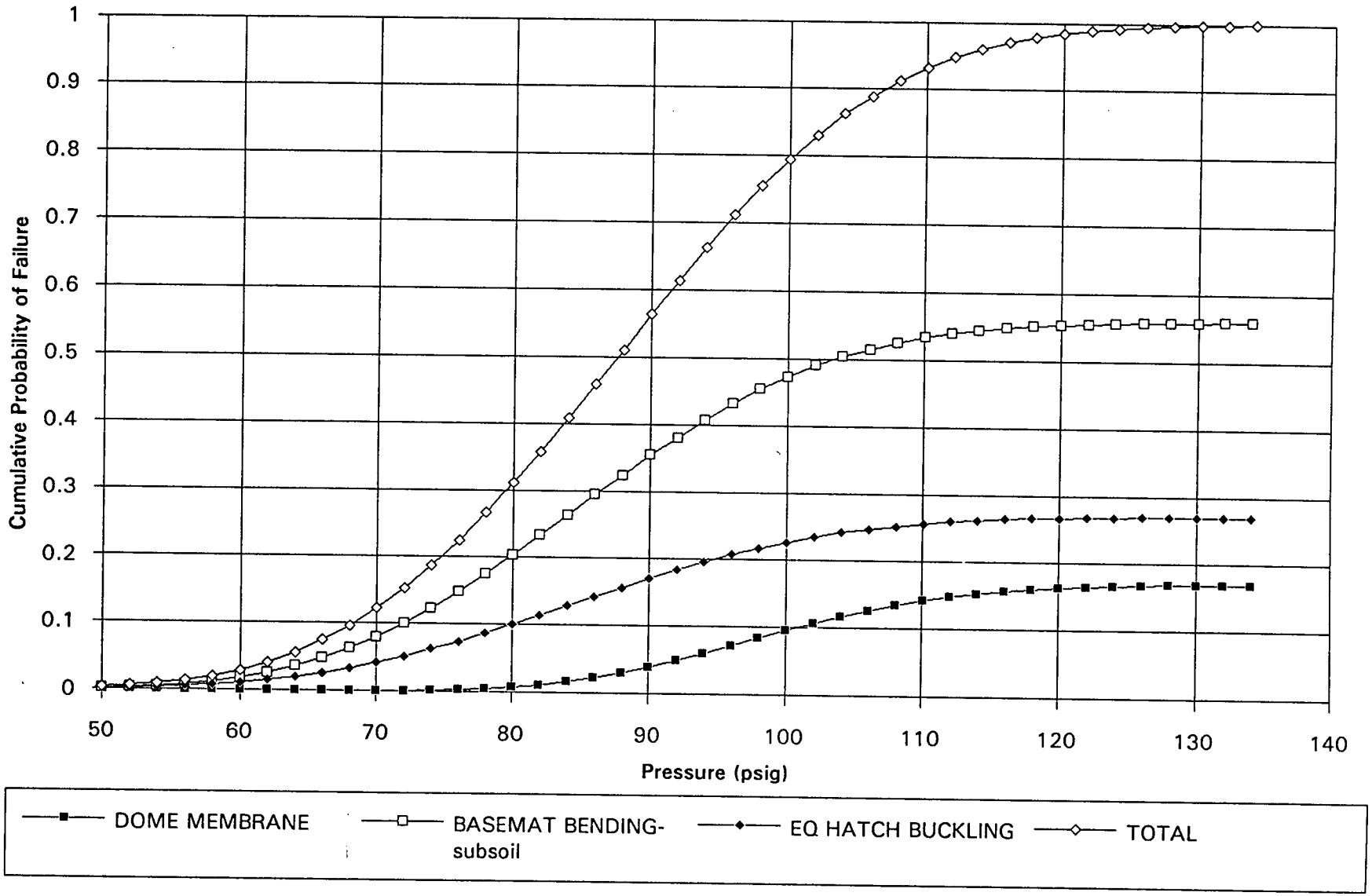


Figure 4.8-22. Cumulative Failure Probability of Watts Bar Containment: Slow Pressure Increase at 500°F

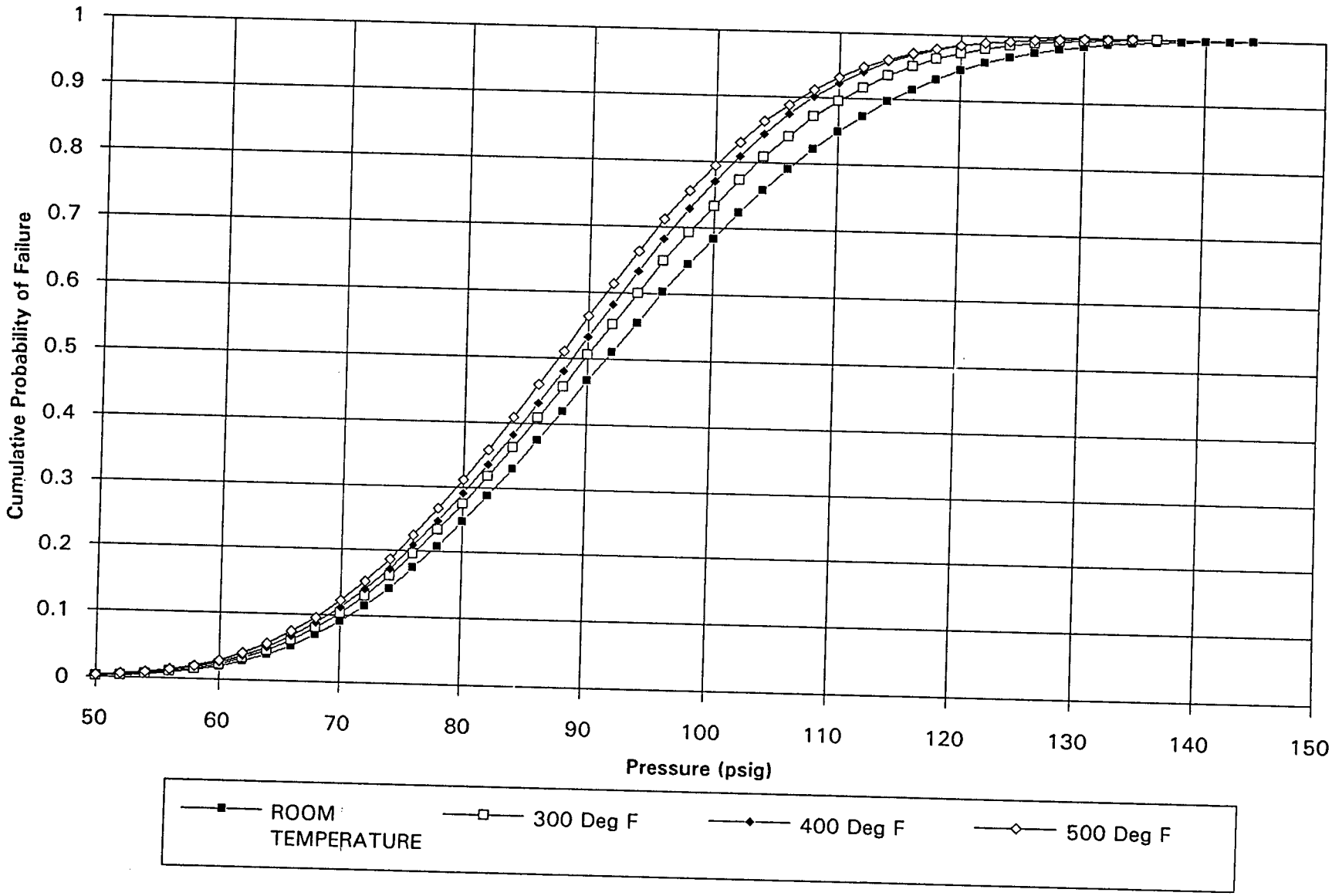


Figure 4.8-23. Cumulative Failure Probability of Watts Bar Containment for Slow Pressure Increases

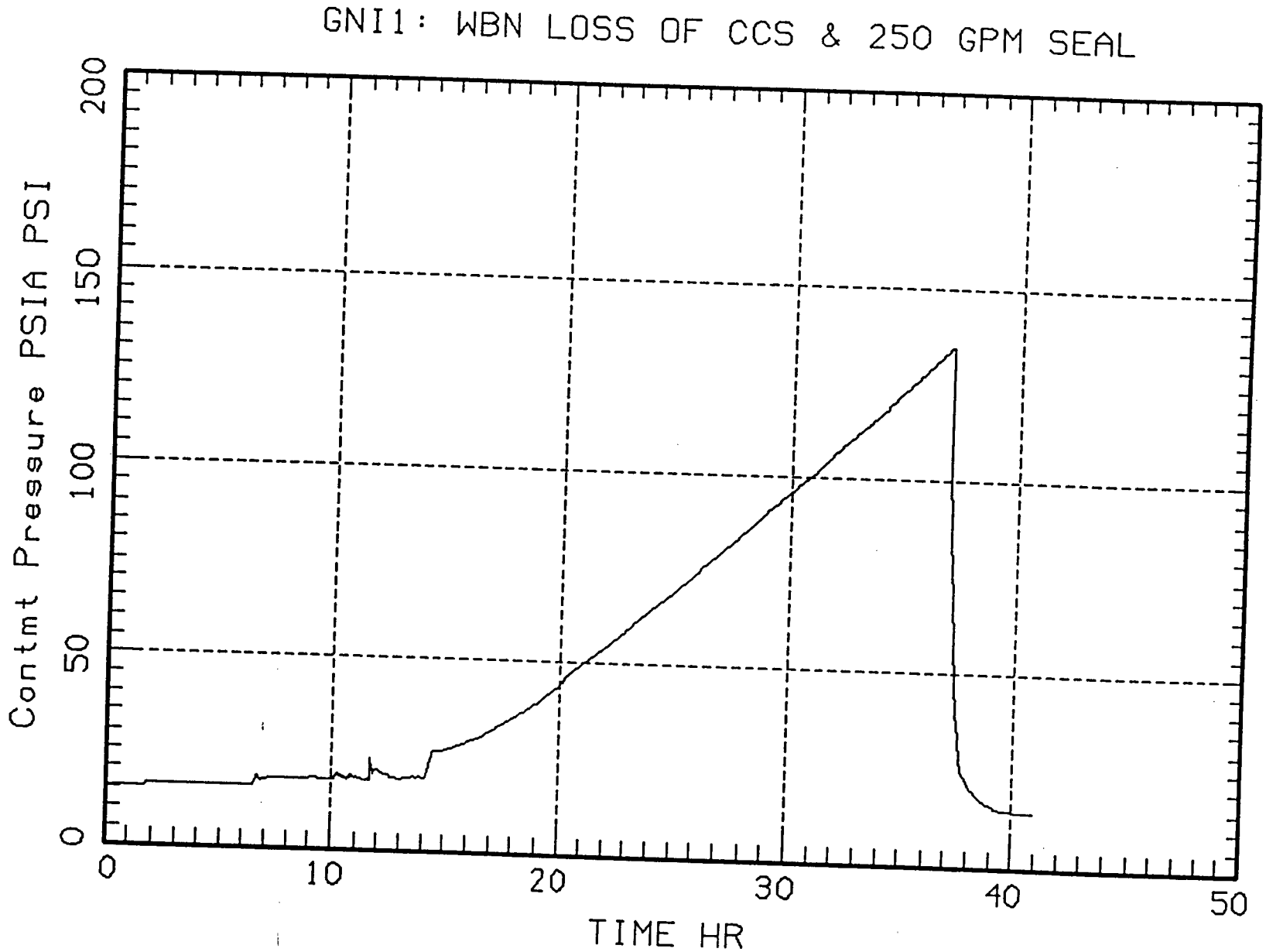


Figure 4.8-24. Containment Pressure Transient for KPDS GNIYA (from MAAP)

4.9 RADIONUCLIDE RELEASE CATEGORIES AND SOURCE TERMS

As shown in Section 4.5, the containment event tree (CET) has thousands of end states. When evaluated for various plant damage state parameter sets or for each plant damage state (PDS), the possible number of unique end states becomes extremely large. Rather than evaluate source terms for each end state, end states with qualitatively similar characteristics are grouped into radionuclide release categories. Source terms can then be quantified for this more limited set of release categories.

This report section describes the process of assigning the CET end states to specific release categories, how key release categories are identified for source term analysis, and how the radiological source terms are characterized for risk dominant release categories. Potential offsite consequences as well as frequency of occurrence are considered in evaluating risk dominant release categories. The Modular Accident Analysis Program (MAAP) code (Reference 4.9-1) has been selected to quantify source terms for Watts Bar.

4.9.1 RELEASE CATEGORY DEFINITION AND ASSIGNMENT

For ice condenser containments, such as those used at Watts Bar, many factors can potentially affect radionuclide releases into the environment during a severe accident. The most important of these factors must be considered in the development of release categories.

Release categories are groups of CET end states that can be represented by similar source terms; i.e., the variations in source terms for accident sequences within a given release category are expected to be smaller than variations from one release category to another. Source terms associated with the various release categories describe the fractional releases for representative radionuclide groups, as well as the timing, duration, and energy of release.

To identify those source term considerations and plant conditions that are potentially important to characterizing the severe accident release categories for an ice condenser containment, the source term information used in other Level 2 probabilistic risk assessments (PRA), and in particular, the NUREG/CR-4551 (Reference 4.9-2) analysis for Sequoyah, was reviewed. Based on insights gained from this review, a framework for defining release categories that takes into account Watts Bar-specific design features and containment pressure capacity information and includes some conservative assumptions is described below.

Table 4.9-1 lists nine important considerations that affect the release of radioactive materials into the environment. The first consideration addresses whether the radionuclides from the damaged fuel are released from the reactor coolant system (RCS) into the containment, or whether the release bypasses the containment. Section 4.9.1.1 discusses release category considerations affecting accidents in which the release is into the containment. Section 4.9.1.2 discusses considerations that affect scenarios in which the release bypasses the containment.

The parameters that are important in characterizing release are displayed in the Watts Bar release category assignment matrix shown in Table 4.9-2; this matrix is somewhat analogous to the PDS matrix shown in Figure 4.3-1. Source terms for key release

categories have been evaluated for Watts Bar using the MAAP code, as described in Section 4.9.3.

4.9.1.1 Releases into Containment

For cases in which the release of radionuclides from the damaged core is into the containment, a major release category consideration is whether containment failure occurs, and, if failure occurs, its timing relative to vessel breach (VB). In general, the earlier the containment failure, the greater is the source term, other factors remaining the same. The Watts Bar CET, described in Section 4.5, evaluates containment failure before VB [Top Event 10 (C1)], at VB [Top Event 14 (C2)], shortly after VB [Top Event 20 (CE)], and late containment failure [Top Events 23 (CL) and 26 (CLT)]. For the release category definition in this study, containment failure will be categorized as "pre-VB" if it occurs prior to VB,* as "early" if it occurs at or shortly after VB, as "late" if it occurs at any longer time, and as "none" if failure does not occur at all. "Late" release categories will include CET end states that incur late failure due to hydrogen burn within about 24 hours after VB [Top Event 23 (CL)] as well as CET end states that incur long-term overpressurization or basemat melt-through on the order of 1 or more days after VB [Top Event 26 (CLT) or 28 (BI)].** Release categories R01 through R04SU contain combinations of pre-VB and/or early containment failures. Release categories R05 and R05S through R08 and R08S contain either pre-VB or early failures, whereas release categories R05L and R05SL through R08L and R08SL combine pre-VB or early failure with late containment failure. Release categories R09 and R09U through R16 contain late containment failures exclusively. Release categories R17L and R17LU are reserved for cases of long-term overpressurization (failures that occur more than 24 hours after VB), while release category R17U contains cases of basemat melt-through. Release categories R21 and R22 contain end states where no containment failure occurs.

A third source term consideration is related to the size of the leakage path, if containment failure occurs. In general, but not always, the larger the failure, the greater the source term. For this study, the size will be categorized as "small" if it is a controlled leak failure mode (with a slow, continuous release into the environment with considerable atmospheric dilution); otherwise, it will be categorized as a "large" break (with a rapid release of the containment airborne constituents). A related (fourth) consideration is the location of containment failure, as any resultant release could be directly into the environment, or it could be attenuated by passing first into an auxiliary building or a contiguous structure, or by passing through the soil in the case of a basemat melt-through.† Note in the CET that a small leak can be followed later by a large break. Thus, separate release categories are defined to evaluate the source terms that result from small pre-VB or early containment failures (e.g., R05S and R05) as well as those from large, late containment failure following early or pre-VB failures; e.g., R05SL and R05L. End states that result from

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*Failures prior to vessel breach include preexisting containment failures, failures to isolate containment, and overpressurization due to hydrogen burn and/or RCS blowdown prior to VB.

**It is very likely that some form of recovery can be implemented within this time frame.

†For this study, all releases are assumed to be directly into the environment, except for bypass events and basemat melt-through.

large, early containment failure following small pre-VB failures are placed in the same release categories as end states with large pre-VB failures; i.e., R01S, R01SI, and R01SIF through R04SU, R04SUI, and R04SUIF.

Another source term consideration relates to containment spray operation for fission product scrubbing. A related consideration is whether the ex-vessel core debris is coolable or scrubbable; i.e., covered with water, which would at least attenuate the fission product release from the core debris. For this study, three containment spray cases have been considered: both the injection and recirculation sprays operate, only the injection sprays operate, or no sprays operate. Containment spray pumps actuate on a high-high pressure signal. Spray may have operated in the injection mode before vessel breach, but the residual heat removal (RHR) system may have failed in the recirculation mode, causing delayed core damage. The timing of automatic spray initiators on high-high containment pressure will be accident sequence dependent. As noted in Section 4.1.4, two containment spray pumps, each operating at its 4,000-gpm design flow rate, will deplete the 350,000-gallon refueling water storage tank (RWST) inventory after about a half-hour. That duration of spray operation is judged to wash out any airborne releases that could occur at vessel breach.

If the RWST is injected, as it would be if the sprays operate, the water in the lower compartment of the containment would not be deep enough to overflow into the reactor cavity. Additional water that is equivalent to the melting of one-fourth of the ice in the ice condenser would be required before water would spill into the reactor cavity. On the other hand, if no RWST injection occurs, which means neither spray nor vessel injection occurs, then complete ice condenser melting alone would not be enough to overflow into the reactor cavity. Thus, RWST injection plus significant ice melting would be required in order to submerge substantial core debris and affect fission product scrubbing and debris cooling. Depending on the RCS pressure and whether the RWST has been injected at the time of vessel breach, the core debris will be on the reactor cavity floor, on the lower compartment floor, and/or in the seal table room. Thus, if conditions are such as to enhance corium entrainment and sweepout from the cavity (i.e., high pressure, dry cases), a large fraction of the debris could be dispersed out the cavity. On the other hand, little sweepout from the reactor cavity would be expected for low pressure, dry cases. In summary, the operability of containment sprays and whether the ex-vessel debris is cooled or scrubbed are important considerations in characterizing Watts Bar release categories. When the ex-vessel debris is neither cooled nor scrubbed, the release is assigned to a category with a "U"; e.g., R01U. Cases in which fission product release from ex-vessel debris is avoided (because of cooling) or significantly attenuated (because of scrubbing) are binned together and assigned to release categories with no "U"; e.g., R01. Categories in which both injection and recirculation sprays are available include the even-numbered release categories through R16. If injection sprays operate but recirculation fails, the attenuation of fission products is not much better than if no sprays operate. Thus, "injection only" is binned with no sprays in the odd-numbered release categories through R15.

Two other source term considerations are related to the effectiveness of the ice condenser at removing fission products from the containment atmosphere. One addresses whether the ice condenser is intact, partially bypassed, or significantly bypassed. The decontamination achieved as fission products pass over an intact ice condenser will significantly exceed that of a bypassed ice condenser, and will be somewhat better than

that of a partially bypassed ice condenser. The other consideration addresses the operability of the air return fans. Operating air return fans can enhance the effectiveness of the ice condenser by recirculating the fission products in the containment atmosphere multiple times over the ice and ice condenser structural components. In contrast, if the air return fans are not operating, the fission products pass over the ice condenser just once. The effectiveness of the ice condensers is considered only for decontaminating the RCS release, or early release. Decontamination of a late release resulting from core-concrete interaction (CCI) is not a consideration in assigning release categories for Watts Bar. Cases with an intact ice condenser or a partially bypassed ice condenser are binned together into one release category that is designated with an "I"; e.g., R02I or R02IF. The "F" designates those release categories that also have operating air return fans. Release categories through R16 with neither an "I" nor an "F" are cases in which the ice condenser is substantially bypassed, including cases in which the ice has melted. (Operation of the air return fans has little effect on fission products if the ice condenser is not effective.)

Another source term factor is whether vessel breach occurs, and if so, the RCS pressure at the time of vessel breach. Fission product release into the environment is minimized if vessel breach does not occur. Early retention of fission products in the RCS is greater if the RCS pressure remains high prior to vessel breach, although late releases can be worse if early retention is higher. The CET characterizes the RCS pressure at the time of vessel breach into four ranges: system setpoint, high, intermediate, and low. For Watts Bar release category characterization, the high and intermediate pressure ranges will be combined and called "medium," and three ranges will be considered: (1) high (system setpoint), (2) medium (~200 to 2,000 psi), and (3) low (< 200 psi). For late containment failure, early, high retention in the primary system can become a liability. Therefore, for late containment failure categories, medium RCS pressure sequences are binned with high RCS pressure sequences for conservatism; e.g., in the R09, R10, R13, R14, and R17 release categories. For early, large containment failure, early, high retention in the primary system is beneficial, whereas for early, small, or preexisting containment failures, leak rates with the potential to convect fission products out of the containment may actually be greater later in the event, and the conservative approximation is to treat medium RCS pressure sequences as if they were "high." Therefore, for categories with large, early containment failures (e.g., the R03 and R04 release categories), medium RCS pressure sequences are binned with "low" RCS pressure sequences; for categories with small, early containment failures (e.g., the R05 and R06 release categories), medium RCS pressure sequences are binned with "high" RCS pressure sequences. All of the R22 release categories consider cases with no vessel breach.

4.9.1.2 Releases that Bypass Containment

Containment bypass scenarios, in which the bulk of the radionuclide release bypasses the containment altogether, are placed into one of three release categories. Release category R18 has been defined for steam generator tube ruptures (SGTR) that are induced by a thermal or pressure transient. Multiple tubes could be affected, so the release path could be large. Interfacing system loss of coolant accidents (LOCA) that bypass the containment (also referred to as V-sequences) are binned to release category R19, which contains large bypass release paths. Events initiated by steam generator tube ruptures are binned to release category R20, which represents a small diameter bypass release path, as it is unlikely that the SGTR affects more than one tube.

At Watts Bar, some interfacing systems that could suffer LOCAs are located such that discharge would be into the containment. Only those interfacing system LOCAs that bypass the containment are placed into a V-sequence category. A release due to a V-sequence is assumed to be outside the containment into the auxiliary building.

The other two categories of containment bypass involve failure of one or more steam generator tubes and the release of primary coolant through the ruptured steam generator tube(s) into the environment through the secondary side. Steam generator tube ruptures may occur as the cause of the plant trip (i.e., the initiating event) or in response to some other accident sequence [e.g., failure of reactor trip or anticipated transient without scram (ATWS)], which might lead to a higher-than-normal pressure differential across the tubes. Multiple steam generator tube failures can also occur as a consequence of elevated RCS gas temperatures and pressure that can occur prior to vessel breach during some core damage sequences. Such failures, referred to as thermally induced steam generator tube ruptures, are included as Top Event 6 (IS) in the CET, as noted in Section 4.5.

In either SGTR case, the release path is directly into the environment, with no holdup in either the containment atmosphere or the auxiliary building. Some scrubbing of the release may occur due to water remaining in the faulted steam generator(s). The specific path through the secondary side depends on the failure mode to isolate. Potential release paths include a failed-open safety valve, atmospheric steam dump valve, or main steam isolation valve on the steam generator with failed tubes.

In summary, the source term characterization parameters selected for Watts Bar, and their possible attributes, are summarized as follows:

- Containment bypass (yes or no).
- Time of containment failure (pre-VB, early, late, or none).
- Size of containment failure or bypass (large break or small leak).
- Location of containment failure or bypass (to environment, to auxiliary building, or to ground).
- Containment spray operation following VB (injection and recirculation, injection only, or none).
- Ex-vessel debris cooling (cooled, scrubbed, or no).
- Ice condenser functionality for the RCS release (intact, partially bypassed, or bypassed).
- Air return fan operation for the RCS release (yes or no).
- RCS pressure at time of VB (high, medium, or low).

These parameters are displayed in the Watts Bar release category assignment matrix shown in Table 4.9-2. The last column shown in Table 4.9-2 is the major release group. The major release group, which has been used as a very informative, high-level plant risk

characterization index, collects large, early releases (group I); small, early releases (group II); late and long-term releases (group III); and the benign case of no containment failure (group IV). For reporting purposes, Group IIIA and IIIB are merged.

4.9.2 SELECTION OF KEY RELEASE CATEGORIES FOR SOURCE TERM ANALYSIS

Quantification of the CET, which is performed for each key plant damage state (KPDS), determines the frequency of each release category defined as an end state of the CET. Table 4.9-3 summarizes the frequencies of the Watts Bar release categories, ordered by decreasing frequency within a general release category group. Those release categories not shown in this table have negligible or no frequency.

Each of the first six release categories in group I exceeds 1×10^{-7} per reactor-year and represents almost 90% of the frequency of that group. The remaining frequency in this group could be subsumed into release category R01DI* if required for Level 3 analysis. This subsumation would increase the frequency of R01DI by approximately 19%. Based on their relative frequencies within the group and the assumption that the remaining frequency could be subsumed into R01DI, if necessary for Level 3 analysis, release categories R01DI, R03IF, R04, R03IF, R01IF, and R01 have been selected as key release categories (KRC) for group I. It should be noted that each KRC is characterized by containment response phenomena for which there is significant uncertainty. Since these phenomena have been treated somewhat conservatively in this analysis, it is expected that the frequencies of these KRCs will decrease as the results of ongoing NRC and industry-sponsored research become available.

As Table 4.9-3 indicates, only one release category (R20) needs to be identified as a KRC for group II.

Although release category R17L represents approximately 53% of the group III frequency, two additional release categories shown in Table 4.9-3 for this group have also been identified as KRCs. Those release categories with late hydrogen burns were not examined in detail since the timing of containment failure varies significantly.

Group IV represents long-term containment intact sequences, including sequences that were recovered in-vessel.

Where possible, source terms for each of the 10 KRCs identified above were developed using the MAAP code. The Level 2 sequence representing each KRCs is discussed in the sections that follow. The source terms for these KRCs are discussed in Section 4.9.3.

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*Key Release Category R01DI does not appear in Table 4.9-2. The letters DI were added to Release Category 01 to denote that the failure was caused by direct impingement.

4.9.2.1 Key Release Category R01DI

KRC R01DI represents approximately 54% of the group I frequency and contains sequences with a variety of KPDS initiators, including GNIYA, HGI, and GNIYN. The sequences in this KRC, however, have the following attributes in common:

- High pressure melt ejection at vessel breach.
- Containment failure at vessel breach due to seal table failure and direct impingement of the debris on the containment wall leading to a large failure shortly after vessel breach.
- Although containment sprays may be available for some KPDS initiators, they are assumed to be ineffective for fission product scrubbing.

4.9.2.2 Key Release Category R03IF

KRC R03IF also contains sequences with a variety of KPDS initiators, including ENIYA, FNI, and KNI. The dominant sequences in this KRC have the following attributes:

- Low pressure alpha-mode failure of the vessel and containment or an ex-vessel steam explosion that failed containment at vessel breach.
- Containment failure was large.
- Sprays unavailable for scrubbing of airborne fission products.
- No concrete attack.

4.9.2.3 Key Release Category R04

KRC R04 has sequences generated by KPDSs FCI and HCI and attributes that are similar to R03IF. The differentiation between end states lies in the initial availability of sprays. In this analysis, sprays are assumed to fail as a result of the large, containment failure. Therefore, only spray scrubbing of the release prior to vessel breach and containment failure occurs.

4.9.2.4 Key Release Category R03I

This KRC is dominated by KPDS ENIYN and has similar attributes to KRC R03IF except that air return fans (ARF) are operating during sequences assigned to this release category, whereas they were not for R03IF.

4.9.2.5 Key Release Category R01IF

This KRC is dominated by sequences generated by KPDS GNIYA. The important attributes of these sequences are as follows:

- Small reactor coolant pump (RCP) seal LOCA or no breach in the RCS.
- Large containment failure at vessel breach due to high pressure melt ejection (HPME).
- Most of the debris outside of cavity; no concrete attack.
- No sprays.

4.9.2.6 Key Release Category R01

This KRC is dominated by a sequence initiated by KPDS HGI. The important attributes for this sequence are as follows:

- Large containment failure at vessel breach due to HPME.
- Ice condenser bypassed prior to vessel breach.
- No sprays.
- No concrete attack.

4.9.2.7 Key Release Category R20

This KRC represents containment bypass scenarios involving SGTRs as an initiating event or a small containment isolation failure that led to a bypass of the containment through the RCP seal return lines. Although only single tube failures are assumed, the corresponding source terms can be quite large if a secondary-side relief valve sticks open. Two KPDSs with SGTRs, EIB, and ENB, are binned to this KRC. KPDS EIB involves a stuck-open steam generator relief valve, and KPDS ENB involves an unisolated bypass to the environment via the turbine-driven AFW pump steam supply line. The source term for KPDS EIB represents an upper bound for the source term associated with KPDS ENB.

The third KPDS that contributes to this KRC is ENS, which represents the RCP seal return bypass. Source terms are required for each of these types of bypasses since their magnitudes can be quite different.

4.9.2.8 Key Release Category R17L

This KRC represents long-term overpressurization failures and contains sequences corresponding to a variety of KPDSs, the most important of which is FNI. The sequences in this KRC are characterized by the following important attributes:

- Large, late overpressure failure of the containment.
- No sprays in operation prior to or after containment failure.
- No concrete attack due to quenching of debris within the cavity.

The timing of containment failure for this KRC (44 hours) is based on the time to reach the median containment failure pressure based on the representative sequence for KPDS FNI.

4.9.2.9 Key Release Category R17LU

This KRC is similar to KRC R17L except that the debris has been dispersed from the cavity due to HPME. The sequences in this KRC are characterized by the following important attributes:

- Large, late overpressure failure of the containment.
- No sprays in operation prior to or after containment failure.
- No concrete attack.

The timing of containment failure for this KRC (27 hours) is based on the time to reach the median containment failure pressure based on the representative sequence for KPDS GNIYA.

4.9.2.10 Key Release Category R17U

This KRC represents long-term containment failure due to basemat melt-through. No MAAP analysis was performed for this KRC as it represents a very benign release.

4.9.3 DETERMINATION OF SOURCE TERMS FOR KEY RELEASE CATEGORIES

One or more MAAP calculations were made of a representative accident sequence selected for each key release category. These were used to define specific fission product source terms and the timing of release to all the sequences assigned to the release category. The timing of the release is for convenience defined with respect to the time of core uncovering. It is worth noting in this regard that many of the sequences involved a cooldown of the RCS. Cooldown generally resulted in an extended period between core uncovery and reactor vessel failure. For this reason, even "early" containment failures that occurred around the time of vessel failure are sometimes several hours after the time of core uncovering. Thus there would be some time available for evacuation and sheltering.

MAAP computes the release of fission products from the containment and from the auxiliary building in terms of 12 fission product "groups." These are shown in Table 4.9-4. By convention, the fraction of the total initial fission product inventory from each group that is released to the environment or auxiliary building is reported.

In Watts Bar, only one of the key release categories involve a containment bypass to the auxiliary building. For conservatism, no credit was taken for retention of fission products in the auxiliary building for any of the other sequences.

A brief discussion of the calculations used to determine representative source terms is given below. Further details on these cases are available in Section 4.7.2.

4.9.3.1 Group I Key Release Categories

Group I includes sequences that result in large, early containment failures or that involve a large bypass of the containment. There are three key release categories in this group.

4.9.3.1.1 Key Release Category R01DI

This release category consists of sequences in which high pressure melt ejection occurs, and containment failure is caused by impingement of debris on the containment wall (i.e., due to dispersal of debris through the seal table). This scenario was represented by rerunning the MAAP calculation for plant damage state HNI (see Section 4.7.2) with reduced seal LOCA sizes to ensure nearly complete dispersal of debris from the reactor cavity. Sprays are available in some sequences in this group, but their effect would be limited since the spray droplets could not reach the debris.

MAAP does not allow the user to explicitly model dispersal of debris to the incore instrument room in which the seal table is located. In order to represent the expected release of fission products due to core-concrete interactions, the plant input parameters were altered in such a way as to prevent sustained interaction between the dispersed debris and water. This was done by creating a large sump in the dead-end compartment to hold all the water which would ordinarily collect in the lower compartment and cool the debris. On the other hand, it should be noted that even with the modification of the plant model described above, melted ice runs across the debris on its way to the sump, so concrete attack was delayed in the calculation as well. More accurate modeling of this sequence would require code modifications or additional calculations, which were considered beyond the scope of the IPE.

The results are shown in Table 4.9-5.

4.9.3.1.2 Key Release Category R03IF

This release category represents low pressure sequences in which the containment is assumed to fail as a result of either an in-vessel or ex-vessel steam explosion. This case was also represented by plant damage state HNI, but in this case the normal seal LOCA assumptions (250 gpm leakage at nominal operating conditions) were made so that debris dispersal out of the reactor cavity was not predicted to occur. The debris was quenched in the cavity, and negligible ex-vessel release of fission products was calculated.

The environmental release fractions are shown in Table 4.9-6. As stated before, very small releases of nonvolatile fission products were predicted due to the absence of core/concrete interactions. Aside from noble gases, release to the environment of volatile fission products liberated during core degradation is relatively small due to the extended period of core damage; this allowed natural removal mechanisms both in the RCS and containment sufficient time to be effective.

4.9.3.1.3 Key Release Category R04

This release category is very similar to R03IF except that sprays are available until the time of containment failure; at this point they are assumed to be failed as a consequence of the events occurring around vessel failure. Considerable attenuation of the fission products released prior to this time therefore takes place.

Calculated release fractions are shown in Table 4.9-7. These were computed using the calculation for the dominant sequence in plant damage state FCI (MAAP case FCI4). The only change was to force a large containment failure at the time of vessel failure.

As shown in the table, releases are small due to the effects of sprays on the pre-vessel failure release, the low primary system pressure at vessel failure, the absence of core-concrete interactions, and the small magnitude of revaporization.

4.9.3.2 Group II Release Categories: Key Release Category R20

This group consists of small containment bypass sequences. For simplicity, all of these sequences are assigned to a single release category, R20. Three plant damage states were considered to represent such sequences, ENS, EIB, and ENB.

Case ENS, described in more detail in Section 4.7.2, involves a bypass of the containment through the seal return lines. The sequence evolves over many hours. The calculated releases to the auxiliary building are relatively high but the releases to the environment are significantly reduced by retention in the auxiliary building as shown in Table 4.9-8.

Plant damage states EIB and ENB both involve steam generator tube rupture sequences with either a stuck safety valve or an unisolated AFW turbine steam supply line. Releases for these cases are shown in Tables 4.9-9 and 4.9-10. With respect to the isotopes of most interest, case EIB is roughly twice those in case ENB, primarily because cooldown of the intact steam generators in ENB reduces the magnitude of the flow from the RCS to the faulted unit and thus increases the residence time.

The calculated releases in case EIB are about double those in ENS. For this reason, the source terms associated with case EIB (i.e., those shown in Table 4.9-9) can be conservatively taken to characterize all the sequences in release category R20.

4.9.3.3 Group III Release Categories

Group III release categories are assigned to sequences involving late failures of the containment. In Watts Bar, these usually involve small source terms, unless revaporization in the RCS results in a substantial release of previously deposited cesium iodide. This group consists of two release categories which are defined below.

4.9.3.3.1 Key Release Category R17L

This release category describes cases involving late failures of the containment due to steam overpressure. To characterize the releases, the MAAP calculation used to simulate plant damage state GNI (case GNI2) was used. GN12 involved a late failure of the containment, and moderate revaporization due to the failure of AFW and the presence of substantial quantities of fuel inside the RPV after vessel failure.

Most of the tellurium is released from the debris at the onset of concrete attack when the unoxidized zirconium mass is high. This is the case because the reaction of zirconium with steam and carbon dioxide in the debris leads to high temperatures and high hydrogen and carbon monoxide to steam ratios. Both effects enhance the release of fission products from the debris. Once the zirconium has been largely oxidized, release rates from the debris diminish greatly.

An extended period of concrete attack preceded containment failure in GNI2. For the reasons cited above, release of tellurium from the debris has effectively ceased long before

the time of containment failure. Releases to the environment are therefore rather modest (i.e., comparable to the iodine release at about 1%). All of the environmental release fractions are shown in Table 4.9-11.

4.9.3.3.2 Key Release Category R17LU

This release category is used to describe sequences with low RCS pressure at vessel failure, and late overpressure of containment due to core-concrete interactions. For purposes of calculating source terms, plant damage state KNI (MAAP case KNI3) was selected. Containment failure was assumed to occur at a relatively low pressure. (This conservatively corresponds to the median failure pressure in Sequoyah).

Nevertheless, as shown in Table 4.9-12, containment failure is sufficiently late to result in low releases of nonvolatile liberated during core-concrete interactions. As far as the volatiles are concerned, releases due to revaporization are small. This is primarily a result of an induced hot leg rupture, which caused primary system retention of cesium iodide to be low.

4.9.3.3.3 Key Release Category R17U

These cases are used to characterize late basemat melt-through sequences. The calculation used to represent plant damage state EGI (MAAP case SQN4) was employed to estimate the release fractions. SQN4 was initiated by a small LOCA. Injection and containment sprays were lost after the switchover to recirculation mode since the refueling cavity drains are assumed to be blocked. Since this calculation used the median failure pressure for Sequoyah, the containment failed at a time earlier than would be anticipated for Watts Bar.

Calculation of release rates through an ablated basemat is problematical. Instead, a late large failure of the containment was assumed. It is believed that this assumption will conservatively represent the release to the environment, since some scrubbing of a basemat release would be expected.

The calculated release fractions to the environment are shown in Table 4.9-13. Aside from noble gases, releases are small due to the late timing of containment failure relative to the onset of concrete attack and the minimal magnitude of RCS revaporization.

4.9.4 REFERENCES

4.9-1. Henry, R. E., and M. G. Plys, "MAAP 3.0B — Modular Accident Analysis Program for LWR Power Plants," Electric Power Research Institute, EPRI NP-7071-CCML, Volumes 1 - 3, November 1990.

4.9-2. Sandia National Laboratories, "Evaluation of Severe Accident Risks: Sequoyah, Unit 1," prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-4551, SAND86-1390, Vol. 5, Rev. 1, Part 2, December 1990.

Table 4.9-1 (Page 1 of 2). General Release Category Considerations for Ice Condenser Containment PWRs

Issue	Why Important?	PDS or CET Event?	Discretization
Containment Bypass (V) or SGTR	Interfacing system LOCA bypassing containment (e.g., WASH-1400 V-sequence) or a steam generator tube rupture has the potential for direct fission product release to the auxiliary building or environment without having the containment "involved" until after vessel failure.	PDS (initiating events)/CET (thermally induced SGTRs)	Yes (y), No (n)
RCS Pressure (R)	High RCS pressure can lead to containment failure at vessel failure, among other things. Also, early retention in the RCS is greater for high RCS pressure. However, late releases can be worse if early retention is higher.	PDS	High (h), Moderate (m), Low (l)
Time of Containment Breach (T)	In general, the earlier the containment failure (i.e., loss of containment function, or bypass), the greater the source term.	PDS (isolation failure)/CET	Pre-VB (i.e., before core degradation) (p), Early (e), Late (l)
Size of Containment Breach (B)	In general, but not always, the larger the containment failure, the greater the source term.	PDS (isolation failure)/CET	Large (l), Small (s)
Location of Containment Breach (L)	If the failure is through or near a penetration, it will most generally be into an auxiliary building or a contiguous structure of some kind. Notable exceptions may include certain large failures such as the purge opening. The containment may also fail due to basemat melt-through, but this applies only to late containment breach, Tl, and a small effective size, Bs. Releases that pass through the auxiliary building or the ground will be smaller, in general, than those going directly into the outside air environment.	CET	Through auxiliary building (a), Outside auxiliary building (o), Basemat melt-through (b), Induced containment bypass (i)
Spray System (S)	Sprays are an important mechanism for fission product removal and heat removal from the containment atmosphere.	PDS/CET (failed due to containment failure)	Injection and recirculation (i and r), Injection only (i), Not available (n)
Ex-Vessel Debris Coolability (C)	After vessel failure (and given that the core debris is not dispersed by high RCS pressure), a "wet" cavity (one in which water is either continuously available or available for a very long time, on the order of 24 hours after vessel failure) provides a means of cooling or at least attenuating the fission product release from the core debris.	PDS	Cooled, no CCI (c), CCI scrubbed (s), CCI not scrubbed (n)

Table 4.9-1 (Page 2 of 2). General Release Category Considerations for Ice Condenser Containment PWRs			
Issue	**Why Important?**	**PDS or CET Event?**	**Discretization**
Ice Condenser (I)	Fission products entrained in steam are removed from the containment atmosphere when the steam is condensed. Volatile fission products also condense onto the cold ice beds. Melted ice or a bypassed condenser will significantly diminish the effectiveness of the ice condenser to remove fission products.	CET	Intact (i), Partial bypass (p), Bypass (b)
Air Return Fans (F)	Air return fans can recirculate the containment atmosphere over the ice condenser beds multiple times, enhancing their effectiveness in removing fission products from the containment.	PDS/CET (failed due to containment failure)	Yes (y), No (n)

Table 4.9-2 (Page 1 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass			
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small	None	
R01	X				X			X-	-X[4]		X-	-X	X-	-X				X							I
R01I	X					X			X		X-	-X	X-	-X				X							I
R01IF	X					X		X			X-	-X	X-	-X				X							I
R01S	X				X			X-	-X		X-	-X	X-	-X		X[5]	+[6]	+							I
R01SI	X					X			X		X-	-X	X-	-X		X	+	+							I
R01SIF	X					X		X			X-	-X	X-	-X		X	+	+							I
R01U	X				X			X-	-X		X-	-X			X			X							I
R01UI	X					X-	-X		X		X-	-X			X			X							I
R01UIF	X					X-	-X	X			X-	-X			X			X							I
R01SU	X				X			X-	-X		X-	-X			X	X	+	+							I
R01SUI	X					X-	-X		X		X-	-X			X	X	+	+							I
R01SUIF	X					X-	-X	X			X-	-X			X	X	+	+							I
R02	X				X			X-	-X	X			X-	-X				X							I
R02I	X					X			X	X			X-	-X				X							I
R02IF	X					X		X		X			X-	-X				X							I
R02S	X				X			X-	-X	X			X-	-X		X	+	+							I
R02SI	X					X			X	X			X-	-X		X	+	+							I

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Some release categories include two containment failure modes. One is indicated by "X," while the other is indicated by "+."
6. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-2 (Page 2 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R02SIF	X					X		X		X			X-	-X[4]		X[5]	+[6]	+							I
R02U	X				X			X-	-X	X					X			X							I
R02UI	X					X-	-X		X	X					X			X							I
R02UIF	X					X-	-X	X		X					X			X							I
R02SU	X				X			X-	-X	X					X	X	+	+							I
R02SUI	X					X-	-X		X	X					X	X	+	+							I
R02SUIF	X					X-	-X	X		X					X	X	+	+							I
R03		X-	-X		X			X-	-X		X-	-X	X-	-X				X							I
R03I		X-	-X			X			X		X-	-X	X-	-X				X							I
R03IF		X-	-X			X		X			X-	-X	X-	-X				X							I
R03S		X-	-X		X			X-	-X		X-	-X	X-	-X		X	+	+							I
R03SI		X-	-X			X			X		X-	-X	X-	-X		X	+	+							I
R03SIF		X-	-X			X		X			X-	-X	X-	-X		X	+	+							I
R03U		X-	-X		X			X-	-X		X-	-X			X			X							I
R03UI		X-	-X			X			X		X-	-X			X			X							I
R03UIF		X-	-X			X		X			X-	-X			X			X							I
R03SU		X-	-X		X			X-	-X		X-	-X			X	X	+	+							I

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Some release categories include two containment failure modes. One is indicated by "X," while the other is indicated by "+."
6. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-2 (Page 3 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R03SUI		X-	-X[4]			X			X		X-	-X			X	X[5]	+[6]	+							I
R03SUIF		X-	-X			X		X			X-	-X			X	X	+	+							I
R04		X-	-X		X			X-	-X	X			X-	-X				X							I
R04I		X-	-X			X			X	X			X-	-X				X							I
R04IF		X-	-X			X		X		X			X-	-X				X							I
R04S		X-	-X		X			X-	-X	X			X-	-X		X	+	+							I
R04SI		X-	-X			X			X	X			X-	-X		X	+	+							I
R04SIF		X-	-X			X		X		X			X-	-X		X	+	+							I
R04U		X-	-X		X			X-	-X	X					X			X							I
R04UI		X-	-X			X			X	X					X			X							I
R04UIF		X-	-X			X		X		X					X			X							I
R04SU		X-	-X		X			X-	-X	X					X	X	+	+							I
R04SUI		X-	-X			X			X	X					X	X	+	+							I
R04SUIF		X-	-X			X		X		X					X	X	+	+							I
R05	X-	-X			X			X-	-X		X-	-X	X-	-X					X						II
R05I	X-	-X				X			X		X-	-X	X-	-X					X						II
R05IF	X-	-X				X		X			X-	-X	X-	-X					X						II

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Some release categories include two containment failure modes. One is indicated by "X," while the other is indicated by "+."
6. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-2 (Page 4 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R05S	X-	-X[4]			X			X-	-X		X-	-X	X-	-X			X								II
R05SI	X-	-X				X			X		X-	-X	X-	-X			X								II
R05SIF	X-	-X				X		X			X-	-X	X-	-X			X								II
R05L	X-	-X			X			X-	-X		X-	-X	X-	-X					X[5]	X					II
R05LI	X-	-X				X			X		X-	-X	X-	-X					X	X					II
R05LIF	X-	-X				X		X			X-	-X	X-	-X					X	X					II
R05SL	X-	-X			X			X-	-X		X-	-X	X-	-X			X			X					II
R05SLI	X-	-X				X			X		X-	-X	X-	-X			X			X					II
R05SLIF	X-	-X				X		X			X-	-X	X-	-X			X			X					II
R05U	X-	-X			X			X-	-X		X-	-X			X				X						II
R05UI	X-	-X				X-	-X		X		X-	-X			X				X						II
R05UIF	X-	-X				X-	-X	X			X-	-X			X				X						II
R05SU	X-	-X			X			X-	-X		X-	-X			X		X								II
R05SUI	X-	-X				X-	-X		X		X-	-X			X		X								II
R05SUIF	X-	-X				X-	-X	X			X-	-X			X		X								II
R05LU	X-	-X			X			X-	-X		X-	-X			X				X	X					II
R05LUI	X-	-X				X-	-X		X		X-	-X			X				X	X					II

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-2 (Page 5 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R05LUIF	X-	-X[4]				X-	-X	X			X-	-X			X				X[5]	X					II
R05SLU	X-	-X			X			X-	-X		X-	-X			X		X			X					II
R05SLUI	X-	-X				X-	-X		X		X-	-X			X		X			X					II
R05SLUIF	X-	-X				X-	-X	X			X-	-X			X		X			X					II
R06	X-	-X			X			X-	-X	X			X-	-X					X						II
R06I	X-	-X				X			X	X			X-	-X					X						II
R06IF	X-	-X				X		X		X			X-	-X					X						II
R06S	X-	-X			X			X-	-X	X			X-	-X			X								II
R06SI	X-	-X				X			X	X			X-	-X			X								II
R06SIF	X-	-X				X		X		X			X-	-X			X								II
R06L	X-	-X			X			X-	-X	X			X-	-X					X	X					II
R06LI	X-	-X				X			X	X			X-	-X					X	X					II
R06LIF	X-	-X				X		X		X			X-	-X					X	X					II
R06SL	X-	-X			X			X-	-X	X			X-	-X			X			X					II
R06SLI	X-	-X				X			X	X			X-	-X			X			X					II
R06SLIF	X-	-X				X		X		X			X-	-X			X			X					II
R06U	X-	-X			X			X-	-X	X					X				X						II

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-2 (Page 6 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R06UI	X-	-X[4]				X-	-X		X	X					X				X						II
R06UIF	X-	-X				X-	-X	X		X					X				X						II
R06SU	X-	-X			X			X-	-X	X					X		X								II
R06SUI	X-	-X				X-	-X		X	X					X		X								II
R06SUIF	X-	-X				X-	-X	X		X					X		X								II
R06LU	X-	-X			X			X-	-X	X					X				X[5]	X					II
R06LUI	X-	-X				X-	-X		X	X					X				X	X					II
R06LUIF	X-	-X				X-	-X	X		X					X				X	X					II
R06SLU	X-	-X			X			X-	-X	X					X		X			X					II
R06SLUI	X-	-X				X-	-X		X	X					X		X			X					II
R06SLUIF	X-	-X				X-	-X	X		X					X		X			X					II
R07			X		X			X-	-X		X-	-X	X-	-X					X						II
R07I			X			X			X		X-	-X	X-	-X					X						II
R07IF			X			X		X			X-	-X	X-	-X					X						II
R07S			X		X			X-	-X		X-	-X	X-	-X			X								II
R07SI			X			X			X		X-	-X	X-	-X			X								II
R07SIF			X			X		X			X-	-X	X-	-X			X								II

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-2 (Page 7 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R07L			X		X			X-	-X[4]		X-	-X	X-	-X					X[5]	X					II
R07LI			X			X			X		X-	-X	X-	-X					X	X					II
R07LIF			X			X		X			X-	-X	X-	-X					X	X					II
R07SL			X		X			X-	-X		X-	-X	X-	-X			X			X					II
R07SLI			X			X			X		X-	-X	X-	-X			X			X					II
R07SLIF			X			X		X			X-	-X	X-	-X			X			X					II
R07U			X		X			X-	-X		X-	-X			X				X						II
R07UI			X			X-	-X		X		X-	-X			X				X						II
R07UIF			X			X-	-X	X			X-	-X			X				X						II
R07SU			X		X			X-	-X		X-	-X			X		X								II
R07SUI			X			X-	-X		X		X-	-X			X		X								II
R07SUIF			X			X-	-X	X			X-	-X			X		X								II
R07LU			X		X			X-	-X		X-	-X			X				X	X					II
R07LUI			X			X-	-X		X		X-	-X			X				X	X					II
R07LUIF			X			X-	-X	X			X-	-X			X				X	X					II
R07SLU			X		X			X-	-X		X-	-X			X		X			X					II
R07SLUI			X			X-	-X		X		X-	-X			X		X			X					II

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-2 (Page 8 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R07SLUIF			X			X-	-X[4]	X			X-	-X			X		X[5]			X					II
R08			X		X			X-	-X	X			X-	-X					X						II
R08I			X			X			X	X			X-	-X					X						II
R08IF			X			X		X		X			X-	-X					X						II
R08S			X		X			X-	-X	X			X-	-X			X								II
R08SI			X			X			X	X			X-	-X			X								II
R08SIF			X			X		X		X			X-	-X			X								II
R08L			X		X			X-	-X	X			X-	-X					X	X					II
R08LI			X			X			X	X			X-	-X					X	X					II
R08LIF			X			X		X		X			X-	-X					X	X					II
R08SL			X		X			X-	-X	X			X-	-X			X			X					II
R08SLI			X			X			X	X			X-	-X			X			X					II
R08SLIF			X			X		X		X			X-	-X			X			X					II
R08U			X		X			X-	-X	X					X				X						II
R08UI			X			X-	-X		X	X					X				X						II
R08UIF			X			X-	-X	X		X					X				X						II
R08SU			X		X			X-	-X	X					X		X								II

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-2 (Page 9 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R08SUI			X			X-	-X[4]		X	X					X		X								II
R08SUIF			X			X-	-X	X		X					X		X								II
R08LU			X		X			X-	-X	X					X				X[5]	X					II
R08LUI			X			X-	-X		X	X					X				X	X					II
R08LUIF			X			X-	-X	X		X					X				X	X					II
R08SLU			X		X			X-	-X	X					X		X			X					II
R08SLUI			X			X-	-X		X	X					X		X			X					II
R08SLUIF			X			X-	-X	X		X					X		X			X					II
R09	X-	-X			X			X-	-X		X-	-X	X-	-X						X					III
R09I	X-	-X				X			X		X-	-X	X-	-X						X					III
R09IF	X-	-X				X		X			X-	-X	X-	-X						X					III
R09U	X-	-X			X			X-	-X		X-	-X			X					X					III
R09UI	X-	-X				X-	-X		X		X-	-X			X					X					III
R09UIF	X-	-X				X-	-X	X			X-	-X			X					X					III
R10	X-	-X			X			X-	-X	X			X-	-X						X					III
R10I	X-	-X				X			X	X			X-	-X						X					III
R10IF	X-	-X				X		X		X			X-	-X						X					III

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-2 (Page 10 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R10U	X-[4]	-X			X			X-	-X	X					X					X					III
R10UI	X-	-X				X-	-X		X	X					X					X					III
R10UIF	X-	-X				X-	-X	X		X					X					X					III
R11			X		X			X-	-X		X-	-X	X-	-X						X					III
R11I			X			X			X		X-	-X	X-	-X						X					III
R11IF			X			X		X			X-	-X	X-	-X						X					III
R11U			X		X			X-	-X		X-	-X			X					X					III
R11UI			X			X-	-X		X		X-	-X			X					X					III
R11UIF			X			X-	-X	X			X-	-X			X					X					III
R12			X		X			X-	-X	X			X-	-X						X					III
R12I			X			X			X	X			X-	-X						X					III
R12IF			X			X		X		X			X-	-X						X					III
R12U			X		X			X-	-X	X					X					X					III
R12UI			X			X-	-X		X	X					X					X					III
R12UIF			X			X-	-X	X		X					X					X					III
R13	X-	-X			X			X-	-X		X-	-X	X-	-X							X				III
R13I	X-	-X				X			X		X-	-X	X-	-X							X				III

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.

Table 4.9-2 (Page 11 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None		
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R13IF	X-	-X[4]				X		X			X-	-X	X-	-X							X				III
R13U	X-	-X			X			X-	-X		X-	-X			X						X				III
R13UI	X-	-X				X-	-X		X		X-	-X			X						X				III
R13UIF	X-	-X				X-	-X	X			X-	-X			X						X				III
R14	X-	-X			X			X-	-X	X			X-	-X							X				III
R14I	X-	-X				X			X	X			X-	-X							X				III
R14IF	X-	-X				X		X		X			X-	-X							X				III
R14U	X-	-X			X			X-	-X	X					X						X				III
R14UI	X-	-X				X-	-X		X	X					X						X				III
R14UIF	X-	-X				X-	-X	X		X					X						X				III
R15			X		X			X-	-X		X-	-X	X-	-X							X				III
R15I			X			X			X		X-	-X	X-	-X							X				III
R15IF			X			X		X			X-	-X	X-	-X							X				III
R15U			X		X			X-	-X		X-	-X			X						X				III
R15UI			X			X-	-X		X		X-	-X			X						X				III
R15UIF			X			X-	-X	X			X-	-X			X						X				III
R16			X		X			X-	-X	X			X-	-X							X				III

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.

Table 4.9-2 (Page 12 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R16I			X			X			X	X			X-	-X[4]							X				III
R16IF			X			X		X		X			X-	-X							X				III
R16U			X		X			X-	-X	X					X						X				III
R16UI			X			X-	-X		X	X					X						X				III
R16UIF			X			X-	-X	X		X					X						X				III
R17U	X-	-X-	-X		X			X-	-X	X-	-X-	-X			X						X[5]				III
R17L	X-	-X-	-X		X			X-	-X			X	X-	-X						X-	-X[6]				III
R17LU	X-	-X-	-X		X			X-	-X			X			X					X-	-X[6]				III
R18	X-	-X																				X			I
R19	X-	-X-	-X																			X			I
R20	X-	-X-	-X																				X		II
R21	X-	-X-	-X																					X	IV
R22				X																				X	IV
R22S				X	X			X-	-X	X-	-X-	-X					X[7]		+						II
R22SI				X		X-	-X		X	X-	-X-	-X					X		+						II
R22SIF				X		X-	-X	X		X-	-X-	-X					X		+						II

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; No = CCI not scrubbed.
3. Includes preexisting failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Basemat melt-through.
6. Long-term containment failure only; i.e., after about 24 hours.
7. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-2 (Page 13 of 13). Release Category Assignment Matrix for Watts Bar

Release Category	RCS Pressure at Vessel Breach (VB)				Early[1] Ice Condenser Failure Mode			Early Air Return Fans		Sprays I = Injection R = Recirculation			Ex-Vessel Debris C = Cooled S = Scrubbed[2]			Containment Failure Mode									Major Release Group
																Pre-VB[3]		Early		Late		Bypass		None	
	High	Medium	Low	No VB	Bypass	Partial Bypass	No	Yes	No	I + R	I	None	C	S	No	Large	Small	Large	Small	Large	Small	Large	Small		
R22L				X	X			X-	-X[4]	X-	-X-	-X				X[5]	+[6]	+							I
R22LI				X		X-	-X		X	X-	-X-	-X				X	+	+							I
R22LIF				X		X-	-X	X		X-	-X-	-X				X	+	+							I

Notes:
1. Ice condenser is assumed to be bypassed shortly after VB.
2. Discriminators for ex-vessel debris are: C = cooled, no CCI; S = CCI scrubbed by overlying pool of water; NO = CCI not scrubbed.
3. Includes pre-existing failures, failures to isolate, and overpressurization due to hydrogen burn prior to VB.
4. Dashed connectors indicate that multiple characteristic attributes have been binned together in one release category.
5. Some release categories include two containment failure modes. One is indicated by "X," while the other is indicated by "+."
6. Some containment failure modes involve both a small and, later, a large failure. Such modes are indicated by marks in more than one column.

Table 4.9-3 (Page 1 of 2). Watts Bar Release Category Frequencies

Release Category Group	Release Category	Frequency Per Reactor-Year
I. (6.9×10^{-6})	R01DI	3.7×10^{-6}
	R031F	1.3×10^{-6}
	R04	5.0×10^{-7}
	R03I	2.3×10^{-7}
	R01IF	2.3×10^{-7}
	RO1	1.7×10^{-7}
	R04IF	9.9×10^{-8}
	RO1I	9.5×10^{-8}
	R03	9.1×10^{-8}
	R03UIF	8.0×10^{-8}
	R18	6.1×10^{-8}
	RO3SUI	5.3×10^{-8}
	R02IF	4.7×10^{-8}
	R19	4.1×10^{-8}
	R04UIF	3.5×10^{-8}
	RO3SI	2.8×10^{-8}
	RO1SI	2.4×10^{-8}
	RO1UIF	1.2×10^{-8}
	R03SUIF	9.9×10^{-9}
	R03SIF	5.3×10^{-9}
	RO1UI	4.6×10^{-9}
	RO1SIF	4.5×10^{-9}
	RO1SUI	1.1×10^{-9}
	RO1SUIF	2.0×10^{-10}
	RO3UI	1.2×10^{-10}

Table 4.9-3 (Page 2 of 2). Watts Bar Release Category Frequencies

Release Category Group	Release Category	Frequency ($year^{-1}$)
II. (1.5×10^{-5})	R20	1.3×10^{-5}
	R07SLUI	8.9×10^{-7}
	R05SLI	4.7×10^{-7}
	RO5SLUI	2.0×10^{-7}
	R077SLUIF	1.7×10^{-7}
	RO5SLIF	8.8×10^{-8}
	RO5SLUIF	3.8×10^{-8}
III (9.5×10^{-5})	R17L	5.0×10^{-5}
	R11I	2.6×10^{-5}
	R17LU	9.9×10^{-6}
	R17U	6.3×10^{-6}
	R11IF	3.9×10^{-6}
	R09I	1.7×10^{-6}
	R09UI	6.5×10^{-7}
	R11UI	1.5×10^{-8}

Table 4.9-4. MAAP Fission Product Groups

Fission Product Group Number	Assumed Form of Fission Products
1	Noble gases: krypton and xenon
2	Iodine as cesium iodide
3	Tellurium as tellurium oxide
4	Strontium oxide
5	Molybdenum oxide
6	Cesium hydroxide
7	Barium oxide
8	Lanthanides
9	Cerium
10	Antimony
11	Tellurium as elemental tellurium
12	Uranium and actinides

Table 4.9-5. Source Term for Key Release Category R01DI*	
Fission Product Group	**Release Fraction**
Noble gases	9.0-1
Cesium iodide	4.2-2
Tellurium (oxide/elemental)	4.4-2
Strontium	2.7-3
Molybdenum	6.5-3
Cesium hydroxide	4.3-2
Barium	4.6-3
Lanthanides	4.8-4
Cerium	4.0-3
Antimony	10.1-2
Uranium and actinides	1.2-5

*Timing of release: 10.8 hours after core uncovering; 8.2 hours after vessel failure.

Note: Exponential notation is indicated in abbreviated form; i.e., 9.0-1 = 9.0×10^{-1}.

Table 4.9-6. Source Term for Key Release Category R03IF*	
Fission Product Group	**Release Fraction**
Noble gases	9.0-1
Cesium iodide	1.1-2
Tellurium (oxide/elemental)	2.3-9
Strontium	5.0-4
Molybdenum	8.9-3
Cesium hydroxide	1.1-2
Barium	6.1-3
Lanthanides	1.6-4
Cerium	5.7-3
Antimony	1.8-2
Uranium and actinides	1.4-13

*Timing of release: 11.5 hours after core uncovering; 8.6 hours after vessel failure.

Note: Exponential notation is indicated in abbreviated form; i.e., 9.0-1 = 9.0×10^{-1}.

Table 4.9-7. Source Term for Key Release Category R04*

Fission Product Group	Release Fraction
Noble gases	8.8-01
Cesium iodide	1.6-03
Tellurium (oxide/elemental)	2.4-09
Strontium	7.0-04
Molybdenum	2.7-03
Cesium hydroxide	2.1-03
Barium	4.1-03
Lanthanides	5.2-04
Cerium	5.4-03
Antimony	9.7-04
Uranium and actinides	2.6-12

*Timing of release: 9.88 hours after core uncovering; 6 hours after vessel failure.

Note: Exponential notation is indicated in abbreviated form; i.e., 8.8-01 = 8.8×10^{-01}.

Table 4.9-8. Source Term for Key Release Category R20, ENS*		
Fission Product Group	**Release Fraction to Auxiliary Building**	**Release Fraction to Environment**
Noble gases	9.2-01	5.6-01
Cesium iodide	8.6-02	4.9-03
Tellurium (oxide/elemental)	2.1-03	7.8-05
Strontium	5.1-03	1.5-04
Molybdenum	6.8-02	2.1-03
Cesium hydroxide	8.2-02	4.8-03
Barium	4.5-02	1.5-03
Lanthanides	1.7-03	3.6-05
Cerium	2.9-02	1.0-3
Antimony	9.0-02	3.4-3
Uranium and actinides	1.7-05	3.2-5

*Timing of release: 12.8 hours after core uncovering; 6 hours after vessel failure.

Note: Exponential notation is indicated in abbreviated form; i.e., 5.6-01 = 5.6×10^{-01}.

Table 4.9-9. Source Term for Key Release Category R20, EIB*	
Fission Product Group	**Release Fraction**
Noble gases	9.1-01
Cesium iodide	2.1-01
Tellurium (oxide/elemental)	4.0-04
Strontium	2.3-03
Molybdenum	7.0-02
Cesium hydroxide	1.9-01
Barium	2.5-02
Lanthanides	2.8-04
Cerium	5.5-04
Antimony	5.8-02
Uranium and actinides	3.5-08

*Timing of release: 0 hours after core uncovering.

Note: Exponential notation is indicated in abbreviated form; i.e., 9.1-01 = 9.1×10^{-01}.

Table 4.9-10. Source Term for Key Release Category R20, ENB*	
Fission Product Group	**Release Fraction**
Noble gases	6.7-01
Cesium iodide	1.3-01
Tellurium (oxide/elemental)	2.3-05
Strontium	7.5-03
Molybdenum	8.0-02
Cesium hydroxide	1.1-01
Barium	6.1-02
Lanthanides	2.2-03
Cerium	3.1-02
Antimony	2.0-01
Uranium and actinides	2.0-09

*Timing of release: 0 hours after core uncovering.

Note: Exponential notation is indicated in abbreviated form; i.e., 6.7-01 = 6.7×10^{-01}.

Table 4.9-11. Source Term for Key Release Category R17L*	
Fission Product Group	**Release Fraction**
Noble gases	9.4-01
Cesium iodide	7.1-03
Tellurium (oxide/elemental)	5.2-03
Strontium	3.6-04
Molybdenum	5.1-04
Cesium hydroxide	1.1-02
Barium	1.3-03
Lanthanides	4.2-06
Cerium	4.0-06
Antimony	2.4-01
Uranium and actinides	1.1-07
*Timing of release: 32 hours after core uncovering; 29 hours after vessel failure.	
Note: Exponential notation is indicated in abbreviated form; i.e., 9.4-01 = 9.4×10^{-01}.	

Table 4.9-12. Source Term for Key Release Category R17LU*	
Fission Product Group	**Release Fraction**
Noble gases	1.0-01
Cesium iodide	1.2-03
Tellurium (oxide/elemental)	7.8-04
Strontium	6.5-08
Molybdenum	7.2-08
Cesium hydroxide	1.1-03
Barium	1.1-06
Lanthanides	9.2-09
Cerium	1.8-08
Antimony	1.7-03
Uranium and actinides	3.7-08

*Timing of release: 43 hours after core uncovering; 40 hours after vessel failure.

Note: Exponential notation is indicated in abbreviated form; i.e., 1.0-01 = 1.0×10^{-01}.

Table 4.9-13. Source Term for Key Release Category R17U*

Fission Product Group	Release Fraction
Noble gases	9.2-01
Cesium iodide	1.3-03
Tellurium (oxide/elemental)	1.4-03
Strontium	1.6-04
Molybdenum	4.8-04
Cesium hydroxide	2.0-03
Barium	7.6-04
Lanthanides	1.9-06
Cerium	2.0-06
Antimony	4.5-04
Uranium and actinides	2.0-07

*Timing of release: 25.8 hours after core uncovering; 22.2 hours after vessel failure.

Note: Exponential notation is indicated in abbreviated form; i.e., 9.2-01 = 9.2×10^{-01}.

4.10 BACK-END RESULTS

This section summarizes the results of the Watts Bar Level 2 examination process.

4.10.1 SUMMARY OF RELEASES BY RELEASE CATEGORY GROUPS

For reporting purposes, the individual release categories have been binned into four major groups. These groups are described below, along with their relative contributions:

General Release Category Group	Description	Percentage of CDF Analyses*
I	Large, Early Containment Failures and Large Bypasses	2
II	Small, Early Containment Failures and Small Bypasses**	4
III	Late Releases and Long-Term Releases	29
IV	Long-Term, Contained Releases†	65

*Group frequency divided by core damage frequency (CDF).
**Includes steam generator tube rupture (SGTR) initiating events.
†Containment intact following vessel breach.

The important benchmark for a Level 2 PRA is the frequency of large, early releases. For this IPE, the frequency of large, early releases is the sum of Release Category Group I plus that fraction (.55) of Release Category Group II which is associated with SGTR initiating events and a stuck-open secondary side relief valve. The Watts Bar frequency of large, early release is approximately 4.2% of the CDF, or 1.5×10^{-5} per reactor-year. This frequency is relatively low and is dominated by containment bypasses resulting from SGTRs, which accounts for approximately 8.3×10^{-6} per reactor-year. As shown in Table 1-10 of Section 1, both the frequency of large, early release and the fraction of CDF which it represents compare very favorably with that calculated for NUREG-1150 (Reference 4.10-1).

Table 4.10-1 summarizes the assignment of individual release categories into these general release category groups.

4.10.2 RELEASE CATEGORY GROUP I — LARGE, EARLY CONTAINMENT FAILURE AND LARGE CONTAINMENT BYPASS

Table 4.10-2 lists those individual sequences whose frequencies are greater than 1×10^{-10} per reactor-year and that contribute to Release Category Group I. Table 4.10-3 summarizes the frequency contribution of the key plant damage state (KPDS) to Group I. As shown in Table 4.10-3, three KPDSs dominated by sequences involving loss of ERCW or loss of offsite power (GNIYA, ENIYA, and GNIYN) account for approximately 50% of the group frequency while the Interfacing Systems LOCAs (KPDS ATV) contributes only approximately 0.6% of the group frequency.

4.10.3 RELEASE CATEGORY GROUP II — SMALL, EARLY CONTAINMENT FAILURE AND SMALL CONTAINMENT BYPASS

Table 4.10-4 lists those individual sequences whose frequencies are greater than 1.0×10^{-11} per reactor-year and contribute to Release Category Group II. Table 4.10-5 summarizes the frequency contribution of the key plant damage states to Group II. As indicated by this table, the two KPDSs associated with SGTR (EIB and ENB) account for approximately 55% of the frequency of this group. Approximately 32% of this group's frequency results from KPDS ENS which is dominated by sequences involving loss of offsite power and associated containment isolation failures resulting in a small containment bypass via the reactor coolant pump (RCP) seal return lines.

4.10.4 RELEASE CATEGORY GROUP III — LATE CONTAINMENT FAILURE AND GROUP IV LONG-TERM CONTAINED RELEASES

Table 4.10-6 lists those individual sequences whose frequencies are greater than 1×10^{-11} per reactor-year and that contribute to Release Category Group III. Table 4.10-7 summarizes the frequency contribution of KPDSs to Group III. As indicated in Table 4.10-7, the dominant KPDS contributor to the frequency of this group is KPDS FNI in which the dominant sequence involves loss of CCS with no long-term containment heat removal capability. Basemat melt-through makes a minor contribution to this group.

Table 4.10-8 lists those individual sequences whose frequencies are greater than 1×10^{-11} per reactor-year and that contribute to Release Category Group IV. It should be noted that sequences involving containment failures at times greater than 48 hours were also binned to this group. The importance of these sequences is discussed in the next section. Table 4.10-9 summarizes the frequency contributions of KPDSs to Group IV.

Late burns were predicted for most of the KPDSs. In nearly all cases, these burns were predicted to occur at a relatively low concentration of hydrogen. In some cases, the oxygen content was eventually depleted to less than 5%, prohibiting additional burns.

Supplement No. 3 to U.S. Nuclear Regulatory Commission Generic Letter No. 88-20 (Reference 4.10-2) requests that "licensees with ice condenser containments are expected to evaluate the vulnerability to interruption of power to the hydrogen ignitors as part of the IPE." Of primary concern is the restoration of power during station blackouts.

As shown in Table 4.6-3 of Section 4.6, only 11% (3.6×10^{-5} per reactor-year) of the core damage frequency involves KPDS which have failure of the ignitor system. The dominant KPDS contributors associated with ignitor unavailability are ENIYN, ENIYB, GNIYN, and ENSYN* which are represented by sequences loss of offsite power, loss of Train A shutdown power, or total loss of ERCW.

Following the recovery of AC power, the operators are instructed to start the containment spray pumps if containment pressure is above the phase B condition and to determine the

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*Plant damage state ENS is represented by a sequence involving a small bypass prior to core damage. Thus, the frequency associated with ENS is binned to Release Category Group II.

volumetric concentration of hydrogen. If this concentration exceeds 6 percent, the ignitors are not energized. If large concentrations of hydrogen are present, there are other sources of ignition which could trigger a hydrogen burn. Since these ignition sources may be of a random nature, an ignition could occur at any time following recovery of AC power. To demonstrate that Watts Bar has no specific vulnerability to ignitor unavailability, it was conservatively assumed that all of the CDF associated with KPDSs with the ignitors unavailable would result in containment failure at some time.

4.10.5 CONTAINMENT EVENT TREE SPLIT FRACTION IMPORTANCE

4.10.5.1 Release Category Group I

The importance evaluation of the split fractions contributing to Release Category Group I is shown in Table 4.10-10. Four importance measures are summarized: (1) the percentage contribution with that split fraction failed (importance); (2) the factor increase in the group frequency when the split fraction is arbitrarily assigned a failure frequency of 1.0 (risk achievement worth); (3) the factor decrease in the group frequency when the split fraction is arbitrarily assigned a failure frequency of 0.0 (risk reduction worth); and (4) the rate of change in group frequency with respect to a particular split fraction (derivative).

Because the frequency of large, early containment failures and bypasses is extremely low (6.9×10^{-6} per reactor-year) and the fraction of CDF that results in low pressure at the time of vessel breach is high, it is not surprising that α-mode failure [at low reactor coolant system (RCS) pressure] of the reactor vessel and containment emerges (split fraction C2A or L2A) as a dominant contributor to the Group I frequency, contributing to approximately 30% of the group frequency. This estimate is based on using the NUREG/CR-4551 (Reference 4.10-3) mean value of 0.008 for the associated split fraction.

Also shown in Table 4.10-10 is the contribution to large, early containment failures due to direct impingement of debris on the containment wall due to seal table failure following high pressure melt ejection. This contribution (the sum of split fractions DII and DIH) amounts to approximately 54% of the frequency of Group I, or 3.7×10^{-6} per reactor-year.

DDT prior to vessel breach (split fraction C1T) and shortly after vessel breach (split fraction CET) contributes to only 3.8% of the Group I frequency despite the rather conservative treatment used in this study (see Section 4.8).

The importance of split fractions associated with high pressure melt ejection (HPME) (the sum of split fractions C2L, C2S, C2P, C2J, C2M, and C2O) indicate that containment failures due to HPME amount to approximately 11% of the Release Category Group I frequency.

4.10.5.2 Release Category Group II

Table 4.10-11 summarizes the importance of specific CET split fractions to the frequency of Release Category Group II. As indicated by the importance of split fraction BYB (SGTR initiating events), bypass scenarios dominate the Group II frequency.

4.10.5.3 Release Category Groups III

Table 4.10-12 summarizes the importance of specific CET split fractions to the frequency of Release Category Group III. This group contains sequences in which containment failure is predicted to occur within 48 hours of the initiating event. Split fractions CLTF and CLTL representing long-term containment overpressurization, appear in 54% of the Group III frequency. Containment failure due to long-term overpressurization is not expected to occur within 24 hours for GNIYA, HNI, FNI, and FGI, which are involved in a large fraction of the long-term overpressurization failures. Split fraction XLTF appears in 62% of the Group III frequency, indicating that failure of long-term containment heat removal is involved in the preponderance of the Group III frequency. Basemat melt-through (as indicated by split fraction BIU) makes less than a 7% contribution to the Group III frequency.

The importance of the assumption regarding ignitor unavailability is illustrated by the contribution of split fraction CLA, which is 34% of the Group III frequency.

4.10.5.4 Release Category Group IV

Table 4.10-13 summarizes the importance of specific CET split fractions to the frequency of Release Category Group IV. This group contains sequences with long-term containment intact as well as sequences in which containment failure is very likely but not within 48 hours. This differentiation is facilitated by examining the split fraction contribution to the frequency of the group. Those sequences that contain split fraction XLTF (no long term containment heat removal) will eventually go to containment failure if no recovery takes place within 48 hours. These sequences account for approximately 52% of the frequency of this group. The remaining sequences in this group represent either "recovered in-vessel" or long-term containment heat removal.

4.10.6 UNCERTAINTIES AND SENSITIVITY CALCULATIONS

Detailed thermal-hydraulic analysis of representative sequences for several of the KPDSs indicated that core damage would not occur in these sequences, and therefore they were treated as "core damage arrested" in the base case Level 2 analysis. Table 4.10-14 shows the impact of this core damage arrest on the frequencies of the various release category groups. Taking credit for this arrest decreases the frequency of Groups I and III somewhat and increases the frequency of Group IV. These changes, however, are not significant.

Despite the relatively low split fraction value (0.008) for low pressure alpha mode failures of the vessel and containment, this uncertain phenomenon contributes approximately 30% (split fraction C2A) of the Release Category Group I frequency. The NUREG/CR-4551 estimates for the probability of containment failure due to alpha mode events represent upper bounds. If split fraction C2A were assigned a value of 0.0, the Group I frequency would be reduced by approximately 30% (risk reduction).

Containment failure due to direct impingement of debris on the containment wall in the seal table room currently accounts for approximately 54% (split fractions DII and DIH) of the Release Category Group I frequency (see Table 4.10-10). Arbitrary increases in split fractions DII and DIH to unity would increase the frequency of Group I by factors of 1.8

and 1.6 (risk achievement), respectively. Thus, the contribution of Top Event DI to Release Category Group I appears to be limited primarily by the relatively low fraction of vessel breaches that occur at high pressure.

The analysis of hydrogen within an event tree framework is extremely difficult. Section 4.8.1.1 provides a lengthy discussion and sensitivity analysis relative to the importance of hydrogen ignitors and air return fans to the response of ice condenser containments during severe accidents. Only a small fraction of the core damage sequences involve failures of the air return fans and/or ignitors. With air return fans and ignitors operating, only sequences involving sudden releases of hydrogen into the containment pose a challenge to the integrity of the containment. Such sequences also lead to the possibility of DDT in the ice condenser. Despite a conservative treatment of this phenomenon in the Level 2 analysis, DDT (as indicated by the importance of split fractions CIT and CET in Table 4.10-10) accounts for less than 4% of the Group I frequency (or 2.6×10^{-7} per reactor-year). Even if split fraction CIT were assigned a value of 1.0, the group frequency would increase only by a factor of 1.45 (risk achievement).

The contribution of hydrogen burns is only important in group III events. There are several reasons for this observation. As discussed in Section 4.8.1, hydrogen phenomena contributed little to overall risk in the NUREG/CR-4551 analysis of Sequoyah when air return fans and ignitors are operating. Modular Accident Analysis Program (MAAP) (Reference 4.10-4) analyses performed for this study substantiated that burns will occur at low hydrogen concentrations and present no challenge to the containment except for cases where large amounts of hydrogen are suddenly released from the vessel (e.g., induced failures of the hotleg or vessel breaches at high pressure)or for cases where ignitors are not in operation. In cases involving sudden release of hydrogen to containment, there is also concern regarding DDT and this is addressed in this study.

Sequences with neither air return fans nor ignitors in operation are typified by station blackout. As indicated by Table 4.6-3, the total frequency of KPDSs with neither ARFs or ignitors operating is approximately 3.6×10^{-5} per reactor-year (11% of the CDF). As noted in Section 4.10.4, this frequency (except for KPDs ENSYN which is binned to Release Category Group II) was conservatively assumed to cause containment failure.

The probability of containment failures due to hydrogen burns following the recovery of AC power to the ignitors, air return fans and sprays will be strongly influenced by accident management strategies currently being developed by industry. In nearly all loss of AC power cases, operator actions will be required to place the ignitors and sprays in service. Air return fans will initiate automatically if a Phase B condition is present but sprays must be manually loaded to their respective buses, and ignitors must be manually energized based on containment hydrogen concentration.

Release Category Group II is dominated by bypass events, and therefore only changes in the associated plant damage state frequency have a significant contribution to the frequency of this group. Since core damage does not occur until the contents of the refueling water storage tank (RWST) are exhausted, there is probably little chance that recovery can be given significant credit once core damage begins.

As noted in the previous section, recovery of containment heat removal systems in the long term (24 to 48 hours) could significantly reduce the frequency of Release Category Group III. This reduction would increase the frequency of Release Category Group IV. Because of the potential for hydrogen combustion/detonation, recovery of containment heat removal systems must be accomplished in a controlled manner. Any recovery of containment heat removal accomplished within 24 hours will have a proportionate decrease in the frequency of Release Category Group III.

4.10.7 REFERENCES

4.10-1. U.S. Nuclear Regulatory Commission, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, December 1990.

4.10-2. U.S. Nuclear Regulatory Commission, "Individual Plant Examination for Severe Accident Vulnerabilities," 10CFR50.54(§), Generic Letter No. 88-20, November 23, 1988.

4.10-3. U.S. Nuclear Regulatory Commission, "Evaluation of Severe Accident Risks: Sequoyah, Unit 1," NUREG/CR-4551, Vol. 5, Rev. 1, December 1990.

4.10-4. Henry, R. E., and M. G. Plys, "MAAP-3.0B — Modular Accident Analysis Program for LWR Power Plants," Electric Power Research Institute, EPRI NP-7071-CCML, Vols. 1-3, November 1990.

Table 4.10-1 (Page 1 of 2). Summary of Release Category Frequency (per reactor-year) and General Grouping

Release Category	Release Category Frequency	General Grouping			
		I	II	III	IV
		Large, Early Containment Failure and Bypass	Small, Early Containment Failure and Bypass	Late Releases and Long-Term Releases	Long-Term, Contained Releases
R21	1.7-4				1.7-4
R17L	4.9-5			4.9-5	
R22	4.2-5				4.2-5
R11I	2.6-5			2.6-5	
R20	1.3-5		1.3-5		
R17LU	7.5-6			7.5-6	
R17U	6.3-6			6.3-6	
R11IF	3.9-6			3.9-6	
R01DI	3.7-6	3.7-6			
R09I	1.7-6			1.7-6	
R03IF	1.3-6	1.3-6			
R07SLUI	8.9-7		8.9-7		
R09UI	6.5-7			6.5-7	
R04	5.0-7	5.0-7			
R05SLI	4.7-7		4.7-7		
R03I	2.3-7	2.3-7			
R01IF	2.3-7	2.3-7			
R05SLUI	2.0-7		2.0-7		
R01	1.7-7	1.7-7			
R07SLUIF	1.7-7		1.7-7		
R04IF	9.9-8	9.9-8			
R01I	9.5-8	9.5-8			
R03	9.1-8	9.1-8			

Note: Exponential notation is indicated in abbreviated form; e.g., 1.7-4 = 1.7×10^{-4}.

Table 4.10-1 (Page 2 of 2). Summary of Release Category Frequency (per reactor-year) and General Grouping

Release Category	Release Category Frequency	General Grouping			
		I	II	III	IV
		Large, Early Containment Failure and Bypass	Small, Early Containment Failure and Bypass	Late Releases and Long-Term Releases	Long-Term, Contained Releases
R05SLIF	8.8-8		8.8-8		
R03UIF	8.0-8	8.0-8			
R18	6.1-8	6.1-8			
R03SUI	5.3-8	5.3-8			
R02IF	4.7-8	4.7-8			
R19	4.1-8	4.1-8			
R05SLUIF	3.8-8		3.8-8		
R04UIF	3.5-8	3.5-8			
R03SI	2.8-8	2.8-8			
R01SI	2.4-8	2.4-8			
R11UI	1.5-8			1.5-8	
R01UIF	1.2-8	1.2-8			
R03SUIF	9.9-9	9.9-9			
R03SIF	5.3-9	5.3-9			
R01UI	4.6-9	4.6-9			
R01SIF	4.5-9	4.5-9			
R01SUI	1.1-9	1.1-9			
R01SUIF	2.0-10	2.0-10			
R03UI	1.2-10	1.2-10			
Total	3.3-4	6.8-6	1.5-5	9.5-5	2.2-4
Fraction of Frequency Analyzed		0.02	0.04	0.29	0.65

Note: Exponential notation is indicated in abbreviated form; e.g., 1.7-4 = 1.7×10^{-4}.

Table 4.10-2 (Page 1 of 2). Individual Sequences Contributing to Release Category Group I

Index	Initiator	Frequency	Failed and Multi-State Split Fractions
3	ENIYA	8.5920E-07	/CVC*SPB*HOB*RPW*C2A*L2A*SOB
5	GNIYA	7.0135E-07	/CVC*SPB*HOB*RPP*MEH*DII
14	GNIYA	6.1506E-07	/CVC*SPB*HOB*RPR*MES*DIH
4	FCI	4.9142E-07	/CVB*HOB*ICEB*RPW*C2A*L2A*SOB
3	FNI	3.4786E-07	/CVC*SPB*HOB*RPW*C2A*L2A*SOB
5	GNIYN	2.9534E-07	/CVC*SPB*HOB*RPP*MEH*DII
9	GNIYA	2.8728E-07	/CVC*SPB*HOB*RPQ*MEH*DIH
6	HGI	2.6066E-07	/CVC*LSO*HOB*ICEB*RPT*MEH*DII
14	GNIYN	2.5900E-07	/CVC*SPB*HOB*RPR*MES*DIH
3	ENIYN	2.0896E-07	/CVC*SPB*RPW*C2A*L2A*SOB
12	HGI	1.6937E-07	/CVC*LSO*HOB*ICEB*RPU*MEH*C2O*L2O*SOB
21	LCI	1.5339E-07	/CVL*LSS*HOB*RPT*MEH*DII
15	GNIYA	1.4373E-07	/CVC*SPB*HOB*RPR*MES*C2S*L2S*SOB
11	HGI	1.3120E-07	/CVC*LSO*HOB*ICEB*RPU*MEH*DIH
9	GNIYN	1.2098E-07	/CVC*SPB*HOB*RPQ*MEH*DIH
8	LCI	1.1353E-07	/CVL*HOB*RP17*MES*DIH
13	HNI	9.9655E-08	/CVC*LSO*SPB*HOB*ICEH*RPB*MEH*DII
27	LCI	9.8863E-08	/CVL*LSS*HOB*RPU*MEH*DIH
12	LCI	9.4439E-08	/CVL*IPS*HOB*C1T*L1T*RPW*SOB
13	KNI	8.8502E-08	/CVC*LSS*RPT*MEH*DII
13	KNSYC	7.6292E-08	/CVC*LSS*C1S*RPT*MEH*DII
4	KNI	7.1243E-08	/CVC*RP17*MES*DIH
17	KNI	6.2039E-08	/CVC*LSS*RPU*MEH*DIH
4	KNSYC	6.1415E-08	/CVC*C1S*RP17*MES*DIH
15	GNIYN	6.0527E-08	/CVC*SPB*HOB*RPR*MES*C2S*L2S*SOB
7	KNI	5.9263E-08	/CVC*IPS*C1T*L1T*RPW*DBCN*SOB
7	HGI	5.6456E-08	/CVC*LSO*HOB*ICEB*RPT*MEH*C2L*L2L*SOB
17	KNSYC	5.3480E-08	/CVC*LSS*C1S*RPU*MEH*DIH
10	GNIYA	5.3278E-08	/CVC*SPB*HOB*RPQ*MEH*C2P*L2P*SOB
7	KNSYC	5.1087E-08	/CVC*IPS*C1T*L1T*RPW*DBCN*SOB
1	ATV	4.0755E-08	/BYV*LBV
13	LNIYC	3.6587E-08	/CVC*LSS*RPT*MEH*DII
4	BCI	3.5143E-08	/CVA*HOB*RPW*C2A*L2A*DBCN*SOB
14	KNI	3.2532E-08	/CVC*LSS*RPT*MEH*C2J*L2J*SOB
3	ENIYB	3.1472E-08	/CVC*SPB*RPW*C2A*L2A*SOB
4	LNIYC	2.9452E-08	/CVC*RP17*MES*DIH
14	KNSYC	2.8044E-08	/CVC*LSS*C1S*RPT*MEH*C2J*L2J*SOB
6	HNI	2.7840E-08	/CVC*LSO*SPB*HOB*RPB*MEH*DII
9	LCI	2.6531E-08	/CVL*HOB*RP17*MES*C2S*L2S*SOB
17	LNIYC	2.5647E-08	/CVC*LSS*RPU*MEH*DIH
7	LNIYC	2.4499E-08	/CVC*IPS*HOB*ICEB*C1T*L1T*RPW*SOB
13	LCI	2.4250E-08	/CVL*ISS
10	GNIYN	2.2436E-08	/CVC*SPB*HOB*RPQ*MEH*C2P*L2P*SOB
14	HNI	2.1584E-08	/CVC*LSO*SPB*HOB*ICEH*RPB*MEH*C2L*L2L*SOB
3	EGI	1.8601E-08	/CVC*HOB*RPW*C2A*L2A*DBCN*SOB
28	LCI	1.8335E-08	/CVL*LSS*HOB*RPU*MEH*C2P*L2P*SOB
5	KNI	1.6649E-08	/CVC*RP17*MES*C2S*L2S*SOB
3	FGI	1.6560E-08	/CVC*SPB*HOB*RPW*C2A*L2A*SOB
8	KNI	1.5217E-08	/CVC*ISS
5	KNSYC	1.4352E-08	/CVC*C1S*RP17*MES*C2S*L2S*SOB
13	KNSYA	1.4290E-08	/CVC*LSS*C1S*RPT*MEH*DII
14	LNIYC	1.3449E-08	/CVC*LSS*RPT*MEH*C2J*L2J*SOB
8	KNSYC	1.3118E-08	/CVC*ISS
3	HCI	1.2578E-08	/CVC*HOB*ICEB*RPW*C2A*L2A*SOB
18	KNI	1.1505E-08	/CVC*LSS*RPU*MEH*C2P*L2P*SOB
4	KNSYA	1.1503E-08	/CVC*C1S*RP17*MES*DIH
12	GNIYA	1.0819E-08	/CVC*SPB*HOB*RPR*X2F*DBCN*HEB*CET*LET*SOB
17	KNSYA	1.0017E-08	/CVC*LSS*C1S*RPU*MEH*DIH
18	KNSYC	9.9181E-09	/CVC*LSS*C1S*RPU*MEH*C2P*L2P*SOB
7	KNSYA	9.5686E-09	/CVC*IPS*C1T*L1T*RPW*DBCN*SOB
9	HNI	8.1247E-09	/CVC*LSO*SPB*HOB*ICEH*RPA*C2A*L2A*SOB
5	LNIYC	6.8828E-09	/CVC*RP17*MES*C2S*L2S*SOB
8	LNIYC	6.2909E-09	/CVC*ISS
2	HGI	6.1870E-09	/CVC*LSO*HOB*ICEB*RPS*C2A*L2A*SOB
14	KNSYA	5.2527E-09	/CVC*LSS*C1S*RPT*MEH*C2J*L2J*SOB
18	LNIYC	4.7564E-09	/CVC*LSS*RPU*MEH*C2P*L2P*SOB

Table 4.10-2 (Page 2 of 2). Individual Sequences Contributing to Release Category Group I

Index	Initiator	Frequency	Failed and Multi-State Split Fractions
6	GNIYA	4.6254E-09	/CVC*SPB*HOB*RPP*MEH*C2M*L2M*SOB
12	GNIYN	4.5558E-09	/CVC*SPB*HOB*RPR*X2F*DBCN*HEB*CET*LET*SOB
4	HGI	4.1762E-09	/CVC*LSO*HOB*ICEB*RPT*C2EV*L2EV*SOB
16	LCI	3.4643E-09	/CVL*LSS*HOB*RPS*C2A*L2A*SOB
5	KNSYA	2.6882E-09	/CVC*C1S*RP17*MES*C2S*L2S*SOB
8	KNSYA	2.4570E-09	/CVC*ISS
10	KNI	2.1739E-09	/CVC*LSS*RPS*C2A*L2A*DBCN*SOB
2	HNI	2.1597E-09	/CVC*LSO*SPB*HOB*RPA*C2A*L2A*SOB
9	HGI	2.0881E-09	/CVC*LSO*HOB*ICEB*RPU*C2EV*L2EV*SOB
6	GNIYN	1.9478E-09	/CVC*SPB*HOB*RPP*MEH*C2M*L2M*SOB
3	LCI	1.8971E-09	/CVL*HOB*RP17*HEB*CET*LET*SOB
10	KNSYC	1.8740E-09	/CVC*LSS*C1S*RPS*C2A*L2A*DBCN*SOB
18	KNSYA	1.8577E-09	/CVC*LSS*C1S*RPU*MEH*C2P*L2P*SOB
11	HNI	1.5967E-09	/CVC*LSO*SPB*HOB*ICEH*RPB*C2EV*L2EV*SOB
2	KNI	1.2532E-09	/CVC*RP17*X2F*DBCN*HEB*CET*LET*SOB
2	KNSYC	1.0803E-09	/CVC*C1S*RP17*X2F*DBCN*HEB*CET*LET*SOB
22	LCI	1.0116E-09	/CVL*LSS*HOB*RPT*MEH*C2M*L2M*SOB
10	LNIYC	8.9870E-10	/CVC*LSS*RPS*C2A*L2A*SOB
2	LNIYC	5.1806E-10	/CVC*RP17*X2F*HEB*CET*LET*SOB
4	HNI	4.2443E-10	/CVC*LSO*SPB*HOB*RPB*C2EV*L2EV*SOB
10	KNSYA	3.5100E-10	/CVC*LSS*C1S*RPS*C2A*L2A*DBCN*SOB
2	GNIYA	2.9608E-10	/CVC*SPB*HOB*RPO*C2A*L2A*DBCN*SOB
2	KNSYA	2.0234E-10	/CVC*C1S*RP17*X2F*DBCN*HEB*CET*LET*SOB
7	HNI	1.8360E-10	/CVC*LSO*SPB*HOB*RPB*MEH*C2M*L2M*SOB
2	GNIYN	1.2468E-10	/CVC*SPB*HOB*RPO*C2A*L2A*DBCN*SOB
5	LCI	9.9850E-11	/CVL*HOB*RP17*X2S*HEB*CET*LET*SOB

Table 4.10-3. KPDS Contributions to Release Category Group I

Initiator.....	Frequency Assigned to Group.....	Fraction of Group....
GNIYA	1.8164E-06	.265
ENIYA	8.5920E-07	.125
GNIYN	7.6491E-07	.112
HGI	6.3014E-07	.092
LCI	5.3581E-07	.078
FCI	4.9142E-07	.072
KNI	3.6038E-07	.053
FNI	3.4786E-07	.051
KNSYC	3.1066E-07	.045
ENIYN	2.0896E-07	.031
HNI	1.6157E-07	.024
LNIYC	1.4898E-07	.022
KNSYA	5.8187E-08	.008
ATV	4.0755E-08	.006
BCI	3.5143E-08	.005
ENIYB	3.1472E-08	.005
EGI	1.8601E-08	.003
FGI	1.6560E-08	.002
HCI	1.2578E-08	.002

Table 4.10-4. Individual Sequences Contributing to Release Category Group II

Index	Initiator	Frequency	Failed and Multi-State Split Fractions
1	EIB	5.4910E-06	/BYB
1	ENSYN	2.9430E-06	/BYB
1	ENB	2.6654E-06	/BYB
1	ENSYA	1.1130E-06	/BYB
6	KNSYC	6.5845E-07	/CVC*IPS*RPW*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
1	ENSYC	3.7750E-07	/BYB
1	ENSYB	3.5210E-07	/BYB
12	KNSYC	2.3767E-07	/CVC*LSS*C1S*RPT*MEH*X2F*HEB*XEF*XLTF*CLTL*LLTG
9	KNSYC	2.3238E-07	/CVC*LSS*C1S*RPS*X2F*DBCN*HEB*XEF*XLTF*CLTL*L LTG
11	KNSYC	1.2650E-07	/CVC*LSS*C1S*RPT*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
3	KNSYC	1.2357E-07	/CVC*C1S*RP17*MES*X2F*HEB*XEF*XLTF*CLTL*LLTG
6	KNSYA	1.2333E-07	/CVC*IPS*RPW*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
16	KNSYC	1.0760E-07	/CVC*LSS*C1S*RPU*MEH*X2F*HEB*XEF*XLTF*CLTL*LLTG
15	KNSYC	6.3247E-08	/CVC*LSS*C1S*RPU*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
12	KNSYA	4.4515E-08	/CVC*LSS*C1S*RPT*MEH*X2F*HEB*XEF*XLTF*CLTL*LLTG
9	KNSYA	4.3524E-08	/CVC*LSS*C1S*RPS*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
11	KNSYA	2.3692E-08	/CVC*LSS*C1S*RPT*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
3	KNSYA	2.3145E-08	/CVC*C1S*RP17*MES*X2F*HEB*XEF*XLTF*CLTL*LLTG
16	KNSYA	2.0154E-08	/CVC*LSS*C1S*RPU*MEH*X2F*HEB*XEF*XLTF*CLTL*LLTG
1	KNSYC	1.3924E-08	/CVC*C1S*RP17*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
15	KNSYA	1.1846E-08	/CVC*LSS*C1S*RPU*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
1	KNSYA	2.6079E-09	/CVC*C1S*RP17*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG

Table 4.10-5. KPDS Contributions to Release Category Group II

Initiator.....	Frequency Assigned to Group.....	Fraction of Group....
EIB	5.4910E-06	.371
ENSYN	2.9430E-06	.199
ENB	2.6654E-06	.18
KNSYC	1.5633E-06	.106
ENSYA	1.1130E-06	.075
ENSYC	3.7750E-07	.026
ENSYB	3.5210E-07	.024
KNSYA	2.9281E-07	.02

Table 4.10-6. Individual Sequences Contributing to Release Category Group III

Rank	Index	Initiator	Frequency	Failed and Multi-State Split Fractions
1	2	FNI	3.7095E-05	/CVC*SPB*HOB*RPW*X2F*HEB*XEF*XLTF*CLTF*LLTF
2	1	ENIYN	2.5911E-05	/CVC*SPB*RPW*X2F*HEB*XEF*CLA*LLA
3	2	BCI	4.1399E-06	/CVA*HOB*RPW*DBCN*HEB*BIU
4	1	ENIYB	3.9025E-06	/CVC*SPB*RPW*X2F*HEB*XEF*CLA*LLA
5	3	FCI	3.0468E-06	/CVB*HOB*ICEB*RPW*X2S*HEB*XEF*XLTF*CLT1*LLT1
6	1	EGI	2.2027E-06	/CVC*HOB*RPW*X2C*DBCN*HEB*XEF*XLTF*BIU
7	4	GNIYA	2.1849E-06	/CVC*SPB*HOB*RPP*MEH*X2F*HEB*XEF*XLTF*CLTL*LLTG
8	2	FGI	1.7660E-06	/CVC*SPB*HOB*RPW*X2F*HEB*XEF*XLTF*CLTF*LLTF
9	2	ENIYA	1.7047E-06	/CVC*SPB*HOB*RPW*X2F*HEB*XEF*XLTF*CLTD*LLTD
10	13	GNIYA	1.2375E-06	/CVC*SPB*HOB*RPR*MES*X2F*HEB*XEF*XLTF*CLTL*LLTG
11	3	GNIYA	1.0692E-06	/CVC*SPB*HOB*RPP*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
12	8	HNI	1.0075E-06	/CVC*LSO*SPB*HOB*ICEH*RPA*X2F*HEB*XEF*XLTF*CLTL*LLTG
13	4	GNIYN	9.2006E-07	/CVC*SPB*HOB*RPP*MEH*X2F*HEB*XEF*CLA*LLA
14	5	HGI	8.1201E-07	/CVC*LSO*HOB*ICEB*RPT*MEH*X2C*HEB*XEF*XLTF*CLTL*LLTG
15	1	HGI	7.6719E-07	/CVC*LSO*HOB*ICEB*RPS*X2C*HEB*XEF*XLTF*CLTL*LLTG
16	6	KNI	7.6383E-07	/CVC*IPS*RPW*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTK
17	8	GNIYA	5.7803E-07	/CVC*SPB*HOB*RPQ*MEH*X2F*HEB*XEF*XLTF*CLTL*LLTG
18	13	GNIYN	5.2113E-07	/CVC*SPB*HOB*RPR*MES*X2F*HEB*XEF*CLA*LLA
19	3	GNIYN	4.5025E-07	/CVC*SPB*HOB*RPP*X2F*DBCN*HEB*XEF*CLA*LLA
20	3	HGI	4.1345E-07	/CVC*LSO*HOB*ICEB*RPT*X2C*HEB*XEF*XLTF*CLTL*LLTG
21	7	GNIYA	3.3975E-07	/CVC*SPB*HOB*RPQ*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
22	6	LNIYC	3.1577E-07	/CVC*IPS*HOB*ICEB*RPW*X2F*HEB*XEF*XLTF*CLTL*LLTG
23	12	HNI	3.1045E-07	/CVC*LSO*SPB*HOB*ICEH*RPB*MEH*X2F*HEB*XEF*XLTF*CLTL*LLTG
24	12	KNI	2.7570E-07	/CVC*LSS*RPT*MEH*X2F*HEB*XEF*XLTF*CLTL*LLT1
25	9	KNI	2.6956E-07	/CVC*LSS*RPS*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLT1
26	1	HNI	2.6781E-07	/CVC*LSO*SPB*HOB*RPA*X2F*HEB*XEF*XLTF*CLTL*LLTG
27	10	HGI	2.6399E-07	/CVC*LSO*HOB*ICEB*RPU*MEH*X2C*HEB*XEF*XLTF*CLTL*LLTG
28	8	GNIYN	2.4341E-07	/CVC*SPB*HOB*RPQ*MEH*X2F*HEB*XEF*CLA*LLA
29	3	BCI	2.1789E-07	/CVA*HOB*RPW*X2S*DBCN*HEB*XEF*XLTF*CLT1*LLT1
30	8	HGI	2.0672E-07	/CVC*LSO*HOB*ICEB*RPU*X2C*HEB*XEF*XLTF*CLTL*LLTG
31	10	HNI	1.5807E-07	/CVC*LSO*SPB*HOB*ICEH*RPB*X2F*HEB*XEF*XLTF*CLTL*LLTG
32	11	KNI	1.4674E-07	/CVC*LSS*RPT*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLT1
33	3	KNI	1.4334E-07	/CVC*RP17*MES*X2F*HEB*XEF*XLTF*CLTL*LLTG
34	7	GNIYN	1.4307E-07	/CVC*SPB*HOB*RPQ*X2F*DBCN*HEB*XEF*CLA*LLA
35	11	GNIYA	1.3944E-07	/CVC*SPB*HOB*RPR*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
36	16	KNI	1.2482E-07	/CVC*LSS*RPU*MEH*X2F*HEB*XEF*XLTF*CLTL*LLT1
37	12	LNIYC	1.1398E-07	/CVC*LSS*RPT*MEH*X2F*HEB*XEF*XLTF*CLTL*LLTG
38	9	LNIYC	1.1144E-07	/CVC*LSS*RPS*X2F*HEB*XEF*XLTF*CLTL*LLTG
39	2	EGI	1.0379E-07	/CVC*HOB*RPW*X2C*DBCN*HEB*XEF*XLTF*CLTE*LLTE
40	5	HNI	8.6729E-08	/CVC*LSO*SPB*HOB*RPB*MEH*X2F*HEB*XEF*XLTF*CLTL*LLTG
41	2	HCI	7.7986E-08	/CVC*HOB*ICEB*RPW*X2S*HEB*XEF*XLTF*CLT1*LLT1
42	15	KNI	7.3369E-08	/CVC*LSS*RPU*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLT1
43	11	LCI	6.0861E-08	/CVL*IPS*HOB*RPW*X2S*HEB*XEF*XLTF*CLT1*LLT1
44	11	LNIYC	6.0662E-08	/CVC*LSS*RPT*X2F*HEB*XEF*XLTF*CLTL*LLTG
45	3	LNIYC	5.9259E-08	/CVC*RP17*MES*X2F*HEB*XEF*XLTF*CLTL*LLTG
46	11	GNIYN	5.8719E-08	/CVC*SPB*HOB*RPR*X2F*DBCN*HEB*XEF*CLA*LLA
47	16	LNIYC	5.1603E-08	/CVC*LSS*RPU*MEH*X2F*HEB*XEF*XLTF*CLTL*LLTG
48	3	HNI	4.2018E-08	/CVC*LSO*SPB*HOB*RPB*X2F*HEB*XEF*XLTF*CLTL*LLTG
49	1	GNIYA	3.6714E-08	/CVC*SPB*HOB*RPO*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
50	15	LNIYC	3.0331E-08	/CVC*LSS*RPU*X2F*HEB*XEF*XLTF*CLTL*LLTG
51	20	LCI	2.3892E-08	/CVL*LSS*HOB*RPT*MEH*X2S*HEB*XEF*XLTF*CLT1*LLT1
52	15	LCI	2.1478E-08	/CVL*LSS*HOB*RPS*X2S*HEB*XEF*XLTF*CLT1*LLT1
53	1	KNI	1.6152E-08	/CVC*RP17*X2F*DBCN*HEB*XEF*XLTF*CLTL*LLTG
54	1	GNIYN	1.5460E-08	/CVC*SPB*HOB*RPO*X2F*DBCN*HEB*XEF*CLA*LLA
55	18	LCI	1.1692E-08	/CVL*LSS*HOB*RPT*X2S*HEB*XEF*XLTF*CLT1*LLT1
56	7	LCI	1.1421E-08	/CVL*HOB*RP17*MES*X2S*HEB*XEF*XLTF*CLT1*LLT1
57	26	LCI	9.9458E-09	/CVL*LSS*HOB*RPU*MEH*X2S*HEB*XEF*XLTF*CLT1*LLT1
58	1	LNIYC	6.6772E-09	/CVC*RP17*X2F*HEB*XEF*XLTF*CLTL*LLTG
59	24	LCI	5.8459E-09	/CVL*LSS*HOB*RPU*X2S*HEB*XEF*XLTF*CLT1*LLT1
60	4	LCI	1.2869E-09	/CVL*HOB*RP17*X2S*HEB*XEF*XLTF*CLT1*LLT1

Table 4.10-7. KPDS Contributions to Release Category Group III

KPDS.....	Frequency Assigned to Group.....	Fraction of Group....
FNI	3.7095E-05	.39
ENIYN	2.5911E-05	.27
GNIYA	5.5856E-06	.059
BCI	4.3578E-06	.046
ENIYB	3.9025E-06	.041
FCI	3.0468E-06	.032
HGI	2.4634E-06	.026
GNIYN	2.3521E-06	.025
EGI	2.3065E-06	.024
HNI	1.8725E-06	.020
KNI	1.8135E-06	.019
FGI	1.7660E-06	.019
ENIYA	1.7047E-06	.018
LNIYC	7.4972E-07	.0079
LCI	1.4642E-07	.0015
HCI	7.7986E-08	.0008

Table 4.10-8. Individual Sequences Contributing to Release Category Group IV

Rank	Index	Initiator	Frequency	Failed and Multi-State Split Fractions
1	1	ENIYA	1.0484E-04	/CVC*SPB*HOB*RPW*X2F*HEB*XEF*XLTF
2	2	FCI	5.7889E-05	/CVB*HOB*ICEB*RPW*HEB
3	1	FCI	2.8907E-05	/
4	1	LCI	1.1598E-05	/
5	1	FNI	6.0388E-06	/CVC*SPB*HOB*RPW*X2F*HEB*XEF*XLTF
6	1	HCI	1.4817E-06	/CVC*HOB*ICEB*RPW*HEB
7	1	BCI	1.3122E-06	/
8	10	LCI	1.1564E-06	/CVL*IPS*HOB*RPW*HEB
9	1	LNIYA	5.3430E-07	/
10	19	LCI	4.5394E-07	/CVL*LSS*HOB*RPT*MEH*HEB
11	14	LCI	4.0809E-07	/CVL*LSS*HOB*RPS*HEB
12	1	FGI	2.8748E-07	/CVC*SPB*HOB*RPW*X2F*HEB*XEF*XLTF
13	17	LCI	2.2215E-07	/CVL*LSS*HOB*RPT*HEB
14	6	LCI	2.1701E-07	/CVL*HOB*RP17*MES*HEB
15	25	LCI	1.8897E-07	/CVL*LSS*HOB*RPU*MEH*HEB
16	23	LCI	1.1107E-07	/CVL*LSS*HOB*RPU*HEB
17	2	LCI	2.4452E-08	/CVL*HOB*RP17*HEB

Table 4.10-9. KPDS Contributions to Release Category Group IV

KPDS	Frequency Assigned to Group	Fraction of Group
ENIYA	1.0484E-04	.49
FCI	8.6796E-05	.40
LCI	1.4380E-05	.067
FNI	6.0388E-06	.028
HCI	1.4817E-06	.0069
BCI	1.3122E-06	.0061
LNIYA	5.3430E-07	.0025
FGI	2.8748E-07	.0013

Table 4.10-10 (Page 1 of 2). CET Split Fraction Importance to Release Category Group I

.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
1.	CVC	8.3895E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.7465E-06
2.	HOB	8.3077E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.6905E-06
3.	SPB	6.1419E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.2070E-06
4.	SOB	4.4425E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0429E-06
5.	MEH	4.3797E-01	1.1608E+00	5.6530E-01	4.0788E-06	7.3000E-01	3.0000E-06
6.	RPW	3.3004E-01	6.6996E-01	0.0000E+00	0.0000E+00	1.0000E+00	2.2606E-06
7.	L2A	2.9891E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0474E-06
8.	C2A	2.9891E-01	3.8065E+01	7.0109E-01	2.5593E-04	8.0000E-03	2.0474E-06
9.	DIH	2.8479E-01	1.5730E+00	7.1521E-01	5.8756E-06	3.3200E-01	1.9507E-06
10.	DII	2.5606E-01	1.7977E+00	7.4394E-01	7.2177E-06	2.4300E-01	1.7539E-06
11.	MES	2.0915E-01	1.0128E+00	8.3047E-01	1.2486E-06	9.3000E-01	1.4326E-06
12.	ICEB	1.6915E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1586E-06
13.	RPR	1.5967E-01	1.2312E+00	9.0555E-01	2.2310E-06	2.9000E-01	1.0937E-06
14.	RPP	1.4647E-01	9.8084E-01	1.0220E+00	-2.8230E-07	5.3500E-01	1.0033E-06
15.	LSO	1.1558E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.9171E-07
16.	RPT	1.1251E-01	1.0000E+00	1.0000E+00	0.0000E+00	5.0000E-01	7.7064E-07
17.	LSS	1.1016E-01	1.0139E+00	9.8613E-01	1.9007E-07	5.0000E-01	7.5453E-07
18.	RPU	8.7462E-02	1.1749E+00	9.4169E-01	1.5975E-06	2.5000E-01	5.9908E-07
19.	CVL	7.8224E-02	1.2619E+00	9.2178E-01	2.3296E-06	2.3000E-01	5.3581E-07
20.	CVB	7.1744E-02	1.0338E+00	9.2826E-01	7.2267E-07	6.8000E-01	4.9142E-07
21.	RPQ	7.0657E-02	1.2743E+00	9.4382E-01	2.2638E-06	1.7000E-01	4.8397E-07
22.	RP17	5.2455E-02	9.4754E-01	0.0000E+00	0.0000E+00	1.0000E+00	3.5930E-07
23.	C1S	4.2720E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9262E-07
24.	L2S	3.9618E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7137E-07
25.	C2S	3.9618E-02	1.3411E+00	9.7354E-01	2.5177E-06	7.2000E-02	2.7137E-07
26.	IPS	3.4871E-02	9.5808E-01	1.1388E+00	-1.2377E-06	7.6800E-01	2.3886E-07
27.	C1T	3.4871E-02	1.4495E+00	9.6513E-01	3.3175E-06	7.2000E-02	2.3886E-07
28.	L1T	3.4871E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3886E-07
29.	DBCN	2.8672E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9639E-07
30.	L2O	2.4727E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6937E-07
31.	C2O	2.4727E-02	1.0385E+00	9.8348E-01	3.7713E-07	3.0000E-01	1.6937E-07
32.	RPB	2.2087E-02	1.0158E+00	9.9077E-01	1.7173E-07	3.6800E-01	1.5128E-07
33.	ICEH	1.9119E-02	1.0006E+00	9.9769E-01	2.0021E-08	7.9000E-01	1.3096E-07
34.	L2P	1.7824E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2209E-07
35.	C2P	1.7824E-02	1.1934E+00	9.8809E-01	1.4061E-06	5.8000E-02	1.2209E-07
36.	L2J	1.1574E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.9279E-08
37.	C2J	1.1574E-02	1.0981E+00	9.9124E-01	7.3188E-07	8.2000E-02	7.9279E-08
38.	L2L	1.1393E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.8041E-08
39.	C2L	1.1393E-02	1.1639E+00	9.9138E-01	1.1815E-06	5.0000E-02	7.8041E-08
40.	ISS	8.9542E-03	1.5433E+00	9.9229E-01	3.7743E-06	1.4000E-02	6.1333E-08
41.	BYV	5.9500E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0755E-08
42.	LBV	5.9500E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0755E-08
43.	CVA	5.1307E-03	1.0015E+00	9.9487E-01	4.5641E-08	7.7000E-01	3.5143E-08
44.	LET	2.9820E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0425E-08
45.	CET	2.9820E-03	1.0384E+00	9.9702E-01	2.8369E-07	7.2000E-02	2.0425E-08
46.	HEB	2.9820E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0425E-08
47.	X2F	2.6904E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8428E-08
48.	RPS	2.1824E-03	1.0044E+00	9.9855E-01	3.9864E-08	2.5000E-01	1.4949E-08
49.	RPA	1.5015E-03	9.9937E-01	1.0011E+00	-1.1674E-08	6.3200E-01	1.0284E-08

Definitions:

Importance = the fraction of the group frequency with that split fraction failed.
Achievement = (Group Frequency with Split Fraction Set to 1.0)/(Group Frequency).
Reduction = (Group Frequency with Split Fraction Set to 0.0)/(Group Frequency).
Derivative = [δ(Group Frequency)]/[δ(Split Fraction)].
Split fraction value is from master frequency file.
Frequency = the total frequency of sequences assigned to the group with this split fraction failed.

Table 4.10-10 (Page 2 of 2). CET Split Fraction Importance to Release Category Group I

.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
50.	L2EV	1.2096E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2854E-09
51.	C2EV	1.2096E-03	1.1198E+00	9.9879E-01	8.2854E-07	1.0000E-02	8.2854E-09
52.	C2M	1.1341E-03	1.5357E+00	9.9914E-01	3.6754E-06	1.6000E-03	7.7683E-09
53.	L2M	1.1341E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.7683E-09
54.	RPO	6.1428E-05	1.0122E+00	9.9994E-01	8.3729E-08	5.0000E-03	4.2076E-10
55.	X2S	1.4577E-05	1.0000E+00	1.0000E+00	0.0000E+00	5.0000E-02	9.9850E-11
56.	SPA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
57.	BYA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
58.	DBCC	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
59.	C2NF	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
60.	HON	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
61.	C1B	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.	C1D	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
63.	MEL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
64.	LSL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
65.	L1S	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
66.	ICEA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
67.	IPL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
68.	ISL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Definitions:

Importance = the fraction of the group frequency with that split fraction failed.
Achievement = (Group Frequency with Split Fraction Set to 1.0)/(Group Frequency).
Reduction = (Group Frequency with Split Fraction Set to 0.0)/(Group Frequency).
Derivative = [δ(Group Frequency)]/[δ(Split Fraction)].
Split fraction value is from master frequency file.
Frequency = the total frequency of sequences assigned to the group with this split fraction failed.

Table 4.10-11. CET Split Fraction Importance to Release Category Group II

.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
1.	BYB	8.7457E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2942E-05
2.	CLTL	1.2543E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8562E-06
3.	CVC	1.2543E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8562E-06
4.	X2F	1.2543E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8562E-06
5.	HEB	1.2543E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8562E-06
6.	LLTG	1.2543E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8562E-06
7.	XLTF	1.2543E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8562E-06
8.	XEF	1.2543E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8562E-06
9.	DBCN	8.7815E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2995E-06
10.	C1S	7.2602E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0744E-06
11.	LSS	6.1570E-02	9.9771E-01	1.0023E+00	-6.7811E-08	5.0000E-01	9.1112E-07
12.	IPS	5.2830E-02	1.0049E+00	9.8369E-01	3.1430E-07	7.6800E-01	7.8178E-07
13.	RPW	5.2830E-02	9.4717E-01	0.0000E+00	0.0000E+00	1.0000E+00	7.8178E-07
14.	RPT	2.9218E-02	1.0000E+00	1.0000E+00	0.0000E+00	5.0000E-01	4.3237E-07
15.	MEH	2.7702E-02	9.9502E-01	1.0135E+00	-2.7281E-07	7.3000E-01	4.0994E-07
16.	RPS	1.8644E-02	1.0373E+00	9.8757E-01	7.3573E-07	2.5000E-01	2.7590E-07
17.	RPU	1.3708E-02	1.0274E+00	9.9086E-01	5.4094E-07	2.5000E-01	2.0285E-07
18.	RP17	1.1031E-02	9.8897E-01	0.0000E+00	0.0000E+00	1.0000E+00	1.6325E-07
19.	MES	9.9144E-03	9.9963E-01	1.0049E+00	-7.8406E-08	9.3000E-01	1.4671E-07
20.	LBB	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
21.	L1S	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
22.	SPA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
23.	MEL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
24.	BYA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
25.	C2P	0.0000E+00	9.9137E-01	1.0005E+00	-1.3562E-07	5.8000E-02	0.0000E+00
26.	C2NF	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
27.	C2S	0.0000E+00	9.9009E-01	1.0008E+00	-1.5810E-07	7.2000E-02	0.0000E+00
28.	CEB	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
29.	C1T	0.0000E+00	9.4717E-01	1.0041E+00	-8.4244E-07	7.2000E-02	0.0000E+00
30.	C2J	0.0000E+00	9.8093E-01	1.0017E+00	-3.0739E-07	8.2000E-02	0.0000E+00
31.	C2A	0.0000E+00	9.8136E-01	1.0002E+00	-2.7812E-07	8.0000E-03	0.0000E+00
32.	ISS	0.0000E+00	9.3614E-01	1.0009E+00	-9.5845E-07	1.4000E-02	0.0000E+00
33.	HON	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
34.	DII	0.0000E+00	9.8093E-01	1.0061E+00	-3.7277E-07	2.4300E-01	0.0000E+00
35.	ICEA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
36.	CET	0.0000E+00	9.9888E-01	1.0001E+00	-1.7814E-08	7.2000E-02	0.0000E+00
37.	CLN	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
38.	DIH	0.0000E+00	9.8145E-01	1.0092E+00	-4.1089E-07	3.3200E-01	0.0000E+00
39.	DBCC	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Definitions:

Importance = the fraction of the group frequency with that split fraction failed.
Achievement = (Group Frequency with Split Fraction Set to 1.0)/(Group Frequency).
Reduction = (Group Frequency with Split Fraction Set to 0.0)/(Group Frequency).
Derivative = [δ(Group Frequency)]/[δ(Split Fraction)].
Split fraction value is from master frequency file.
Frequency = the total frequency of sequences assigned to the group with this split fraction failed.

Table 4.10-12 (Page 1 of 2). CET Split Fraction Importance to Release Category Group III

.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
1.	HEB	1.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.5152E-05
2.	XEF	9.5649E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.1012E-05
3.	CVC	9.2064E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.7601E-05
4.	X2F	8.6969E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2753E-05
5.	RPW	8.5452E-01	1.4548E-01	0.0000E+00	0.0000E+00	1.0000E+00	8.1309E-05
6.	SPB	8.4276E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.0190E-05
7.	HOB	6.6305E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.3091E-05
8.	XLTF	6.1845E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8846E-05
9.	LLTF	4.0841E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8861E-05
10.	CLTF	4.0841E-01	1.0665E+00	5.9159E-01	4.5188E-05	8.6000E-01	3.8861E-05
11.	CLA	3.3805E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2166E-05
12.	LLA	3.3805E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2166E-05
13.	CLTL	1.3121E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2485E-05
14.	LLTG	1.1383E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0831E-05
15.	DBCN	1.0706E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0187E-05
16.	BIU	6.6658E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.3426E-06
17.	MEH	6.3052E-02	9.9020E-01	1.0265E+00	-3.4526E-06	7.3000E-01	5.9995E-06
18.	ICEB	6.2047E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.9039E-06
19.	X2C	5.0129E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7699E-06
20.	RPP	4.8600E-02	9.9364E-01	1.0073E+00	-1.3012E-06	5.3500E-01	4.6244E-06
21.	LLT1	4.6024E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.3793E-06
22.	CVA	4.5798E-02	1.0137E+00	9.5420E-01	5.6595E-06	7.7000E-01	4.3578E-06
23.	LSO	4.5568E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.3359E-06
24.	X2S	3.6669E-02	1.6532E+00	9.6562E-01	6.5424E-05	5.0000E-02	3.4891E-06
25.	CLT1	3.6669E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4891E-06
26.	CVB	3.2020E-02	1.0151E+00	9.6798E-01	4.4806E-06	6.8000E-01	3.0468E-06
27.	MES	2.0732E-02	9.9922E-01	1.0103E+00	-1.0542E-06	9.3000E-01	1.9727E-06
28.	RPR	2.0565E-02	1.0298E+00	9.8783E-01	3.9916E-06	2.9000E-01	1.9568E-06
29.	RPT	1.9528E-02	1.0000E+00	1.0000E+00	0.0000E+00	5.0000E-01	1.8581E-06
30.	CLTD	1.7915E-02	2.1018E+00	9.8208E-01	1.0654E-04	1.6000E-02	1.7047E-06
31.	LLTD	1.7915E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7047E-06
32.	ICEH	1.5512E-02	9.9996E-01	1.0002E+00	-2.0021E-08	7.9000E-01	1.4760E-06
33.	LSS	1.3989E-02	9.9950E-01	1.0005E+00	-9.5074E-08	5.0000E-01	1.3311E-06
34.	RPQ	1.3707E-02	1.0532E+00	9.8910E-01	6.1007E-06	1.7000E-01	1.3043E-06
35.	RPA	1.3402E-02	9.9440E-01	1.0096E+00	-1.4476E-06	6.3200E-01	1.2753E-06
36.	RPS	1.2293E-02	1.0246E+00	9.9180E-01	3.1191E-06	2.5000E-01	1.1697E-06
37.	IPS	1.1986E-02	1.0011E+00	9.9630E-01	4.5850E-07	7.6800E-01	1.1405E-06
38.	RPU	8.0569E-03	1.0161E+00	9.9463E-01	2.0444E-06	2.5000E-01	7.6663E-07
39.	LLTK	8.0275E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.6383E-07
40.	RPB	6.2770E-03	1.0045E+00	9.9738E-01	6.7796E-07	3.6800E-01	5.9726E-07
41.	RP17	2.5028E-03	9.9750E-01	0.0000E+00	0.0000E+00	1.0000E+00	2.3814E-07
42.	CVL	1.5388E-03	1.0052E+00	9.9846E-01	6.3662E-07	2.3000E-01	1.4642E-07
43.	LLTE	1.0908E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0379E-07
44.	CLTE	1.0908E-03	1.0000E+00	1.0000E+00	3.5821E-22	4.5000E-02	1.0379E-07
45.	RPO	5.4833E-04	1.1086E+00	9.9945E-01	1.0382E-05	5.0000E-03	5.2174E-08
46.	C1B	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
47.	XLTI	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
48.	C1T	0.0000E+00	9.8801E-01	1.0009E+00	-1.2289E-06	7.2000E-02	0.0000E+00
49.	C1D	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
50.	BYA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
51.	XEI	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
52.	SPA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
53.	C2A	0.0000E+00	1.3122E-01	1.0070E+00	-8.3332E-05	8.0000E-03	0.0000E+00
54.	CET	0.0000E+00	9.9766E-01	1.0002E+00	-2.3952E-07	7.2000E-02	0.0000E+00
55.	C2O	0.0000E+00	9.9723E-01	1.0012E+00	-3.7713E-07	3.0000E-01	0.0000E+00
56.	DIH	0.0000E+00	9.6590E-01	1.0169E+00	-4.8570E-06	3.3200E-01	0.0000E+00
57.	DBCC	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
58.	C2NF	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Definitions:

Importance = the fraction of the group frequency with that split fraction failed.
Achievement = (Group Frequency with Split Fraction Set to 1.0)/(Group Frequency).
Reduction = (Group Frequency with Split Fraction Set to 0.0)/(Group Frequency).
Derivative = [δ(Group Frequency)]/[δ(Split Fraction)].
Split fraction value is from master frequency file.
Frequency = the total frequency of sequences assigned to the group with this split fraction failed.

Table 4.10-12 (Page 2 of 2). CET Split Fraction Importance to Release Category Group III

.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
59.	DII	0.0000E+00	9.5031E-01	1.0159E+00	-6.2453E-06	2.4300E-01	0.0000E+00
60.	HON	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
61.	CLN	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
62.	CEB	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
63.	C2P	0.0000E+00	9.8941E-01	1.0007E+00	-1.0699E-06	5.8000E-02	0.0000E+00
64.	C2S	0.0000E+00	9.7927E-01	1.0016E+00	-2.1257E-06	7.2000E-02	0.0000E+00
65.	MEL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
66.	C2J	0.0000E+00	9.9590E-01	1.0004E+00	-4.2449E-07	8.2000E-02	0.0000E+00
67.	C2EV	0.0000E+00	9.9138E-01	1.0001E+00	-8.2854E-07	1.0000E-02	0.0000E+00
68.	C2L	0.0000E+00	9.8820E-01	1.0006E+00	-1.1815E-06	5.0000E-02	0.0000E+00
69.	LSL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
70.	C2M	0.0000E+00	9.6621E-01	1.0001E+00	-3.2207E-06	1.6000E-03	0.0000E+00
71.	ICEA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
72.	IPL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
73.	ISS	0.0000E+00	9.8551E-01	1.0002E+00	-1.3982E-06	1.4000E-02	0.0000E+00
74.	ISL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

Definitions:

Importance = the fraction of the group frequency with that split fraction failed.
Achievement = (Group Frequency with Split Fraction Set to 1.0)/(Group Frequency).
Reduction = (Group Frequency with Split Fraction Set to 0.0)/(Group Frequency).
Derivative = [δ(Group Frequency)]/[δ(Split Fraction)].
Split fraction value is from master frequency file.
Frequency = the total frequency of sequences assigned to the group with this split fraction failed.

Table 4.10-13. CET Split Fraction Importance to Release Category Group IV

.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
1.	HOB	8.0363E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7332E-04
2.	HEB	8.0363E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7332E-04
3.	RPW	7.9609E-01	2.0391E-01	0.0000E+00	0.0000E+00	1.0000E+00	1.7169E-04
4.	CVC	5.2231E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1264E-04
5.	SPB	5.1544E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1116E-04
6.	X2F	5.1544E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1116E-04
7.	XLTF	5.1544E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1116E-04
8.	XEF	5.1544E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1116E-04
9.	ICEB	2.7529E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.9371E-05
10.	CVB	2.6842E-01	9.9228E-01	1.0164E+00	-5.2032E-06	6.8000E-01	5.7889E-05
11.	CVL	1.2900E-02	9.8941E-01	1.0032E+00	-2.9662E-06	2.3000E-01	2.7820E-06
12.	LSS	6.4183E-03	9.9994E-01	1.0001E+00	-2.7190E-08	5.0000E-01	1.3842E-06
13.	IPS	5.3618E-03	1.0005E+00	9.9834E-01	4.6489E-07	7.6800E-01	1.1564E-06
14.	RPT	3.1349E-03	1.0000E+00	1.0000E+00	0.0000E+00	5.0000E-01	6.7608E-07
15.	MEH	2.9810E-03	9.9956E-01	1.0012E+00	-3.5344E-07	7.3000E-01	6.4291E-07
16.	RPS	1.8922E-03	1.0038E+00	9.9874E-01	1.0882E-06	2.5000E-01	4.0809E-07
17.	RPU	1.3912E-03	1.0028E+00	9.9907E-01	8.0012E-07	2.5000E-01	3.0004E-07
18.	RP17	1.1196E-03	9.9888E-01	0.0000E+00	0.0000E+00	1.0000E+00	2.4146E-07
19.	MES	1.0062E-03	9.9996E-01	1.0005E+00	-1.1597E-07	9.3000E-01	2.1701E-07
20.	ISS	0.0000E+00	9.9352E-01	1.0001E+00	-1.4177E-06	1.4000E-02	0.0000E+00
21.	XLTI	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
22.	XEI	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
23.	ISL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
24.	MEL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
25.	SPA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
26.	X2S	0.0000E+00	7.1181E-01	1.0152E+00	-6.5424E-05	5.0000E-02	0.0000E+00
27.	LSL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
28.	BYA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
29.	C2NF	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
30.	C2P	0.0000E+00	9.9912E-01	1.0001E+00	-2.0061E-07	5.8000E-02	0.0000E+00
31.	C2M	0.0000E+00	9.9790E-01	1.0000E+00	-4.5467E-07	1.6000E-03	0.0000E+00
32.	CEB	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
33.	C2S	0.0000E+00	9.9899E-01	1.0001E+00	-2.3385E-07	7.2000E-02	0.0000E+00
34.	CET	0.0000E+00	9.9989E-01	1.0000E+00	-2.6349E-08	7.2000E-02	0.0000E+00
35.	C1A	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
36.	C1D	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
37.	C2A	0.0000E+00	2.0738E-01	1.0064E+00	-1.7232E-04	8.0000E-03	0.0000E+00
38.	C1T	0.0000E+00	9.9464E-01	1.0004E+00	-1.2461E-06	7.2000E-02	0.0000E+00
39.	IPL	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
40.	DIH	0.0000E+00	9.9812E-01	1.0009E+00	-6.0775E-07	3.3200E-01	0.0000E+00
41.	DII	0.0000E+00	9.9790E-01	1.0007E+00	-5.9966E-07	2.4300E-01	0.0000E+00
42.	DBCC	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
43.	ICEA	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
44.	CLN	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
45.	CLTD	0.0000E+00	5.1390E-01	1.0079E+00	-1.0654E-04	1.6000E-02	0.0000E+00
46.	CLTF	0.0000E+00	9.7067E-01	1.1802E+00	-4.5188E-05	8.6000E-01	0.0000E+00
47.	CVY	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
48.	CVA	0.0000E+00	9.9392E-01	1.0204E+00	-5.7051E-06	7.7000E-01	0.0000E+00

Definitions:

Importance = the fraction of the group frequency with that split fraction failed.
Achievement = (Group Frequency with Split Fraction Set to 1.0)/(Group Frequency).
Reduction = (Group Frequency with Split Fraction Set to 0.0)/(Group Frequency).
Derivative = [δ(Group Frequency)]/[δ(Split Fraction)].
Split fraction value is from master frequency file.
Frequency = the total frequency of sequences assigned to the group with this split fraction failed.

Table 4.10-14. Impact of Core Damage "Arrest" on Release Group Frequencies

Release Category Group	Description	With Arrest		Without Arrest	
		Frequency per reactor-year	Fraction	Frequency	Fraction
I	Large, Early Containment Failure and Large Diameter Bypass	6.9×10^{-6}	0.02	9.4×10^{-6}	0.028
II	Small, Early Containment Failure and Small Diameter Bypass	1.5×10^{-5}	0.04	1.5×10^{-5}	0.045
III	Late and Long Term Failures	9.5×10^{-5}	0.29	9.8×10^{-5}	0.3
IV	Long-Term Intact	2.2×10^{-4}	0.65	2.1×10^{-4}	0.63
	Total	3.3×10^{-4}		3.3×10^{-4}	

4A. MODIFICATIONS MADE TO MAAP/PWR REVISION 17.02 FOR USE IN THE WATTS BAR IPE

1. Error in Break Uncovering Event Flag

   a. Description: The break uncovering logic in Revision 17 erroneously allows the break to "uncover;" i.e., discharge only gas if the collapsed level is below the elevation of the break.

   b. Impact: If the elevation of the break allows the collapsed level to drop below the break while the system average void fraction is less than VFSEP, the occurrence of phase separation will normally be postponed until safety injection fails. This could have an impact on sequence timing due to the feedback of pressure on safety injection flow. On the other hand, in most sequences in Westinghouse plants, the break is located low enough that the system void fraction is larger than VFSEP prior to break uncovering; in such cases, any discrepancies would be small.

   c. Correction: A simple check was added to subroutine EVENTS that prevents break uncovering if a two-phase natural circulation is occurring (see Attachment 1). This is consistent with the treatment in Revision 18.

2. Error in Concrete Attack Model

   a. Description: Two errors in the diagnostic messages for subroutine DECOMP in Revision 17 can lead to the code getting into an endless loop.

   b. Impact: If the number of messages issued by the subroutine exceeds the maximum allowed (50), the code can loop endlessly; otherwise, there is no impact on results.

   c. Correction: Two statements in subroutine DECOMP were corrected. This is consistent with the treatment in Revision 18.

3. Error and Improvement To Burn Model

   a. Description: An uninitialized variable in the gas combustion model can lead to problems on some computers. The use of the time step for the burn time when auto-ignition is taking place can lead to excessive run times.

   b. Impact: On some computers, the uninitiated variable can lead to run termination. In some sequences with high cavity temperatures, excessive run times can occur due to use of the time step for deriving the burning rate since this feeds back on the time step selection; otherwise, the effect is minor.

   c. Correction: A new statement was added, and an existing statement was modified in subroutine IGBURN. These changes are consistent with the treatment in Revision 18.

4. Error in Volume of Concrete Slag in Cavity

a. Description: An inconsistency in how the volume of the concrete slag is computed compared to the way that the cavity volume grows due to concrete attack can cause the cavity to slowly fill solid with slag.

b. Impact: If concrete attack proceeds vigorously enough that the cavity becomes half filled with debris, the cavity outer wall becomes "covered." This will cause the run to terminate due to the assumption that the heat flux from the cavity wall enters the cavity water pool (which is generally nonexistent at this point). No impact on sequences with little concrete attack or very large cavities.

c. Correction: Corrections from Revision 18 were made in subroutine CCOMPT.

5. Inappropriate logic for setting cavity solid and cavity T/H model event codes

a. Description: If the reactor cavity is going solid with water, an MAAP "event code" (68) is set. This causes the cavity to draw in enough water to complete the fill process. In plants in which there is no curb at the mouth of the instrument tunnel, this may cause the lower compartment water mass to go negative, which often results in fatal thermodynamic model errors. In plants with a curb of sufficient size (including Watts Bar and Sequoyah), this will not happen, but there is still a pronounced discontinuity caused by the rapid filling transient.

A related problem exists for sequences in which the lower compartment debris can be dry when considerable water exists in the cavity. In such cases, a highly accelerated rate of water depletion occurs in the cavity due to circulating superheated steam through the cavity when the equilibrium thermodynamics model is activated (event code 65).

b. Impact: Nonphysically large evaporation rates (and containment pressurization) can also occur after debris dryout until the nonequilibrium model is activated.

c. Correction: It is believed that the existing event code logic is undesirable and is unnecessarily complicated, given that we are now allowing time step selection to be based on cavity water mass. (This was not done previously.) Accordingly, the following logic changes were made.

The cavity goes to a solid condition if we are not entraining water to either the lower or upper compartments, the volume available for gas is less than 10% of the original (unabated) cavity volume (10% of the volume is "reserved" for gas to collect in when the cavity transitions back to a non-solid condition), and if there is water available to keep the cavity solid, either on the lower compartment floor or flowing out of the RPV. Note that causing the transition at this point prevents the discontinuity, which is now seen when the cavity draws in a large amount of water. The cavity

transitions to a nonsolid state if the volume available for gas has increased to 12% of the total (this should only happen if there is no longer water available to flow into the cavity), or if entrainment is occurring. Finally, if the cavity solid flag is set, the equilibrium thermodynamics model was activated (event code 65).

To solve the nonphysical evaporation problem, the nonequilibrium model is used whenever natural circulation is allowed.

6. Error in Steam Generator Thermodynamics Model

a. Description: The equilibrium thermodynamics model is generally used on the secondary side of the steam generators if the tube bundle is fully covered. This leads to erroneous results if cold water is rapidly added to the secondary side; e.g., due to a break or an AFW overfill transient. A related problem is that if the equilibrium model is being used, the time step selection does not consider the steam mass on the secondary side; this can cause artificially large swings in pressure.

b. Impact: Inappropriate secondary side pressure in affected sequences. This can lead to errors in predicted primary system response; e.g., in some SGTRs.

c. Reference for further discussion: Proceedings: MAAP Thermal-Hydraulic Qualifications and Guidelines for Plant Application Workshop, EPRI NP-7515, October 1991.

d. Correction: A minor correction for the logic for event codes 158 and 167 was made. An additional change was made to subroutine INTGRT to force control of time step based on secondary side steam mass under all conditions. Both changes are consistent with the treatment in Revision 18.

7. Error in Accumulator Modeling if Primary System Solid

a. Description: If the RCS is solid, no accumulator discharge will occur.

b. Impact: Incorrect modeling of accumulator flow in relatively unusual sequences.

d. Correction: A one-line change was made to subroutine PRISYS to consider the sum of the RCS and pressurizer gas volumes in the semi-implicit accumulator discharge model. This is consistent with the treatment in Revision 18.

4B. TIME-CONSTANT FOR MIXING BETWEEN THE UPPER PLENUM AND THE UPPER COMPARTMENT

Consider the time period prior to ice melt in which the steam concentration in the two compartments can be considered negligible. The density of gas ρ is given by

$$\rho = \frac{P}{RT}\left[A_a(1-n_{H2}) + A_{H2}\, n_{H2}\right]$$

where

P = pressure.

R = ideal gas constant.

T = temperature.

A_a, A_{H2} = molecular weight of air and H_2, respectively.

n_{H2} = mole fraction of hydrogen.

For the conditions of interest, we can neglect the last term. Then, the relative difference in density between the two compartments is approximately

$$\frac{\Delta\rho}{\rho} \cong \Delta n_{H2}$$

where Δn_{H2} is the difference in the hydrogen concentration between the upper compartment and upper plenum. Assume conservatively that while a larger hydrogen concentration has developed in the upper plenum, there is currently no forced flow of gas from the ice condenser. In this situation, a counter-current flow of gas will be induced; i.e., a jet of the less dense upper plenum gas will rise upward from the middle of the plenum and an equal volume of upper compartment gas will fall into the periphery. It is reasonable to treat the upper plenum geometry as a series of cubic cells, in each of which a jet develops. Epstein* has developed a correlation for the volumetric flow rate Q expected in this situation:

$$Q = .055\left[(1.1S)^5 g\frac{\Delta\rho}{\rho}\right]^{1/2}$$

S = length of cube.

g = acceleration of gravity.

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*Epstein, M., "Buoyancy-Driven Exchange Flow Through Small Openings in Horizontal Positions," *Journal of Heat Transfer*, May 5, 1987.

A time constant for mixing can be derived by dividing the cell volume by the volumetric flowrate:

$$\tau_{mix} = \frac{S^3}{Q}$$

$$\tau_{mix} = \frac{1}{.07}\sqrt{\frac{S}{g\Delta n_{H2}}}$$

Let the upper plenum hydrogen concentration be around the lower limit for Deflagration to detonation transition, $n_{H2} \sim 0.14$. Conservatively assume that the upper compartment is not quite at the lower limit for ignition, $n_{H2} \sim 0.08$. Taking

$$S \sim 5m$$

we obtain

$$\tau_{mix} \sim 40 \text{ seconds.}$$

We conclude that differences in hydrogen concentration between the upper plenum and upper compartment will quickly "wash-out."

4C. EFFECT OF ICE CONDENSER COOLING ON PRESSURE RISE DURING DEFLAGRATIONS

Consider a situation in which a large hydrogen burn occurs in the upper compartment. We wish to estimate the effect of backflow of hot gases through the ice condenser, and, in particular, the benefit obtained due to the cooling of these gases.

It is conservative to neglect the change in composition of the gases in the containment and the condensation of steam produced by combustion in the ice condenser. If we assume that many of the intermediate deck doors fail, only a small pressure difference will develop between the upper compartment and the lower compartment (which, for the purpose of this calculation, is also taken to include the dead-end compartments). For this reason, we will assume that the rate of pressurization, $\dot{P}$, of both is the same. We denote the two compartments by A and B, respectively. Assuming ideal gas behavior, under these assumptions, we have

$$\dot{P} = \frac{\dot{m}_A R T_A}{A_A V_A} + \frac{m_A R \dot{T}_A}{A_A V_A} \tag{4C.1}$$

where

m_A = mass of gas in A.

T_A = temperature.

A_A = molecular weight of the gases in A.

V_A = volume.

R = gas constant.

Similarly, for B, we have

$$\dot{P} = \frac{-\dot{m}_A R T_B}{A_B V_B} + \frac{m_B R \dot{T}_B}{A_B V_B} \tag{4C.2}$$

where we used $\dot{m}_B = -\dot{m}_A$

The rate of change of gas temperature in the two compartments is given by energy conservation:

$$m_A C_{V,A} \dot{T}_A + \dot{m}_A C_{V,A} T_A = Q + \dot{m}_A C_{P,A} T_A \tag{4C.3}$$

where C_V and C_P are the specific heats at constant volume and pressure, respectively, and Q is the rate of energy release by burning hydrogen.

In the lower compartment

$$m_B C_{V,B} \dot{T}_B - \dot{m}_A C_{V,B} T_B = -\dot{m}_A C_{P,A} T_x \tag{4C.4}$$

where T_x is the temperature of the gases leaving the ice condenser and entering B. Treating the ice condenser as a heat exchanger with a turbulent convective flow heat transfer coefficient h (i.e., constant through the ice condenser), we have the well-known result:

$$T_x = T_I + (T_A - T_I)\exp\left[-\frac{hA_I}{|\dot{m}_A| C_{PA}}\right] \tag{4C.5}$$

where

T_I = interface temperature between the ice and the gas.

A_I = surface area for heat transfer.

If we substitute Equation (4C.4) into Equation (4C.2) and manipulate, we obtain

$$\dot{P} = \frac{-R\dot{m}_A}{A_B V_B} \frac{C_{P,A}}{C_{V,B}} T_x \tag{4C.6}$$

Substituting Equation (4C.6) into Equation (4C.1),

$$\dot{P}\left[1 + \frac{C_{V,B} A_B V_B T_A}{C_{P,A} A_A V_A T_x}\right] = \frac{m_A R \dot{T}_A}{A_A V_A} \tag{4C.7}$$

Eliminating $\dot{T}_A$ with Equation (4C.3), we obtain:

$$\dot{P} = \frac{RQ}{A_A V_A C_{V,A}} \Big/ \left[1 + \frac{V_B}{\gamma V_A}\frac{T_A}{T_X}\right] \tag{4C.8}$$

where

$$\gamma \equiv \frac{C_{P,A}}{C_{V,B}}$$

Given the simplifying assumptions made earlier, a burn occurring in a closed compartment A would pressurize the compartment at a rate given by

$$\dot{P} = \frac{m_A R \dot{T}_A}{A_A V_A} \tag{4C.9}$$

where

$$\dot{T}_A = \frac{Q}{m_A C_{V,A}} \tag{4C.10}$$

or

$$\dot{P} = \frac{RQ}{A_A V_A C V_A} \tag{4C.11}$$

Comparing Equations (4C.11) and (4C.8), we see that the effect of backflow of gases through the ice condenser is to reduce the pressurization rate, and, thus, the total pressure rise, by the factor

$$F = 1 + \frac{V_B}{\gamma V_A}\frac{T_A}{T_x} \tag{4C.12}$$

To see what impact this has, it is first necessary to compute the ice condenser exit temperature. The HECTR code (Reference 4C-1) models heat transfer in the ice condenser using the Dittus-Boelter correlation but increases the calculated result by a factor of 5 to account for roughness. Proceeding in the same way, we note that the gas temperature in the upper compartment will typically vary over a range of about 300°K to 1,200°K during the burn. Let us consider gas entering the ice condenser at about the midpoint, 800°K. If the pressure is 2 atmospheres and is mostly air,

$$\rho \sim 1\frac{kg}{m^3}$$

$$C_P = 1{,}100\ \frac{J}{k_g{}^\circ K}$$

$$\mu = 3.6 \times 10^{-5}\ \frac{kg}{m\text{-}sec}$$

$$k = .06\ \frac{W}{m^\circ K}$$

The upper compartment volume is 20,000 m^3. Consulting Reference 4C-1, we estimate a burn velocity of 8 m/sec, which leads to about a 5-second total burn time. The flow rate of gas entering the ice condenser is then very roughly

$$\frac{(20{,}000\ m^3)\left(1\frac{kg}{m^3}\right)}{5\ \text{seconds}\ (2)}$$

or 2,000 kg/sec. As we shall see below, we are relatively insensitive to this approximation. Estimates of the ice condenser geometry are contained in Reference 4C-1 and lead to

A_x (flow area) = 100 m^2

D_{HY} (hydraulic diameter) = .3 m

A_{HT} (heat transfer area) = 1×10^4 m^2 (assuming that ice is half-melted)

The Reynolds number is

$$Re = \frac{\left(2{,}000 \frac{kg}{sec}\right)(.3m)}{(100\ m^2)\left(3.6 \times 10^{-5} \frac{kg\text{-}m}{sec}\right)}$$

$$\cong 1.7 \times 10^5$$

So, for a Prandtl number of 0.7, we have

$$Nu = (5)\ (.023)\ (1.7 \times 10^5)^{.8}\ (.7)^{.3}$$

$$= 1{,}600$$

$$h = \frac{(Nu)(.06)}{.3}$$

$$= 300 \frac{W}{m^\circ K}$$

If the interface temperature between the gas and the ice is taken to be 0°C due to melting ice,

$$T_x - T_I = (800-273)\exp\left[\frac{-(300)(10^4)}{(2{,}000)(1{,}100)}\right]$$

$$\cong 500\ e^{-1.4}$$

$$\cong 130^\circ K$$

We observe that the outlet temperature is much closer to the ice temperature than to the inlet gas temperature. This conclusion is valid for relatively wide variations in the assumed flow area and the heat transfer area but is somewhat dependent on the heat transfer augmentation factor for roughness assumed in HECTR.

Finally, substituting into Equation (4C.12) with

$$\gamma \sim 1.3$$

$$\frac{V_B}{V_A} \sim .66$$

we obtain

$$F \cong 2$$

By contrast, if we neglect backflow entirely,

$$F = 1$$

and if we assume there is backflow but either no ice or no heat transfer to the ice, we have (with $T_X = T_A$):

$$F = 1.5$$

This is, roughly speaking, consistent with the changes observed in the HECTR runs in which the ice condenser doors, which were discussed in Section 6, were removed.

REFERENCES

4C-1. Dingman, S. E., et. al., "HECTR Version 1.5 User's Manual," prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-4507, February 1988.

5. UTILITY PARTICIPATION AND INTERNAL REVIEW TEAM

5.1 IPE PROGRAM ORGANIZATION

TVA initiated plans to develop an individual plant examination (IPE) for Watts Bar Nuclear Plant Unit 1 in 1989. The Risk Assessment Staff (RAS) of Corporate Engineering was given the responsibility to perform a probabilistic risk assessment (PRA) on Watts Bar to satisfy the requirements of U.S. Nuclear Regulatory Commission (NRC) Generic Letter No. 88-20. The organizations that are involved in developing the IPEs are summarized in Figure 5-1. Table 5-1 is a matrix detailing the Watts Bar individual contributors from Watts Bar and Corporate Engineering.

The TVA/RAS team for Watts Bar consisted of six individuals, including the project manager. These individuals included the leads for Level 1, Level 2, and data; an electrical systems analyst; and system analysts. The expertise of a licensed reactor operator, assigned full-time to support the PRA, provided plant-specific input. In addition, the TVA team was augmented by a full-time contractor located with the TVA team. The focus of the TVA participation for Level 1 was in the areas of systems analysis and event trees. TVA participated in all areas of the Level 2 effort.

The draft event sequence diagrams (ESD) were developed by TVA. TVA then developed the frontline event trees used in the plant model. The development was supported by the full-time contractor and underwent periodic reviews by the Watts Bar reactor operators and contract personnel.

TVA developed the draft system analyses. This involved definition of the various top events based on the Level 1 model, system familiarization, establishment of system boundary conditions, system notebook preparation, construction of fault trees, and a preliminary quantification for the boundary condition of "all support available." The system notebooks were then finalized by PLG. TVA site organizations, including site engineering, technical support, and operations in addition to RAS, conducted detailed reviews of the system notebooks.

TVA participated strongly in a number of areas in the Level 1 effort. These included:

- Providing input to and the review of initiating event categories.
- Developing the dependency matrices with detailed review by Watts Bar site personnel and RAS.
- Leading the team that performed the plant walkdown for the internal flooding analysis.
- Defining the dynamic human actions modeled and conducting the detailed interviews of the operating crews. In addition, the licensed operator team member directly participated in the preparation of the operation response forms.
- Performing the data screening used to develop the common cause failure parameters.

- Quantifying of the Level 1 model.
- Developing the insights and recommendations for the IPE.

TVA had extensive participation in the Level 2 effort. This included the plant damage state definitions, the containment event tree, release categories, and the identification of representative sequences for split fraction quantification. The development of the original Modular Accident Analysis Code (MAAP, Reference 5-1), parameter file was done by nuclear engineering. The containment walkdowns included RAS personnel, plant operations, nuclear engineering, and a Watts Bar independent consultant.

The principal outside contractor was PLG. Support was also provided by ERIN Engineering; Gabor, Kenton and Associates (GKA); and EQE Engineering. PLG participated in all facets of the project. The major areas included the system analyses, basic event databases, and the event trees. The interfacing systems LOCA (ISLOCA) and internal flooding analyses were performed by PLG. ERIN had responsibility for the initiating event categories; finalizing the ESDs; heating, ventilation, and air conditioning (HVAC) screening; and participating in the event tree development. GKA was responsible for the thermal-hydraulic severe accident progression and source term analysis (MAAP) of the representative sequences. A limited-scope containment structural analysis and the component and piping fragilities used in the ISLOCA analysis were performed by EQE Engineering.

5.2 COMPOSITION OF INDEPENDENT REVIEW TEAM

The RAS coordinated review of the IPE with Watts Bar nuclear engineering, operations, and technical support to ensure both site participation and "buy-in" to the PRA. Watts Bar had primary responsibility for the TVA independent review and for ensuring that the IPE represents the current design and operation of the plant (defined as of December 1991). Table 5-1 lists the independent reviewers and their organizations. This table illustrates the extensive site participation and exposure to the PRA.

PRA training sessions were held for site personnel by the RAS staff. Before the release of the draft report, meetings were held in which the accident sequences, insights, and recommendations were presented to the various site organizations. Additionally, the supporting analyses performed by PLG received independent internal review by senior members of their staff.

In coordination with the Watts Bar personnel, Dr. Ian B. Wall conducted an independent review of the Watts Bar IPE. His review focused on overall approach, methodology, and responsiveness to NRC requirements as stated in NUREG-1335 and Generic Letter No. 88-20. He used checklists in EPRI Report TR-100369, "Individual Plant Examination Review Guide," as a basis for his independent review.

A major interactive review session of the Watts Bar PRA was conducted in August 1992 prior to presentation to upper management. Site engineering and operations with RAS and PLG performed a detailed review of the final PRA over several days.

5.3 AREAS OF REVIEW AND MAJOR FINDINGS

TVA conducted ongoing reviews for work products (e.g., system analysis notebooks and dependency matrices) and of the draft final report. The major areas of review are listed with the reviewers in Table 5-1.

The overall interaction enhanced the accuracy of the IPE relative to design and operation of the plant. In addition, the extensive review led to further explanations and discussions about the PRA process and enhanced the plant personnel's overall understanding of PRA and its applications. No major findings were identified as a result of the final review session held in August 1992.

5.4 RESOLUTION OF COMMENTS

Comment resolution was also conducted on an ongoing basis. Comments were incorporated during the normal iterative process of developing a PRA. The final review comments were input into the interactive review session in August 1992. This session resulted in concurrence with the comment resolution and final submittal. No significant findings were identified as a result of this review.

5.5 REFERENCES

5-1. Henry, R. E., and M. G. Plys, "MAAP-3.0B — Modular Accident Analysis Program for LWR Power Plants," Electric Power Research Institute, EPRI NP-7071-CCML, November 1990.

Table 5-1 (Page 1 of 4). Participation Matrix

Organization	Name	Title	PRA Preparation Phase					
			System Analysis	Data Analysis	Level I Plant Analysis	Level II Containment Analysis	Final Report	Executive Summary and Results
Site Participation								
Management	W. J. Museler	Site Vice President						R
	H. H. Weber	Manager, Engineering and Modifications						R
	D. H. Moody	Plant Manager						R
	D. L. Koehl	Manager, Technical Support						R
	L. L. Jackson	Manager, Operations						R
	R. G. Mende	Project Manager, Operations						R
	W. L. Elliott	Manager, Nuclear Engineering						R
	G. L. Pannell	Manager, Site Licensing						R
	R. N. Mays	Licensing Engineer						R
	W. D. Stevens	Project Manager			R	R	R	R
Nuclear Engineering	J. S. Thompson	Mechanical Engineer	R					
	J. S. Robertson	Mechanical Engineer	R		R			
	D. W. Posey	Mechanical Engineer	R					
	K. R. Turnbull	Mechanical Engineer	R					

Note: R = Reviewed. P = Participant.

Table 5-1 (Page 2 of 4). Participation Matrix

Organization	Name	Title	PRA Preparation Phase					
			System Analysis	Data Analysis	Level I Plant Analysis	Level II Containment Analysis	Final Report	Executive Summary and Results
Site Participation								
Nuclear Engineering (continued)	H. R. Persinger	Mechanical Engineer	R					
	J. S. Arrington	Mechanical Engineer	R					
	D. L. Beals	Mechanical Engineer	R					
	Hussin Hasan	Civil Engineer				R		
	W. T. Holbert	Electrical Engineer	R,P		R			
	S. A. Cutts	I & C Engineer	R					
	J. A. Vogel	Specialist, MOE	R			R		
	J. S. Craig	I & C Engineer	R					
	F. A. Koontz	Manager, MOE	R	R	R	R	R	R
	M. D. Davis	Supervisor, NSSS	R		R		R	R
	R. A. Sulfridge	Engineer, MOE		R	R	R		
	M. S. Teeple	Engineer, MOE			R	R		
	J. F. Lund	Supervisor, BOP	R, P		R			
	S. D. Ferrell	Project Engineer	R		R	R	R	R
Technical Support	Chris A. Haerr	System Engineer	R		R			
	Claude M.Key	System Engineer	R		R			
	Ernie C. Clauss	System Engineer	R		R			
	Curtis V. Overall	System Engineer	R		R			
	M. Ken Jones	System Engineer	R		R			

Note: R = Review. P = Participant.

Table 5-1 (Page 3 of 4). Participation Matrix

Organization	Name	Title	PRA Preparation Phase					
			System Analysis	Data Analysis	Level I Plant Analysis	Level II Containment Analysis	Final Report	Executive Summary and Results
Site Participation								
Technical Support (continued)	John A. Tucker	System Engineer	R		R			
	Craig M. Williams	System Engineer	R		R			
	Landy L. McCormick	Supervisor, NSSS	R		R		R	R
	J. Steven Woods	Supervisor, Electrical I & C	R		R		R	R
	Adrian M. Hansing	System Engineer	R		R			
	John T. Maddux	System Engineer	R		R			
	Bill J. Hensley	System Engineer	R		R			
	Terry R. Smith	System Engineer	R		R			
	Douglas F. Helms	Supervisor, Engineering Support	R		R			
	Jose J. Ortiz	LRT Engineer	R		R			
	Craig Faulkner	Coordinator, Reactor Engineering	R		R	R	R	R
	Gerald L. Baker	System Engineer	R		R			
	Ed. L. Steinhauser	System Engineer						
	John W. Ferguson	System Engineer						
	Doug J. Heidrich	System Engineer	R		R			
	Jeff B. Fawcett	System Engineer	R		R			
Operations	Sheila Baker	Shift Operations Supervisor (SOS)	R					
	Wilbur Harris	SOS			P, R	R	R	R
	Gary Seaman	Assistant SOS (ASOS)	R					

Note: R = Reviewed. P = Participant.

Table 5-1 (Page 4 of 4). Participation Matrix

Organization	Name	Title	PRA Preparation Phase					
			System Analysis	Data Analysis	Level I Plant Analysis	Level II Containment Analysis	Final Report	Executive Summary and Results
Site Participation								
Operations (continued)	Mark Luksic	ASOS	P, R		P, R	R	R	P, R
	Larry Tucker	ASOS			P, R			
Risk Assessment Team								
Risk Assessment Team	Richard McMahon	RAS Manager	P, R	R	P, R	R	P, R	P, R
	Carla Borrelli	Data Specialist	P, R	P	P, R		P, R	R
	J. Stephen Clements	Level I Specialist	P, R	R	P, R	R	P, R	R
	Ara Djirikian	Electrical Systems Analyst	P, R	R	P, R		R	R
	Raj Paul	System Analyst	P, R					R
	Bill Mims	Level II Analyst	P		R	P, R	P, R	P, R

Notes: R = Review. P = Participant.

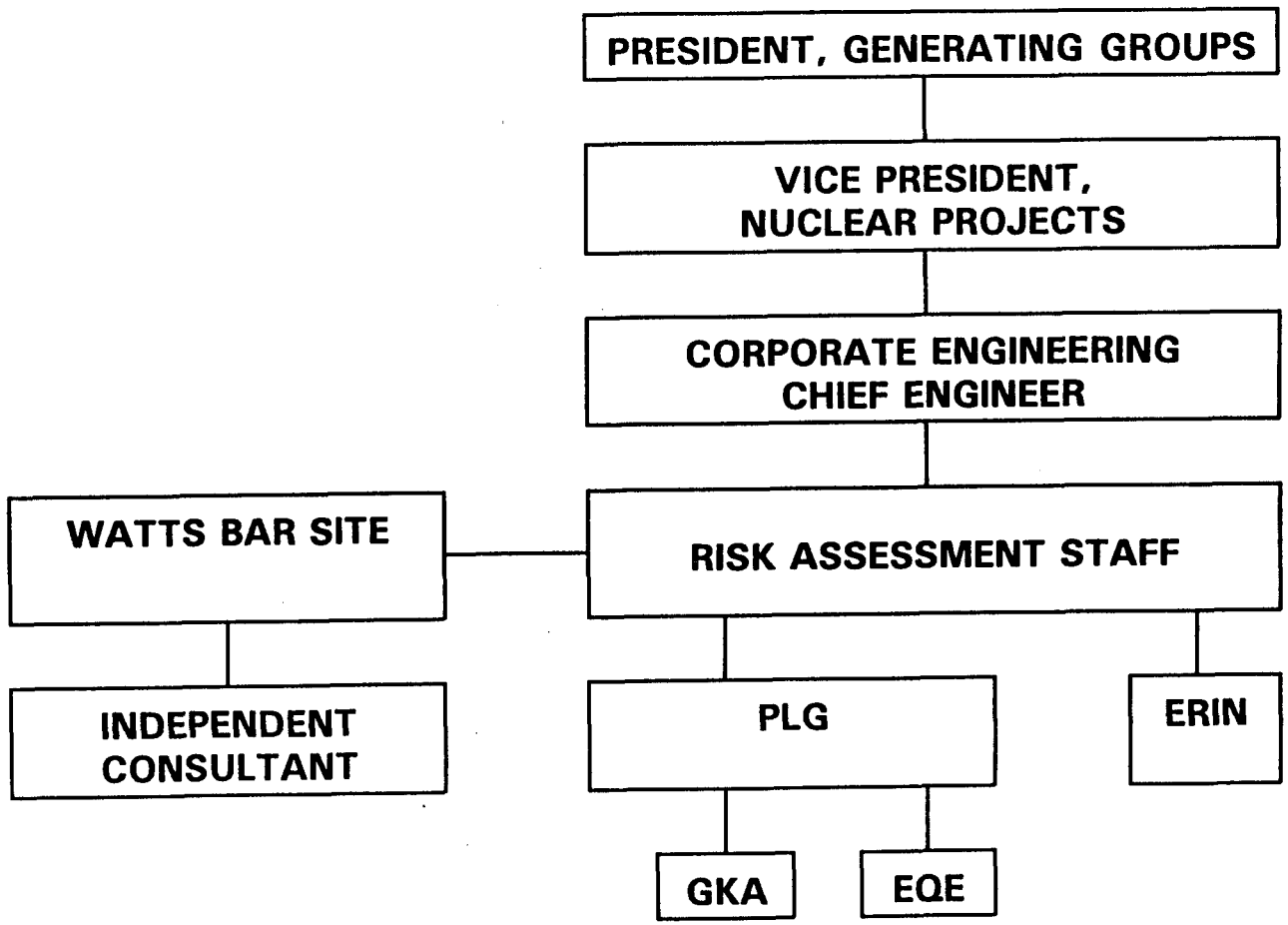

Figure 5-1. Tennessee Valley Authority Management

6. PLANT IMPROVEMENTS AND UNIQUE SAFETY FEATURES

6.1 INTRODUCTION

The purposes of this section are to document the unique safety features that were identified in this individual plant examination (IPE), to discuss the evaluation of potential plant and procedural improvements, and to summarize the lessons learned from the IPE. The important plant and containment features and operator actions are identified.

The two risk factors that have been considered are the mean core damage frequency and the frequency of core damage sequences that involve large early containment failure or bypass. The second figure of merit is hereafter referred to as the large early release frequency.

Consideration of the containment features associated with the early release frequency is discussed in Section 6.3.3. The core damage and early release frequencies and the contributors to them are discussed in Sections 3.4 and 4.6. For Watts Bar, certain operator actions, plant hardware, and containment features have been found to be beneficial in the estimates of frequencies of core damage sequences. These are discussed in Section 6.2. While these features are not necessarily unique, they are important to the overall safety of Watts Bar.

As discussed previously in Section 3.4.3, no plant vulnerabilities have been identified for Watts Bar. However, some potential plant enhancements have been identified that would be beneficial to lowering either or both the mean core damage frequency and the mean early release frequency. These potential enhancements are described in Section 6.3.

Additionally, TVA recognizes that there are substantial uncertainties in the probabilistic risk assessment (PRA) models both for the Level 1 and the Level 2 analyses. As is necessary in any PRA model, a number of assumptions must be made in the development of the plant and containment models. Some additional areas for study are identified in Section 6.4.

6.2 WATTS BAR MAIN BENEFICIAL FEATURES

6.2.1 BENEFICIAL PROCEDURES/OPERATOR ACTIONS

For Watts Bar, the Emergency Operating Procedures follow the strategies of the Westinghouse Owners Group symptom-based standard Emergency Response Guidelines. Relative to much earlier versions of emergency procedures at other plants for which PRAs were performed, a number of additional key actions are now proceduralized, and have a safety benefit. These proceduralized actions include:

1. The actions to provide makeup to the refueling water storage tank (RWST) in the event of a loss of coolant accident (LOCA) or steam generator tube rupture for continued high pressure injection in sequences in which recirculation from the containment sump is not available are directed in procedure ECA-1.1, "Loss of RHR Sump Recirculation."

2. The actions to depressurize the reactor coolant system (RCS), to ensure containment isolation, and to locally operate the turbine-driven auxiliary feedwater (AFW) pump flow control valves in the event of a loss of all AC power are directed by procedure ECA-0.0, "Loss of All AC Power."

3. The actions to align for feed and bleed cooling in the event of a loss of all secondary heat removal are directed by procedure FR-H.1, "Response to Loss of Secondary Heat Sink."

4. The actions to emergency borate and to locally trip the motor generator sets to remove power from the control rod drives in response to an anticipated transient without scram (ATWS) sequence are directed by FR-S.1, "Response to Nuclear Power Generations/ATWS."

5. The actions to begin refilling the condensate storage tank (CST) as soon as it drops below the technical specification limit, rather than waiting until it gets closer to emptying, are directed by procedure E-1, "Loss of Reactor on Secondary Coolant."

One other action is also found to be beneficial. In the event of a loss of all CCS cooling to the reactor coolant pump (RCP) thermal barriers and to the charging pumps, essential raw cooling water (ERCW) header 1A can be manually aligned to provide cooling to the centrifugal charging pump A and to reestablish RCP seal injection. This action limits the dependence of both RCP thermal barrier cooling and RCP seal injection on CCS.

6.2.2 BENEFICIAL PLANT HARDWARE

For Watts Bar, the plant hardware found to be beneficial include the following:

1. The condensate storage tank has a relatively large capacity (i.e., 370,000 gallons) and, by administrative procedure, is kept topped off above the Technical Specification limit. The capacity of the tank is such that the time available for refilling the CST is greatly extended relative to some other plants.

2. There are eight pumps available for the two units at Watts Bar for the ERCW system; i.e., the safety grade ultimate heat sink. Each of the eight pumps can supply headers that provide flow to both units. This is in contrast to some two-unit stations that have only four pumps total for two units.

3. There are two independent high pressure injection systems (i.e., the charging pumps and the safety injection pumps) for a total of four pumps that can provide high pressure injection flow under LOCA conditions.

4. A standby electric-driven main feedwater (MFW) pump is available for restoring feed (greater than 440 gpm) to the steam generators for sequences involving a plant trip in which all AFW is unavailable.

5. The shutdown buses do not have to transfer to an alternate offsite power supply for every unit trip as at some other plants.

6. The ATWS mitigation safeguards actuation system (AMSAC) is currently installed for ATWS mitigation.

7. Steam generator level indication is, in part, powered from the 125V DC vital batteries of the opposite unit. Consequently, level indication will still be available to the operators during an extended loss of unit AC.

8. Also, DC power for the turbine-driven AFW pump is supplied from the opposite unit. Therefore, in a loss of all AC to one unit, DC power is still available from the other unit to permit extended heat removal via the turbine-driven AFW pump. This feature is especially important for the Level 2 analysis. AFW is used for steam generator cooldown during unit blackouts. During a unit blackout, both the turbine-driven AFW pump controls and the steam generator level instrumentation are still available after the Unit 1 batteries are depleted. This means that if core damage occurs due to RCP seal leakage, the RCS will remain at low pressure, rather than repressurize due to the loss of all AFW after battery depletion.

6.2.3 BENEFICIAL CONTAINMENT OPERATION FEATURES

The Watts Bar containment design and operating features found to be beneficial include the following:

1. The three relief valves in the residual heat removal (RHR) system have large relief capacity and vent to the containment. This relief capacity helps to limit the potential for an interfacing LOCA. The leakage past the redundant, normally closed valves on the RHR suction and discharge lines must be very great to exceed the relief capacity by enough to overpressure the RHR system, resulting in leakage outside containment.

   In addition, leakage from the discharge paths must leak past a third check valve to reach the RHR heat exchangers and pumps. Although the 8-inch piping between the check valve and the reactor coolant pressure boundary is designed to 600 psig; the materials and schedule of piping provide design margins, making pipe failure unlikely.

2. Four separate pumps can take suction from the containment sump during recirculation; i.e., two RHR pumps and two containment spray pumps. Each pump has an associated heat exchanger, and only one pump and associated heat exchanger is needed for long-term containment heat removal.

Wherever possible, appropriate credit was taken in the analysis for secondary-side depressurization and cooldown. These actions had several important impacts:

1. Core damage was precluded for some important events, and, for others, the time to core uncovery was extended beyond the time frame of interest. (Such sequences were treated as "core damage arrested" in the Level 2 analysis.)

2. The time between the beginning of core uncovery and vessel breach is significantly extended. This provides a larger time window for recovery, but such recovery was

not taken in this analysis. Since station blackout events are not an important contributor to core damage, this recovery may not be a significant factor.

3. For those sequences that progress to vessel breach, sustained cooldown/depressurization ensures that the reactor coolant system (RCS) pressure is low prior to failure, thus negating the contribution of high pressure melt ejection (HPME) and direct impingement to Level 2 results.

In a number of important core damage sequences, reactor trip occurs at t = 0, but inventory loss from the RCS does not begin for at least 4 hours. During this period, the AFW removes the decay heat from the core as well as some of the sensible heat. This "cooldown period" also extends the time to core uncovery and vessel breach.

In terms of the frequency of occurrence, no specific containment vulnerabilities were identified. However, given HPME and failure of the seal table, containment failure due to direct impingement of debris on the steel containment wall cannot be dismissed.

The availability of a substantial quantity of water from melted ice guarantees a flooded reactor cavity if the contents of the RWST are also injected into the containment. Recent industry research (see Reference 6-1) has suggested that in-vessel debris can be cooled, thereby preventing vessel breach, if a sustained supply of water can reach the external surface of the reactor vessel. For this cooling to occur, water in the cavity must penetrate the reactor vessel insulation to the bottom head, and, if steam is produced by the cooling of the vessel, there must be a sufficient flow area to prevent "steam binding" of the flow. This beneficial feature has not been credited in the Level II analyses.

6.3 WATTS BAR VULNERABILITIES IDENTIFIED AND POTENTIAL ENHANCEMENTS CONSIDERED

No plant vulnerabilities were identified for Watts Bar. Therefore, no potential enhancements were identified to specifically address vulnerabilities.

In addition to the vulnerability screening criteria identified in Section 3.4.3, TVA has developed an interim set of in-house PRA screening criteria for consideration of potential plant enhancements not associated with vulnerabilities. The PRA screening criteria require the examination of major contributors to either the total core damage frequency or the early release frequency if the impacts of such contributors exceed numerically defined thresholds. The evaluation process was directed at verifying PRA modeling assumptions. If the analysis conclusions were found to be valid, potential enhancements were identified to address the issue, and will be evaluated for cost effectiveness, and suitability for implementation.

For individual initiators, single component failures, or single operator actions, potential enhancements were evaluated if they contributed more than 5×10^{-5} per reactor-year to the core damage frequency. Potential enhancements of a single system train were evaluated further if they contributed more than 1×10^{-4} per reactor-year to the total core damage frequency.

The results for Watts Bar lead to the conclusion that there are three contributors to the total core damage frequency that exceed the PRA screening criteria for consideration of

potential enhancements. Loss of offsite power and the total loss of CCS initiating event categories each contribute greater than 5 X 10^{-5} to the total core damage frequency. Additionally, failure of operator action to trip the RCPs in the event of a loss of CCS train A contributes greater than 5 X 10^{-5} to the total core damage frequency.

Like the discussion of beneficial features, the options for potential enhancement are organized in terms of changes to procedural, plant hardware, and containment features.

6.3.1 ENHANCED PROCEDURES/OPERATOR ACTIONS

1. For addressing a loss of CCS train A, consideration should be given to revising AOI-15, "Loss of Component Cooling Water," to facilitate stopping the RCPs on loss of CCS train A to minimize the potential for RCP seal damage due to pump bearing failure.

2. Also, in the event of a total loss of CCS, clearer guidance on the desirability of cooling down the RCS prior to a seal LOCA developing to minimize the potential for seal damage should be considered. In general, additional training on the loss of CCS initiator is suggested.

3. In the event of a loss of offsite power followed by the failure of both shutdown boards on one unit, the procedures would be enhanced by adding the guidance to align the C-S diesel generator (i.e., the fifth diesel generator) to one of the shutdown buses not powered in the accident sequence due to the loss of a normally aligned diesel generator. This alignment could be accommodated by including a reference to the spare diesel generator in AOI-35, "Loss of Offsite Power."

6.3.2 ENHANCED PLANT HARDWARE

A potential improvement that could be evaluated is a plant change to provide connections for both centrifugal charging pumps, on both units, to the ERCW system for lube oil cooling in the event of a loss of CCS cooling to the associated pump. Currently, this capability is only available for centrifugal charging pump A on Unit 1. A sensitivity study shows that this could result in a decrease of about 4% in the total CDF.

6.4 ADDITIONAL INSIGHTS AND RECOMMENDATIONS

Some additional insights were derived from the IPE process based on sensitivities to various scenarios. The recommendations offered are not associated with significant plant vulnerabilities and are below the PRA enhancement criteria for further evaluation. The insights and recommendations offered below are simply viewed as additional considerations.

1. Enhancements to the operator training and procedures for responding to failures of support systems could potentially be beneficial, with emphasis on anticipating problems and coping.

2. Ventilation has been conservatively modeled in this study. Area ventilation is provided to the motor-driven AFW pumps and the CCS pumps from multiple

systems serving the plant elevation where these pumps are located. Beyond design basis concurrent failures of the available unit 1 ventilation is assumed to impact the long-term availability of the AFW and CCS. An evaluation of the CCS/AFW area cooling requirements could be performed which could reduce this interdependence by crediting natural convection and availability of other coolers at this plant elevation.

3. In the event of a loss of ERCW, which would eventually lead to a loss of CCS cooling, additional guidance on the relationship of CCS to ERCW and the desirability of eliminating CCS loads to extend the time of suitable CCS temperatures is a potential consideration for evaluation. This could be accomplished by revising AOI-13, "Loss of ERCW," to alert the operators to shed CCS loads prior to CCS heatup.

4. During a loss of all AC, the steam generator power-operated relief valves (PORV) are to be locally operated to depressurize the steam generators, thereby cooling down the RCS. The addition of provisions for remote operation of these valves could potentially be beneficial due to the high area temperatures that may be encountered.

5. In the event of a loss of CCS cooling to the charging pumps, the time available for operation of the pumps would be limited by the loss of lube oil heat exchanger cooling. To extend the time available to protect the pumps, consideration could be given to increasing the oil capacity.

6. Losses of RCP seal cooling could potentially be reduced if the RCP thermal barrier cooling dependence on component cooling water, which is required for the charging pumps that provide RCP seal injection, could be eliminated (addressed by actions under Section 6.3.2).

7. Currently, ventilation for the 480V board room that contains the unit vital inverters is provided by one train of ventilation. The current models rely substantially on recovery actions by the operators. Consideration could be given to providing two trains. This condition has been previously documented and is being resolved by the Watts Bar corrective action program.

8. From a severe accident point of view, one potential change, for consideration, would be the delaying of spray operations relative to the Phase B condition. Currently, containment sprays actuate immediately in response to a Phase B condition, and air return fans (ARF) actuate after a 10-minute delay. This is currently a requirement of the design basis LOCA where switchover to containment spray recirculation occurs prior to ice melt; thereby limiting pressure increases below containment design pressure. Modular Accident Analysis Program (MAAP, Reference 6-2) analyses of representative core damage sequences indicate that actuation of the containment sprays while ice remains in the ice condenser has little impact on severe accident containment performance and may be detrimental in that operation of the sprays rapidly depletes the inventory of the RWST, making its contents unavailable for vessel injection. Since many scenarios have successful injection but failure at recirculation, the rapid depletion of the RWST due to spray

operation accelerates the time to core damage. Therefore, an evaluation balancing the severe accident versus design basis requirements could be made.

6.5 KEY MODELING UNCERTAINTIES/CONSERVATISM

In the development of the PRA plant models for Watts Bar, a number of engineering assumptions were made. To the greatest extent possible, realistic assumptions were chosen. When supporting analysis was inconclusive, however, the more conservative assumption was chosen. If the conservative assumption later turned out to be important, additional evaluation would be requested only at that time.

A few such areas of uncertainty were identified following the final quantification, and are discussed below:

1. Oil leaks involving the cooling medium for the RCP motor bearings were not evaluated in the PRA but may have similar impacts to that currently modeled for loss of CCS cooling. The frequency of occurrence, potential timing, and failure modes for such oil leaks are not currently known.

2. One key uncertainty is the allowable centrifugal charging pump run time without lube oil heat exchanger cooling from CCS. The time available will dictate the practicality of relying on the operators to trip the charging pumps prior to realigning to ERCW cooling in the event of a loss of all CCS. The only available documentation on this issue notes that the time available is at least 1 minute, but a realistic estimate is not provided. The question is whether the charging pumps can be operated for as long as 10 minutes to provide adequate time for the operators to trip the running charging pumps.

3. Industry experience data are limited for determining the frequency of common cause events involving highly redundant systems with more than four trains of equipment; e.g., the eight ERCW pumps. Additionally, experience data are limited on the frequency of common cause events involving groups of equipment in which some pumps are normally running, and others are in standby.

4. Another uncertainty is the timing of hydrogen burns when ignitors are not available, especially in cases involving loss of all AC power.

5. The efficiency of natural circulation in the mixing of the containment atmosphere in cases in which air return fans are inoperable was another uncertainty.

6. Benefit was obtained in this study, as in NUREG 1150, for the depressurization of the reactor coolant system caused by high temperature failures of the hot leg and surge line. The likelihood of such failures is subject to uncertainties in core melt progression phenomena.

A few of the potential conservatisms were identified following the final quantification, and they are discussed below:

1. The containment spray pumps are provided seal cooling and lube oil cooling by flow from CCS. It is unclear how long the spray pumps could operate in the injection mode, taking suction from the RWST without CCS available. If the pumps can operate in the injection mode, it may also be true that the pumps could operate in the recirculation mode without CCS, provided that ERCW is available to cool the spray heat exchangers. This dependence of the spray pumps on CCS is important because the spray system heat exchangers are cooled by ERCW. As the design is now, the spray trains are dependent on both CCS and ERCW.

2. In the event of a loss of CCS train A cooling to the RCP upper and lower motor bearings, the operators have just a short time to trip the RCPs. A realistic estimate of the time available to trip the RCPs under these conditions is not available. Plant procedures indicate that only 2 minutes are available. The timing and failure modes associated with not tripping the RCPs in response to a loss of CCS cooling are a significant uncertainty in the current PRA plant model. For the current PRA plant model, failure to trip the RCPs within 10 minutes was assumed to result in a small LOCA through the RCP seals due to excess pump vibration, even if RCP seal injection was maintained.

3. The current models take credit for makeup to the RWST in the event of a steam generator tube rupture with leakage through the secondary side, and for LOCAs in which the spray pumps are available, but recirculation from the sump is not available for core heat removal. Credit for makeup to the RWST for small LOCAs in which spray recirculation is not available was not taken. This is because of the perceived short time available for action; i.e., procedural guidance directs the operators to wait until the RWST has nearly emptied before attempting to switch to recirculation, and makeup to the RWST is only then directed after recirculation from the sump is determined to be unavailable.

   Earlier filling of the RWST is not attempted since there is a desire not to exceed selected flood levels within containment. However, procedural guidance also directs the operators to use charging pump flow from the volume control tank (VCT). This path can provide approximately 140 gpm with makeup to the VCT from the primary water tanks. There is uncertainty about whether this rate of flow, after the RWST empties, is sufficient to provide inventory during a small LOCA. With successful operator cooldown and with auxiliary feedwater available, it may be sufficient.

4. The current success criterion for feed and bleed cooling requires one of the four high pressure injection pumps (i.e., the two charging and two safety injection pumps) provide injection (feed) with both pressurizer PORVs held open to provide a bleed path. Additional thermal-hydraulic analyses may show that one pressurizer PORV, or one PORV with two or more high pressure injection pumps, would also be successful. Use of head vents may also be beneficial. Relaxing the success criteria for these cases would reduce the core damage frequency.

5. For small LOCAs, the Level 1 success criteria assumed that high pressure recirculation was necessary to prevent core damage. However, Level 2 calculations indicated that if cooldown of the reactor coolant system is accomplished by depressurizing the steam generators, low pressure recirculation alone will be sufficient to provide make-up and prevent core uncovery.

6.6 REFERENCES

6-1. Henry, R. E., et al., "Cooling of Core Debris within the Reactor Vessel Lower Head," *ANS Transactions 63*, Page 260, June 1991 (also to be published in *Nuclear Safety*.)

6-2. Henry, R.E., and M.G. Plys, "MAAP-3.0B — Modular Accident Analysis Program for LWR Power Plants," Electric Power Research Institute, EPRI NP-7071-CCML, November 1990.

7. SUMMARY AND CONCLUSIONS

A systematic safety assessment has been performed for Watts Bar using probabilistic risk assessment (PRA) technology. This Watts Bar PRA is a Level 2 analysis using state-of-the-art methods. It includes a treatment of internal initiating events and internal floods.

This report constitutes the Watts Bar individual plant examination (IPE) submittal. It is organized in accordance with the reporting guidelines of NUREG-1335.

Tennessee Valley Authority (TVA) participated in all aspects of the Watts Bar PRA. TVA personnel, who are familiar with the details of the design, controls, procedures and system configurations, have been involved with the analyses. TVA personnel participated in the plant walk throughs and provided independent reviews. As a result, TVA is confident that the PRA represents the actual plant configuration and operation.

The PRA has resulted in increased understanding that certain design features and procedures are beneficial to Watts Bar safety. The results of the current study indicate a low risk from severe accidents. Using the definition of vulnerabilities from Section 3.4, no severe accident vulnerabilities were uncovered. A contributor to core damage is the dependency of reactor coolant pump thermal barrier cooling and centrifugal charging pump lube oil cooling (reactor coolant pump seal injection) on the component cooling system.

In conclusion, TVA has developed the technological capability to perform PRAs. Through this PRA, TVA has developed an appreciation of severe accidents, gained a better understanding of the sequences involved and obtained a quantitative evaluation of core damage and release probabilities.

A. SUCCESS CRITERIA IN EVENT TREES

This section presents a summary of the success criteria used in the Watts Bar individual plant examination (IPE) event trees. The success criteria presented are further defined in the Watts Bar systems analysis packages.

Success criteria for IPE event trees are usually based on the success criteria defined for the safety systems used in the analyses of the design basis accidents presented in Chapter 15 of the facility Final Safety Analysis Reports (FSAR). The safety analyses are based on not exceeding certain core parameters (e.g., 2,200°F maximum clad temperature for a design basis LOCA) with conservative values of reactor power, trip delays, etc. In addition, the safety analysis usually assume a single active failure coincident with a loss of offsite power at the time of the initiator. Using just the FSAR system success criteria is sometimes too conservative for IPE purposes. In these cases, other methods of determining realistic success criteria are used. These methods include a review of previously published and reviewed IPEs for other similar plants, or a plant-specific analysis for a particular type of scenario.

For the Watts Bar IPE, FSAR success criteria, previously published probabilistic risk assessment (PRA) criteria and plant-specific analyses have been used to develop the success criteria used in the system analysis process.

Table A-1 presents a summary of the functional success criteria used in the Watts Bar IPE. These functional criteria are based on NUREG/CR-4550, Vol. 5, Sequoyah plant analysis to support NUREG-1150. The criteria in NUREG/CR-4550 are based on previously published and reviewed PRAs. The anticipated transient without scram (ATWS) functional success criteria are based on WCAP-11993, which was performed to support Westinghouse response to the U.S. Nuclear Regulatory Commission (NRC) ATWS concerns.

The functional success criteria define, in terms of general functions, what must be satisfied to ensure successful core cooling. The Watts Bar IPE event tree top events do not present functions but present system trains and/or components that perform the function. Tables A-2 through A-4 present the top event success criteria developed for use in the Watts Bar IPE.

Tables A-5 through A-7 present system success criteria from the Watts Bar Final Safety Analysis Report for the top events in the IPE for comparison with the actual criteria used in the IPE. Specific differences between the FSAR criteria and those used in the IPE are described below.

- **IPE Time Criteria.** The IPE generally requires that systems perform their function for 24 hours after any initiating event. Within this 24-hour period, repair of failed components is not modeled for most systems. Selected, scenario-specific repair actions (e.g., restart diesel generators) are included as recovery actions, where appropriate. After 24 hours, IPEs implicitly assume that there is sufficient time to complete any necessary repairs prior to core damage due to the low decay heat values after 24 hours. The FSAR does not generally analyze accident scenarios for

24 hours; rather, scenarios are modeled until stable plant conditions are achieved. In addition, the FSAR analyses, in the context of a single failure criterion, do not allow additional failures after the imposed single limiting failure.

- **RHR Injection Path — Top Event RI.** The FSAR implies a success criterion of two of four injection paths for general transient and small LOCA initiators. The IPE defines success as one of four injection paths, which is consistent with criteria used in NRC-reviewed or NRC-sponsored PRAs.

- **Diesel Generator Operating Times.** The diesel generator operating times are based on simulation studies of the loss of offsite power and the site-specific data on time to restore offsite power.

- **DC Power Availability.** The FSAR implies batteries need only DC power loads for 2 hours after a loss of offsite power. The IPE uses 4 hours based on unit-specific station blackout study requirements.

- **ECCS Injection.** The FSAR implies that one complete train of emergency core cooling system (ECCS) pumps (centrifugal charging, safety injection, and residual heat removal) is necessary for all classes of LOCAs. The IPE uses criteria based on break size as developed for previous PRAs and the Westinghouse Emergency Operating Procedures background documents.

- **Essential Raw Cooling Water (ERCW) Pump Success Criteria for Loss of Offsite Power.** The success criteria for the number of operating ERCW pumps that are necessary for diesel generator cooling after a loss of offsite power are based on a plant-specific calculation for the IPE.

- **Heating, Ventilation, and Air Conditioning (HVAC) System Success Criteria.** HVAC success criteria for the systems modeled in the IPE are based on plant-specific calculations performed in support of other NRC-required analyses; e.g., Appendix R, Fire Safe Shutdown.

- **Medium LOCA.** Medium LOCA is a subset of the small LOCA class modeled in the FSAR. This event is defined as a unique initiator in the IPE. The success requirement for high pressure injection for small LOCAs is any one of four available high pressure pumps (centrifugal charging and safety injection). For IPE medium LOCAs, this requirement is any two of four available high pressure pumps. With a small LOCA, secondary heat removal is required to remove decay heat, or a larger LOCA must be induced; i.e. "feed and bleed cooling." For medium LOCAs, break flow is capable of removing core decay heat without secondary heat removal.

LIST OF REFERENCES

1. Tennessee Valley Authority, "Watts Bar Final Safety Analysis Report," through April 1992.

2. Bertucio, R. C. and S. R. Brown, "Analysis of Core Damage Frequency: Sequoyah Unit 1," prepared for U.S. Nuclear Regulatory Commission. NUREG/CR-4550, Volume 5.

3. Westinghouse Electric Company, WCAP-11993, Owners Group Response to ATWS Rulemaking.

4. Engineering Evaluation, ERCW Success Criteria Under Loss of Offsite Power Conditions, June 1992.

Table A-1 (Page 1 of 2). Watts Bar Event Tree Success Criteria — Functional Success Criteria			
System/Function	**Success Criteria**	**Reference**	**Comments**
1. Reactivity Control	No More than One RCCA Fails To Insert	NUREG/CR-4550	Based on review of accepted PRAs.
2. Secondary Heat Removal	Feedwater to Two Steam Generators; One of Three AFW or MFW Pumps	NUREG/CR-4550	Based on review of accepted PRAs.
3. Feed and Bleed Cooling	Two of Two Pressurizer PORVs Open and Remain Open, and One of Four HPI Pumps (CVCS or Safety Injection)	NUREG/CR-4550	Based on review of accepted PRAs.
4. High Pressure Injection			
4.1 Small LOCA (< 2")	One of Four HPI Pumps (CVCS or Safety Injection)	NUREG/CR-4550	Based on review of accepted PRAs.
4.2 Medium LOCA (2" to 6")	Two of Four HPI Pumps (CVCS or Safety Injection)	NUREG/CR-4550	Based on review of accepted PRAs.
4.3 Large LOCA (> 6")	Not Modeled in NUREG/CR-4500		Not modeled in most accepted PRAs.
5. Low Pressure Injection			
5.1 Large and Medium LOCA	One of Two Trains	NUREG/CR-4550	Based on review of accepted PRAs.
6. Accumulators			
6.1 Large LOCA (> 6")	Three of Three on Intact Loops	NUREG/CR-4550	Based on review of accepted PRAs.
6.2 Medium LOCA (2" to 6")	Two of Three on Intact Loops		Not modeled in NUREG/CR-4550.
7. RCP Seal Cooling	CVCS to Seal Injection or CCS to Thermal Barrier	NUREG/CR-4550	Based on review of accepted PRAs.

Table A-1 (Page 2 of 2). Watts Bar Event Tree Success Criteria — Functional Success Criteria			
System/Function	**Success Criteria**	**Reference**	**Comments**
8. Recirculation Cooling			
8.1 Low Pressure Recirculation	One of Two Trains with Heat Exchanger	NUREG/CR-4550	Based on review of accepted PRAs.
8.2 High Pressure Recirculation	One of Four HPI Pumps and Low Pressure Recirculation	NUREG/CR-4550	Based on review of accepted PRAs.
9. Containment Heat Removal			
9.1 Injection	One of Two CS Trains	NUREG/CR-4550	Based on review of accepted PRAs.
9.2 Recirculation	One of Two CS Trains with Heat Removal		Not modeled in NUREG/CR-4550.
10. ATWS			
10.1 RCS Pressure Limit 3,200 psig	Maintain Pressure < 3,200 psig	ASME (5)	Based on review of accepted PRAs.
10.2 Auxiliary Feedwater	TDP or Two of Two MDP to All Steam Generators	WCAP-11993	WCAP, p. 4-14.
10.3 Primary Pressure Relief	UET (unfavorable exposure time) Not Exceeded	WCAP-11993	WCAP, p. 4-15.
10.4 Manual Rod Insertion	At Least One Bank in 1 Minute	WCAP-11993	WCAP, p. 3-5, "...insertion of only one RCCA bank adds sufficient reactivity to preclude peak RCS pressure concerns during the limiting ATWS events." Start prior to pressure peak.
10.5 Moderator Temperature Coefficient (Note 1)	< -20 pcm/°F > -7 pcm/°F	NUREG/CR-4550 NUREG/CR-4550	No pressure relief required. Pressure relief not possible.
10.6 Manual Trip	Within 1 Minute	NUREG/CR-4550	
Note: Moderator temperature coefficient is modeled in Top Event SR of the Watts Bar IPE.			

Table A-2 (Page 1 of 5). Watts Bar IPE Event Tree Success Criteria — Frontline Systems

System/Function	Top Event	Success Criteria	Reference		Comments
			FSAR	Other	
General Transient, SLOCA, SGTR					
Reactor Trip	RT	No More than One RCCA Fails To Fully Insert	7.2	WCAP-11993	Assumed > One RCCA fail to insert leads to ATWS.
Operator Actions for Manual Rod Insertion	MR	Operator Successfully Inserts RCCAs		WCAP-11993	
Turbine Trip	TT	Auto/Manual Trip of Turbine All Four Stop or All Four Governor	10.2		
Power Level < 40%	PL	Switch for ATWS	10.3	WCAP-11993	AMSAC armed > 40% power. WCAP-11993, p. 4-3.
Main Steam Isolation	MS	Three of Four MSIVs Close, Given Isolation Condition	15		
Main Condenser Available for Controlled Cooldown	CD	Remain Available for 24 hours	15, 10.4		Includes Support Systems (TBVs, Condensate, and CST).
Feedwater Availability in ATWS Paths	FW	One MFW Pump Path to One Steam Generator		WCAP-11993	
ATWS Mitigating System Actuating Circuitry	AM	Provide TT and AFW Start Signal Following ATWS	7		
Motor-Driven AFW Pump — 1A-A	MA	Provide AFW to Steam Generators for 24 Hours	10.4.9		Includes ERCW backup.
Motor-Driven AFW Pump — 1B-B	MB	Provide AFW to Steam Generators for 24 Hours	10.4.9		Includes ERCW backup.
Turbine-Driven AFW Pump	TP	Provide AFW to Steam Generators for 24 Hours	10.4.9		Includes one of two ventilation fans. Includes ERCW backup.
Auxiliary Feedwater to Steam Generators	AF	One AFW Pump Feeding at Least Two Steam Generators	15, 10.4.9		410-gpm total flow to two steam generators (System Design Criteria Document).
Main Feedwater Restoration	MF	Feedwater Isolation Signal Removed and Feedwater restored to One Steam Generator			Non-ATWS sequences only.
Operator Actions To Restore MFW	OF	Operator Successfully Restores MFW			Prior to entry into "Feed and Bleed."

Table A-2 (Page 2 of 5). Watts Bar IPE Event Tree Success Criteria — Frontline Systems

System/Function	Top Event	Success Criteria	Reference		Comments
			FSAR	Other	
Primary Relief	SR	Three Safety Valves or Two of Three Safety and Two of Two PORVs	6.2.7	WCAP-11993	ATWS sequences only.
Secondary Leakage to the Environment	SL	Operator Isolates Steam Generator Release Paths after SGTR			
Supply to CCPs 1A-A and 1B-B	VS	A Path for Borated Water to CCPs Exists (24 hours)	9.3.4, 6.3		
Centrifugal Charging Pump 1A-A (CCP)	VA	Pump Starts and Operates for 24 Hours	9.3.4		Includes room cooling.
Centrifugal Charging Pump 1B-B (CCP)	VB	Pump Starts and Operates for 24 Hours	9.3.4		Includes room cooling.
CCP Cold Leg Injection	VC	CCP Flow through BIT to Two of Four Cold Leg Injection Lines (24 hours)	9.3.4, 6.3		
Emergency Boration (also operator actions to trip CRD motor generator sets)	EB	Operator Successfully Initiates Boration (10 minutes)		WCAP-11993	ATWS only. WCAP-11993, p. 4-6.
RCS Primary Relief Water Challenge	WC	Switch for PORV Challenge			Depends on initiating event.
RCS Pressure Relief	PR	Pressure Relief via Safety and PORVs Successful			Includes successful reclosing of safety valves and PORVs.
RCP Thermal Barrier Cooling	TB	TB Booster Pumps and CCS Operate To Provide Cooling (24 hours)	9.2.2		Guaranteed failure for Phase B.
RCP Seal Injection/Seal LOCA	SE	Maintain Seal Integrity			Includes operator action to trip RCP on Phase B or loss of CCS train 1A.
Safety Injection Pump 1A-A (SI)	S1	Safety Injection Pump Starts and Operates for 24 Hours	6.3		Includes room cooling.
Safety Injection Pump 1B-B (SI)	S2	Safety Injection Pump Starts and Operates for 24 Hours	6.3		Includes room cooling.

Table A-2 (Page 3 of 5). Watts Bar IPE Event Tree Success Criteria — Frontline Systems

System/Function	Top Event	Success Criteria	Reference		Comments
			FSAR	Other	
Safety Injection System Discharge Piping	SI	Suction Path and Injection Path (one of four) Remain Available for 24 Hours	6.3		
Depressurize Secondary and Cool Down RCS	DS	Feedwater Source and Controllable Steam Release (24 hours)			
Depressure RCS to RHR Entry Conditions	DP	Operator Action To Open One PORV and Associated Block Valve or One Spray Valve			Normal spray or one PORV.
PORVs Isolated after RCS Depressurization	PI	Leaking PORV Isolated by Block Valve Closure			
Operators Go To Feed and Bleed Cooling	OB	One HHSI and Two of Two PORVs for 24 Hours			
RHR Pump 1A-A	RA	Pump Starts and Operates for 24 Hours	6.3, 5.5.7		Requires cooling and/or restart if RCS pressure >pump shutoff head. Includes room cooling.
RHR Pump 1B-B	RB	Pump Starts and Operates for 24 Hours	6.3, 5.5.7		Requires cooling and/or restart if RCS pressure >pump shutoff head. Includes room cooling.
RHR Injection Path	RI	Suction Path and One of Four Injection Paths Available for 24 Hours			
Normal RHR Cooldown	RD	Operator Successfully Enters RHR Cooling Mode	5.5.7, 6.3		
Recirculation Not Required	RQ	Secondary Heat Removal Successful and No LOCA			Switch for recirculation event tree.
No Core Melt	CM	Plant Systems Successfully Mitigate Initiating Event (Injection Phase)			Long-term sump recirculation required for success. Switch for core damage sequences.
Ice Condenser	IC	Function To Reduce Containment Pressure	6.5	NUREG/CR-4550	
Containment Purge Isolation	CP	Purge Lines Successfully Isolate	6.2.4		

Table A-2 (Page 4 of 5). Watts Bar IPE Event Tree Success Criteria — Frontline Systems

System/Function	Top Event	Success Criteria	Reference		Comments
			FSAR	Other	
Containment Air Return Fans	AR	One of Two Fans for 24 Hours	6.6		
Containment Spray Pump 1A-A	CSA	Starts and Operates To Reduce Containment Pressure	6.2		Includes room cooling.
Containment Spray Pump 1B-B	CSB	Starts and Operates To Reduce Containment Pressure	6.2		Includes room cooling.
Operator Terminates Containment Spray	OT	Operator Stops CS Pumps if Containment Pressure is < Phase B Isolation Setpoint		NUREG/CR-4550	Necessary to conserve RWST water. NUREG/CR-4550 Appendix A sprays will actuate for most small LOCAs (> 1/2").
Containment Sump Available	SU	Water in Sump and Drains Upper to Lower Open	6.3		
Initiation of RHR Containment Sump Switchover	RL	Generate Automatic/Manual Switchover Signal	7.5		
Train A RHR Sump Swapover Valve	RVA	Sump Valve Opens and Remains Open, RWST Isolates	6.3		
Train B RHR Sump Swapover Valve	RVB	Sump Valve Opens and Remains Open, RWST Isolates	6.3		
RHR Recirculation	RR	CCS to RHR Heat Exchangers, HH Recirculation Aligned	6.3		
Containment Spray in Recirculation Mode	CH	At Least One CS Train Aligned to Containment Sump, CS Heat Exchanger Cooled by ERCW	6.2		
RHR Spray	RS	Operator Aligns RHR to RHR Spray Mode	6.3		
Containment Isolation	CI	Nonessential Penetrations Isolate	6.2.4		Only those penetrations whose failure results in containment bypass are modeled.

Table A-2 (Page 5 of 5). Watts Bar IPE Event Tree Success Criteria — Frontline Systems

System/Function	Top Event	Success Criteria	Reference		Comments
			FSAR	Other	
Hydrogen Ignitors	HH	All 34 Ignitors in One Train Function	6.2.5A		
Medium LOCA					RCS break > 2" but < 6" (only differences from GT, SLOCA, etc., presented).
Centrifugal Charging Pump Cold Leg Injection Path	VF	Flow through BIT and Two of Three Intact Cold Leg Paths for 24 Hours			
Safety Injection System Discharge Piping	IP	Flow to Two of Three Intact Cold Leg Paths for 24 Hours			
Cold Leg Accumulators Discharge	CL	Two of Three Accumulators or Intact Cold Legs Inject	6.3		FSAR, p. 6.3-13, "...accumulators inject only in the event of a large LOCA...." p. 6.3-26, "...accumulators not needed for small LOCA...."
RHR Injection Path	RF	Suction Path and Flow to Two of Three Intact Cold Legs			Large LOCA >0.5FT²; small LOCA 3/8" to 6".
Large LOCA					> 6" (only differences from GT, SLOCA, MLOCA, etc., presented).
Excessive LOCA	EX	Switch To Differentiate Large and Excessive LOCAs			
Cold Leg Accumulators Discharge	LCL	Three of Three Accumulators on Intact Loops Inject	6.3, 15.3		
RHR Hot Leg Recirculation	RH	One RHR Train Aligned for Hot Leg Recirculation			

Table A-3 (Page 1 of 2). Watts Bar IPE Event Tree Success Criteria — Electrical Support Systems

System/Function	Top Event	Success Criteria	Reference		Comments
			FSAR	Other	
Offsite Grid	OG	161-kV Supply Remains Available for 24 Hours after Trip	8.2		Model assumes failure of any one CSST fails top.
Fuel Oil Transfer and Supply	FA(FB, FC,FD)	Day Tank Remains Available, One of Two Fuel Oil Xfr Pumps Maintain Level	9.5.4		Independent systems for each diesel generator.
Diesel Generator 1A-A Includes other Diesel Generator Support Not Identified Above	GA	Start and Operate for 24 Hours	8.3, 9.5.5 9.5.7		Six hours in NUREG/CR-4550 SBO Coping Study, B25 890403 813. Includes room cooling.
Diesel Generator 1B-B Includes Other Diesel Generator Support Not Identified Above	GB	Start and Operate for 24 Hours	8.3, 9.5.5 9.5.7		Six hours in NUREG/CR-4550 SBO Coping Study, B25 890403 813. Includes room cooling.
Diesel Generator 2A-A Includes Other Diesel Generator Support Not Identified Above	GC	Start and Operate for 24 Hours	8.3, 9.5.5 9.5.7		Six hours in NUREG/CR-4550 SBO Coping Study, B25 890403 813. Includes room cooling.
Diesel Generator 2B-B Includes Other Diesel Generator Support Not Identified Above	GD	Start and Operate for 24 Hours	8.3, 9.5.5 9.5.7		Six hours in NUREG/CR-4550 SBO Coping Study, B25 890403 813. Includes room cooling.
Unit 1 Shutdown Board Ventilation	V1	One of Two AHUs Start and Operate for 24 Hours	9.4.2		TI-ECS-95, chiller not required.
Unit 2 Shutdown Board Ventilation	V2	One of Two AHUs Start and Operate for 24 Hours	9.4.2		TI-ECS-95, chiller not required.
6.9-kV Shutdown Board 1A-A	AA	Provide Power for 24 Hours	8.3		
6.9-kV Shutdown Board 1B-B	BA	Provide Power for 24 Hours	8.3		
6.9-kV Shutdown Board 2A-A	AB	Provide Power for 24 Hours	8.3		
6.9-kV Shutdown Board 2B-B	BB	Provide Power for 24 Hours	8.3		
480V Shutdown Board 1A1-A	A1	Provide Power for 24 Hours	8.3		

Table A-3 (Page 2 of 2). Watts Bar IPE Event Tree Success Criteria — Electrical Support Systems

System/Function	Top Event	Success Criteria	Reference		Comments
			FSAR	Other	
480V Shutdown Board 1A2-A	A2	Provide Power for 24 Hours	8.3		
480V Shutdown Board 1B1-B	B1	Provide Power for 24 Hours	8.3		
480V Shutdown Board 1B2-B	B2	Provide Power for 24 Hours	8.3		
125V DC Subsystem I	DA	Provide Power for 24 Hours Battery — 4 Hours after SBO	8.3.2		SBO Coping Study, B25 890403 813.
125V DC Subsystem II	DB	Provide Power for 24 Hours Battery — 4 Hours after SBO	8.3.2		SBO Coping Study, B25 890403 813.
125V DC Subsystem III	DC	Provide Power for 24 Hours Battery — 4 Hours after SBO	8.3.2		SBO Coping Study, B25 890403 813.
125V DC Subsystem IV	DD	Provide Power for 24 Hours Battery — 4 Hours after SBO	8.3.2		SBO Coping Study, B25 890403 813.
120V AC Instrument Power Board 1A	DG	Provide Power for 24 Hours	8.3		
6.9-kV Common Board A and 480V Auxiliary Common Board A	A3	Provide Power for 24 Hours	8.3		
6.9-kV Common Board B and 480V Auxiliary Common Board B	B3	Provide Power for 24 Hours	8.3		
250V DC Board 1	D1	Provide power for 24 Hours Battery — 4 Hours after SBO	8.3.2		SBO Coping Study, B25 890403 813.
250V DC Board 2	D2	Provide Power for 24 Hours Battery — 4 Hours after SBO	8.3.2		SBO Coping Study, B25 890403 813.
120V AC Power Subsystem I	DAAC	Provide Power for 24 Hours	8.3.2		
120V AC Power Subsystem II	DBAC	Provide Power for 24 Hours	8.3.2		
120V AC Power Subsystem III	DCAC	Provide Power for 24 Hours	8.3.2		
120V AC Power Subsystem IV	DDAC	Provide Power for 24 Hours	8.3.2		

Table A-4 (Page 1 of 2). Watts Bar IPE Event Tree Success Criteria — Mechanical Support Systems

System/Function	Top Event	Success Criteria	Reference		Comments
			FSAR	Other	
ESFAS Train A	ZA	Provide Actuation Signal	7.3		Necessary signal varies with initiator.
ESFAS Train B	ZB	Provide Actuation Signal	7.3		Necessary signal varies with initiator.
Manual Action To Back Up ESFAS	OS	Successful Action in Response to Indications			
Essential Raw Cooling Water (ERCW) Train A Pumps	AE	Two of Four Aligned Pumps Start/Operate for 24 Hours. One of Two Pumps under LOSP Conditions.	9.2.2		
Essential Raw Cooling Water (ERCW) Train B Pumps	BE	Two of Four Aligned Pumps Start/Operate for 24 Hours. One of Two Pumps under LOSP Conditions.	9.2.2		
ERCW Header 1A	CE	Provide Flow for 24 Hours	9.2.2		Includes strainer.
ERCW Header 1B	DE	Provide Flow for 24 Hours	9.2.2		Includes strainer.
ERCW Header 2A	EE	Provide Flow for 24 Hours	9.2.2		Includes strainer.
ERCW Header 2B	FE	Provide Flow for 24 Hours	9.2.2		Includes strainer.
ERCW Discharge Header A	GE	Allow Discharge Flow for 24 Hours	9.2.2		
ERCW Discharge Header B	HE	Allow Discharge Flow for 24 Hours	9.2.2		
Component Cooling Water Pumps and MD AFW Pumps Ventilation	V3	One of Two Coolers Starts and Operates for 24 Hours or Auxiliary Building General Ventilation Available	9.4.2		TI-ECS-95, one of four area coolers with operator action.
Component Cooling System (CCS) Train 1A	AC	Both Pumps or One Pump and SFP Cooling Reduced, and Heat Exchanger for 24 Hours	9.2.1		Failure assumed to fail CCP, SIP, and RHRP due to loss of cooling.

Table A-4 (Page 2 of 2). Watts Bar IPE Event Tree Success Criteria — Mechanical Support Systems

System/Function	Top Event	Success Criteria	Reference		Comments
			FSAR	Other	
Component Cooling System (CCS) Train B	BC	Pump and Heat Exchanger for 24 Hours	9.2.1		Failure assumed to fail CCP, SIP, and RHRP due to loss of cooling.
Component Cooling System (CCS) Train 2A	ACU2	One Pump and Heat Exchanger for 24 Hours	9.2.1		Failure assumed to fail CCP, SIP, and RHRP due to loss of cooling.
ERCW to Control Air Compressors	PE	One Unit 1 Train Supplies Header for 24 Hours	9.2.2		
Nonessential Control Air	PD	Two of Four Control Air System Compressors Start and Operate for 24 Hours	9.3.1		Includes receiver, etc.
Auxiliary Control Air System — Train A	PA	Compressor, etc., Start/Operate for 24 Hours	9.3.1		
Auxiliary Control Air System — Train B	PB	Compressor, etc., Start/Operate for 24 Hours	9.3.1		
Refueling Water Storage Tank	RW	Available To Provide Water to ECCS and CS Pumps	6.3		
Condensate Storage Tank	CT	Available To Provide Water to AFW	9.3.6		SBO Coping Study, B25 890403 813.
Long-Term Makeup to CST	CTMU	Operator and Equipment To Refill CST			
Makeup to RWST for SGTR or SLOCA	MU	Operator Action and Equipment To Refill RWST			
Auxiliary Board Room Air Conditioning Train B	VINV1, VINV2	One of Two AHUs per Train for 24 Hours	9.4.2		TI-ECS-95, TI-ECS-61, and TI-ECS-69.
Shutdown Transformer Room Ventilation	VT1A, VT1B, VT2A, VT2B	One Fan per Room for 24 Hours	9.4.2		TI-ECS-95.

Table A-5 (Page 1 of 3). Watts Bar FSAR Success Criteria — Frontline Systems

System/Function	Top Event	Success Criteria	FSAR	Comments
GENERAL TRANSIENT, SLOCA, SGTR				
Reactor Trip	RT	No More Than One RCCA Fails To Fully Insert	7.2, 5.3	IPE uses same success criteria.
Turbine Trip	TT	Auto/Manual Trip of Turbine All Four Stop or all Four Governor	10.2	IPE uses same success criteria.
Main Steam Isolation	MS	Three of Four MSIVs Close, Given Isolation Condition	15	IPE uses same success criteria.
Main Condenser Available for Controlled Cooldown	CD	Remain Available for 24 Hours	15, 10.4	IPE uses same success criteria.
ATWS Mitigating System Actuating Circuitry	AM	Provide TT and AFW Start Signal Following ATWS	7	IPE uses same success criteria.
Motor-Driven AFW Pump 1A-A	MA	Provide AFW to Steam Generators for 24 Hours	10.4.9	IPE uses same success criteria.
Motor-Driven AFW Pump 1B-B	MB	Provide AFW to Steam Generators for 24 Hours	10.4.9	IPE uses same success criteria.
Turbine-Driven AFW Pump	TP	Provide AFW to Steam Generators for 24 Hours	10.4.9	IPE uses same success criteria.
Auxiliary Feedwater to Steam Generators	AF	One AFW Pump Feeding at Least Two Steam Generators	15, 10.4.9	IPE uses same success criteria.
Primary Relief (ATWS)	SR	Three Safety Valves or Two of Three Safety and Two of Two PORVs	6.2.7	No criteria in FSAR.
Supply to CCPs 1A-A and 1B-B	VS	A Path for Borated Water to CCPs Exists (24 hours)	9.3.4, 6.3	IPE uses same success criteria.
Centrifugal Charging Pump 1A-A (CCP)	VA	Pump Starts and Operates for 24 Hours	9.3.4, 6.3	IPE uses same success criteria.
Centrifugal Charging Pump 1B-B (CCP)	VB	Pump Starts and Operates for 24 Hours	9.3.4, 6.3	IPE uses same success criteria.
CCP Cold Leg Injection	VC	CCP Flow through BIT to Two of Four Cold Leg Injection Lines (24 hours)	9.3.4, 6.3	IPE uses same success criteria.
Emergency Boration (also operator actions to trip CRD motor generator sets)	EB	Operator Successfully Initiates Boration (10 minutes)	9.3.4	IPE uses same success criteria.

Table A-5 (Page 2 of 3). Watts Bar FSAR Success Criteria — Frontline Systems

System/Function	Top Event	Success Criteria	FSAR	Comments
GENERAL TRANSIENT, SLOCA, SGTR				
RCS Pressure Relief	PR	Pressure Relief via Safety and PORVs Successful		IPE uses same success criteria.
RCP Thermal Barrier Cooling	TB	TB Booster Pumps and CCS Operate To Provide Cooling (24 hours)	9.2.2	IPE uses same success criteria.
Safety Injection Pump 1A-A	S1	Safety Injection Pump Starts and Operates for 24 Hours	6.3	IPE uses same success criteria.
Safety Injection Pump 1B-B	S2	Safety Injection Pump Starts and Operates for 24 Hours	6.3	IPE uses some success criteria.
Safety Injection System Discharge Piping	SI	Suction Path and Injection Path (one of four) Remain Available for 24 Hours	6.3	IPE uses same success criteria.
RHR Pump 1A-A	RA	Pump Starts and Operates for 24 Hours	6.3, 5.5.7	IPE uses same success criteria.
RHR Pump 1B-B	RB	Pump Starts and Operates for 24 Hours	6.3, 5.5.7	IPE uses same success criteria.
RHR Injection Path	RI	Suction Path and Two of Four Injection Paths Available for 24 Hours	6.3	Different from IPE success criteria.
Ice Condenser	IC	Function To Reduce Containment Pressure	6.5	IPE uses same success criteria.
Containment Purge Isolation	CP	Purge Lines Successfully Isolate	6.2.4	IPE uses same success criteria.
Containment Air Return Fans	AR	One of Two Fans for 24 Hours	6.6	IPE uses same success criteria.
Containment Spray Pump 1A-A	CSA	Starts and Operates To Reduce Containment Pressure	6.2	IPE uses same success criteria.
Containment Spray Pump 1B-B	CSB	Starts and Operates To Reduce Containment Pressure	6.2	IPE uses same success criteria.
Containment Sump Available	SU	Water in Sump and Drains Upper to Lower Open	6.3	IPE uses same success criteria.
Initiation of RHR Containment Sump Switchover	RL	Generate Automatic Switchover Signal	7.4	IPE uses same success criteria.
Train A RHR Sump Swapover Valve	RVA	Sump Valve Opens and Remains Open, RWST Isolates	6.3	IPE uses same success criteria.

Table A-5 (Page 3 of 3). Watts Bar FSAR Success Criteria — Frontline Systems

System/Function	Top Event	Success Criteria	FSAR	Comments
GENERAL TRANSIENT, SLOCA, SGTR				
Train B RHR Sump Swapover Valve	RVB	Sump Valve Opens and Remains Open, RWST Isolates	6.3	IPE uses same success criteria.
RHR Recirculation	RR	CCS to RHR Heat Exchangers, HH Recirculation Aligned	6.3	IPE uses same success criteria.
Containment Spray in Recirculation Mode	CH	At Least One CS Train Aligned to Containment Sump, CS Heat Exchanger Cooled by ERCW	6.2	IPE uses same success criteria.
RHR Spray	RS	Operator Aligns RHR to RHR Spray Mode	6.3	IPE uses same success criteria.
Containment Isolation	CI	Nonessential Penetrations Isolate	6.2.4	IPE uses same success criteria.
Hydrogen Ignitors	HH	All 34 Ignitors in One Train Function	6.2.5A	IPE uses same success criteria.
MEDIUM LOCA (> 2" TO < 6")				
Centrifugal Charging Pump Cold Leg Injection Path	VF	Flow through BIT and Two of Three Intact Cold Leg Paths for 24 Hours	15.3, 6.3	Not specifically modeled in FSAR.
Safety Injection System Discharge Piping	IP	Flow to Two of Three Intact Cold Leg Paths for 24 Hours	15.3, 6.3	Not specifically modeled in FSAR.
Cold Leg Accumulators Discharge	CL	Two of Three Accumulators on Intact Loops Inject	6.3	Not specifically modeled in FSAR.
RHR Injection Path	RF	Suction Path and Flow to Two of Three Intact Cold Legs	6.3	Not specifically modeled in FSAR.
LARGE LOCA (> 6")				
Cold Leg Accumulators Discharge	LCL	Three of Three Accumulators on Intact Loops Inject	6.3, 15.3	IPE uses same success criteria.
RHR Hot Leg Recirculation	RH	One RHR Train Aligned for Hot Leg Recirculation	15.3	IPE uses same success criteria.

Table A-6 (Page 1 of 2). Watts Bar FSAR Success Criteria — Electrical Support Systems

System/Function	Top Event	Success Criteria	FSAR	Comments
Offsite Grid	OG	161-kV Supply Remains Available for 24 Hours after Trip	8.2	IPE uses same success criteria.
Fuel Oil Transfer and Supply	FA (FB, FC, FD)	Day Tank Initially Available, One of Two Fuel Oil Transfer Pumps Maintain Level	9.5.4	IPE uses same success criteria.
Diesel Generator 1A-A Includes Other Diesel Generator Support Not Identified Above	GA	Start and Operate for 24 Hours	8.3, 9.5.5 9.5.7	SBO Coping Study, B25 890403 813.
Diesel Generator 1B-B Includes Other Diesel Generator Support Not Identified Above	GB	Start and Operate for 24 Hours	8.3, 9.5.5 9.5.7	SBO Coping Study, B25 890403 813.
Diesel Generator 2A-A Includes Other Diesel Generator Support Not Identified Above	GC	Start and Operate for 24 Hours	8.3, 9.5.5 9.5.7	SBO Coping Study, B25 890403 813.
Diesel Generator 2B-B Includes Other Diesel Generator Support Not Identified Above	GD	Start and Operate for 24 Hours	8.3, 9.5.5 9.5.7	SBO Coping Study, B25 890403 813.
Unit 1 Shutdown Board Ventilation	V1	One of Two AHUs Starts and Operates for 24 Hours	9.4.2	IPE use same success criteria.
Unit 2 Shutdown Board Ventilation	V2	One of Two AHUs Starts and Operates for 24 Hours	9.4.2	IPE use same success criteria.
6.9-kV Shutdown Board 1A-A	AA	Provide Power for 24 Hours	8.3	IPE uses same success criteria.
6.9-kV Shutdown Board 1B-B	BA	Provide Power for 24 Hours	8.3	IPE uses same success criteria.
6.9-kV Shutdown Board 2A-A	AB	Provide Power for 24 Hours	8.3	IPE uses same success criteria.
6.9-kV Shutdown Board 2B-B	BB	Provide Power for 24 Hours	8.3	IPE uses same success criteria.
480V Shutdown Board 1A1-A	A1	Provide Power for 24 Hours	8.3	IPE uses same success criteria.
480V Shutdown Board 1A2-A	A2	Provide Power for 24 Hours	8.3	IPE uses same success criteria.

Table A-6 (Page 2 of 2). Watts Bar FSAR Success Criteria — Electrical Support Systems

System/Function	Top Event	Success Criteria	FSAR	Comments
480V Shutdown Board 1B1-B	B1	Provide Power for 24 Hours	8.3	IPE uses same success criteria.
480V Shutdown Board 1B2-B	B2	Provide Power for 24 Hours	8.3	IPE uses same success criteria.
125V DC Subsystem I	DA	Provide Power for 24 Hours Battery — 2 Hours after LOSP	8.3.2	Different from IPE criteria.
125V DC Subsystem II	DB	Provide Power for 24 Hours Battery — 2 Hours after LOSP	8.3.2	Different from IPE criteria.
125V DC Subsystem III	DC	Provide Power for 24 Hours Battery — 2 Hours after LOSP	8.3.2	Different from IPE criteria.
125V DC Subsystem IV	DD	Provide Power for 24 Hours Battery — 2 Hours after LOSP	8.3.2	Different from IPE criteria.
120V AC Instrument Power Board 1A	DG	Provide Power for 24 Hours	8.3	IPE uses same success criteria.
6.9-kV Common Board A and 480V Auxiliary Common Board A	A3	Provide Power for 24 Hours	8.3	IPE uses same success criteria.
6.9-kV Common Board B and 480V Auxiliary Common Board B	B3	Provide Power for 24 Hours	8.3	IPE uses same success criteria.
250V DC Board 1	D1	Provide Power for 24 Hours Battery — 4 Hours after LOSP	8.3.2	Different from IPE criteria.
250-V DC Board 2	D2	Provide Power for 24 Hours Battery — 4 Hours after LOSP	8.3.2	Different from IPE criteria.
120V AC Power Subsystem I	DAAC	Provide Power for 24 Hours	8.3.2	IPE Uses Same Criteria.
120V AC Power Subsystem II	DBAC	Provide Power for 24 Hours	8.3.2	IPE Uses Same Criteria.
120V AC Power Subsystem III	DCAC	Provide Power for 24 Hours	8.3.2	IPE Uses Same Criteria.
120V AC Power Subsystem IV	DDAC	Provide Power for 24 Hours	8.3.2	IPE Uses Same Criteria.

Table A-7 (Page 1 of 2). Watts Bar FSAR Success Criteria — Mechanical Support Systems

System/Function	Top Event	Success Criteria	FSAR	Comments
ESFAS Train A	ZA	Provide Actuation Signal	7.3	IPE uses same success criteria.
ESFAS Train B	ZB	Provide Actuation Signal	7.3	IPE uses same success criteria.
Essential Raw Cooling Water (ERCW) Train A Pumps	AE	Two of Four Aligned Pumps Start/ Operate for 24 Hours. One of Two Pumps Start and Operate after LOSP.	9.2.2	IPE uses same success criteria. Based on calculation performed at Watts Bar.
Essential Raw Cooling Water (ERCW) Train B Pumps	BE	Two of Four Aligned Pumps Start/ Operate for 24 Hours. One of Two Pumps Start and Operate after LOSP.	9.2.2	IPE uses same success criteria. Based on calculation performed at Watts Bar.
ERCW Header 1A-A	CE	Provide Flow for 24 Hours	9.2.2	IPE uses same success criteria.
ECRW Header 1B-B	DE	Provide Flow for 24 Hours	9.2.2	IPE uses same success criteria.
ECRW Header 2A-A	EE	Provide Flow for 24 Hours	9.2.2	IPE uses same success criteria.
ERCW Header 2B-B	FE	Provide Flow for 24 Hours	9.2.2	IPE uses same success criteria.
ERCW Discharge Header A	GE	Allow Discharge Flow for 24 Hours	9.2.2	IPE uses same success criteria.
ERCW Discharge Header B	HE	Allow Discharge Flow for 24 Hours	9.2.2	IPE uses same success criteria.
Component Cooling Water Pumps and MD AFW Pumps Ventilation	V3	One of Two Coolers Starts and Operates for 24 Hours	10	IPE uses same success criteria.
Component Cooling System (CCS) Train 1A	AC	Both Pumps or One Pump and SFP Cooling Reduced, and Heat Exchanger for 24 Hours	9.2.1	IPE uses same success criteria.
Component Cooling System (CCS) Train B	BC	Pump and Heat Exchanger for 24 Hours	9.2.1	IPE uses same success criteria.
Component Cooling System (CCS) Train 2A	ACU2	One Pump and Heat Exchanger for 24 Hours	9.2.1	IPE uses same success criteria.

Table A-7 (Page 2 of 2). Watts Bar FSAR Success Criteria — Mechanical Support Systems

System/Function	Top Event	Success Criteria	FSAR	Comments
ERCW to Control Air Compressors	PE	One Unit 1 Train Supplies Header for 24 Hours	9.2.2	IPE uses same success criteria.
Nonessential Control Air	PD	Two of Four Control Air System Compressors Start and Operate for 24 Hours	9.3.1	IPE uses same success criteria.
Auxiliary Control Air System — Train A	PA	Compressor, etc., Start/Operate for 24 Hours	9.3.1	IPE uses same success criteria.
Auxiliary Control Air System — Train B	PB	Compressor, etc., Start/Operate for 24 Hours	9.3.1	IPE uses same success criteria.
Condensate Storage Tank	CT	Available To Provide Water to AFW	9.3.6	IPE uses same success criteria.

B. HUMAN ACTION ANALYSIS

B.1 OVERVIEW

This appendix presents the detailed methodology and results of the human actions evaluations performed in the Watts Bar Nuclear Plant Probabilistic Risk Assessment (PRA). Section B.1.1 summarizes the types of actions evaluated and their use within the model. Sections B.2 and B.3 address errors made during normal maintenance and testing that leave systems unavailable to perform their safety functions if an initiating event should occur. Sections B.4 and B.5 present the evaluation of errors made by the operating crew as they dynamically respond to the plant conditions during the sequence of events following an initiating event. Finally, Sections B.6 and B.7 address actions to recover functions through alternate alignments or restoration of failed systems to service.

B.1.1 TYPES OF ACTIONS EVALUATED

Human errors and human solutions are a vital part of nuclear power plant operation and accident response. In fact, the causes for nearly all plant problems can ultimately be traced to some form of human fallibility, and nearly all plant problems can be solved by humans if they are provided with the appropriate information, guidance, and tools. Within the context of this PRA, however, the evaluation of human errors encompasses only those actions accomplished within the plant that directly:

- Impact the availability of support or safety systems at the time of the initiating event.
- Mitigate against core damage or breach of containment during the sequence of events following the initiating event.

With this in mind, the following types of human actions are evaluated:

- **Routine Actions before an Initiating Event.** Routine actions considered in the PRA involve restoring a component or flow path to normal after completing the testing, inspection, or maintenance and ensuring that the sensing equipment is correctly aligned and calibrated for automatic response to emergency actuation conditions. Errors that are important to plant risk leave safety-related equipment disabled or in an undetected, misaligned state, causing it to be unavailable to accomplish its function on demand during an event sequence.
- **Actions That Can Cause Initiating Events.** Actions that can initiate plant transients are implicitly accounted for in the quantification of initiating event frequencies to the extent that these human actions are the cause of such events. A generic operating experience database is used to assign total initiating event frequencies of which human errors are only one cause.
- **Dynamic Operator Actions Accomplished during the Plant Response to an Initiator.** Guided by the plant emergency response procedures, the operators make active decisions and take appropriate actions in response to a complex series of stimuli during the sequence of events following an initiator. They are scenario specific and

include well-defined tasks for manual initiation, control, and alignment of plant emergency equipment or selected backup systems. Usually, the operators must complete a particular activity within a specified period of time to avoid an unfavorable change in the state of the plant. These actions are an integral part of the plant response to the initiating event.

- **Recovery Actions.** Recovery actions generally involve recovery from failures that completely or partially disable the standard system response during a plant transient. They generally involve alignment of alternate systems or repair and restoration of the failed system. They may be well defined in procedures or based on general guidance and the training and knowledge of the operators and plant staff. For the purposes of this study, recovery actions are those that are only considered after the first quantification, when the dominant scenarios are identified.

B.1.2 INCORPORATION OF HUMAN ACTIONS INTO THE PLANT MODEL

TVA's approach to human interaction modeling provides a systematic and consistent framework for identifying, evaluating, and documenting human responses at all levels of the study. The approach emphasizes a close coordination with plant operators and a thorough review of their procedures.

Quantified human error rates (HER) can be incorporated into the plant model in a number of ways, depending on the influence of the action on other events in the sequence and, in particular, how they impact the quantification of other events. The potential dependencies of HERs on other elements of the plant model can strongly affect how the action and subsequent events are quantified. There are three general types, as follows:

1. Plant-human dependency accounts for the impact of the plant instrumentation and other performance indications on the ability of the operators to accomplish the action. They are scenario dependent and influence the degree of difficulty that the operators face when responding to the scenario.

2. Human-plant dependency accounts for those actions that can cause more than one system to fail. The event trees that TVA uses to express the plant response to an initiating event are an ideal vehicle to represent these dependencies. Once the impact of the action is identified, the affected systems are placed to the right of the action and are required to fail, given failure of the action.

3. Human-human dependency involves the increased potential for making a series of errors once the first error is made. These dependencies are presented to the operators for consideration during the evaluation process.

Depending on the type of dependency involved, any one of the following approaches can be used to incorporate human actions into the overall risk model:

- An action may be included within the system model if the human error affects subsequent events in the sequence in the same way as hardware causes of system failure. Errors that occur before the initiating event fall into this category.

- If failure of an operator action that fails a system has a different effect on the subsequent response of the plant than a hardware failure, a separate top event must be used to represent the human action. Dynamic operator actions generally, but not always, fall into this category.

- Recovery actions are often appended to accident sequences as separate top events at the end of the sequence. In this way, they can be made very sequence specific and not alter the remainder of the model.

B.2 ROUTINE ACTIONS BEFORE AN INITIATING EVENT

Routine human actions considered in the PRA are system-specific activities performed by one or more operations staff members as part of their normal workday duties to align a safety function properly before leaving it in its ready condition. These include:

- Realignment of a component or flow path to normal after completing the testing, inspection, or maintenance.

- Removal of jumpers or other temporary system alterations to restore it back to service.

- Calibration and alignment of sensing equipment to ensure proper automatic response to emergency actuation conditions.

Errors that are important to plant risk cause the system to be unavailable to accomplish properly its function following an initiating event. Failure modes that could produce this condition:

- Leave safety-related equipment disabled or in an undetected misaligned state, causing it to fail to operate upon demand.

- Require automatic actuation signals to recover the proper alignment, if provided by the design. This adds an additional failure mode to the system since an additional transition will have to occur for system success. (As a practical matter, these are rather minor contributors to system unavailability.)

- Cause a system to actuate at an inappropriate time, thereby suffering damage and becoming inoperable. For example, aligning for low pressure injection at high reactor pressure can damage low pressure piping, rendering the low pressure system inoperable.

The system analyst is responsible for evaluating routine actions that cause equipment unavailability. This approach is used because the system analyst is most familiar with the equipment, its location, control room alarms and indications, and details of all procedures and other guidance impacting the maintenance and surveillance testing of the system.

Normally, only surveillance procedures are evaluated to identify specific causes of equipment unavailability. Maintenance procedures are evaluated only if the operability of the system is not verified by a surveillance procedure at the conclusion of the maintenance or repair activity.

Each surveillance procedure is subjected to a screening evaluation to determine if it can leave the system in an undetected failed state. The systems analyst documents this evaluation in Section 1.5.1 of the system notebook. The unavailability due to a test is not quantified if it can be shown that:

- The alignment of the system has not been changed by the test.
- The test brings the system into closer alignment with its active safety function configuration than its standby alignment.
- The alignment of the system is a displayed parameter in the control room subject to active monitoring by the operators.
- Equipment reconfiguration during periods of plant shutdown that are subject to verification of alignment during startup. Verifications contained in change of mode checklists fall into this category. Exceptions to this guideline are made when the human error is judged to be the primary contributor to the top event unavailability.

Those tests that are judged to have a potential for leaving the system in an unavailable state are assigned a "misalignment after test" designator of up to six digits to identify uniquely the test in the quantitative system model, as shown in the example below. A further discussion of alignments is contained in the system notebook.

For the quantification of system split fractions, the system analyst sets the "misalignment after test" designator equal to one of the generic error rates given in Table B-1. These error rates are derived in Reference B-1 for an average restoration within a group of typical testing situations following the method developed by Swain and Guttman and documented in NUREG/CR-1278 (Reference B-2). Selection of the category of generic error rate is accomplished with the guidelines given in the table. The system analyst consults with the human action analyst when the assessment requires judgment regarding mixtures of restoration type, location, and complexity.

Recovery of equipment from its unavailable state is permitted if normal rounds or inspections that are explicitly covered in written procedures check the alignment. Specific reference must be made to the steps in the backup procedure that can reveal the presence of the disabled, misaligned, or improperly calibrated equipment prior to the end of the surveillance interval. Under these circumstances, the system analyst may reduce the unavailability due to the original error by the ratio of the rounds or inspection interval to the surveillance interval.

As an example of the quantification process, suppose that test SI-4.0.5, a monthly test (test frequency = 1 test 730 hours), is judged to have the potential to leave valves misaligned. The alignment is independently verified at the end of the test and is verified by weekly rounds (discovery time = 168 hours) inspections. The resulting average unavailability would be written as:

RAATE = HS405*(168/730)

where

RAATE = alignment designator for Top Event RA, train A, test error.

HS405 = human error designator assigned by the systems analyst for test SI-4.0.5.

The human error designator is then set equal to the generic error rate that describes the error being made. In this case, ZHERLL would be used to designate a realignment using controls, done at one local location, and having low complexity.

The recovery model assumes that the rounds inspection will detect the misalignment. Differences in time, procedures, and personnel doing the inspection are judged to make the dependence that of an independent checker in an active independent inspection. Since the written rounds inspection can be done at any time after the surveillance inspection up to the rounds inspection interval used in the above equation, the fraction assigned above is considered to be a conservative estimate of the impact of rounds inspection for reducing undetected misalignments.

The human actions analyst provides an advisory and oversight role for the systems analysts to ensure that the quantitative model for the error frequency evaluations is consistently performed for all systems. The human actions analyst also develops the quantification of human error rates contained in Table B-1, using the methods developed by Swain and Guttman and documented in NUREG/CR-1278 (Reference B-2).

TVA recognizes that the above approach to quantification is primarily a screening tool. If the impact of a human error during normal operations is found to be an important contributor to a risk-dominant accident sequence, it is subjected to an individually documented quantitative evaluation with plant personnel who are familiar with the procedure in question. The ultimate objective of this evaluation is to reduce the risk by identifying a means to reduce the potential for errors.

B.3 RESULTS OF ROUTINE ACTION EVALUATION

B.3.1 SUMMARY

The systems analyses determined that 10 surveillance tests have sufficient enough potential to leave a component in an undetected unavailable state to warrant quantification. The surveillance test and impacted systems are summarized in Table B-2.

Of these tests, the following was found to be present in sequences important to risk:

- **Failure To Remove Refueling Cavity Drain Plugs following Refueling.** When the screening error rate ZHERLL was used to model this error, the loss of inventory to cool the core in the recirculation mode was a dominant contributor to risk. A more detailed evaluation of the procedures addressing this task indicates that the actual failure rate is several orders of magnitude lower than the screening value and this error is not a contributor to risk (see Section B.3.2).

- No other routine human errors during surveillance tests were found to be a significant contributor to risk.

B.3.2 REMOVAL OF REFUELING CAVITY DRAIN PLUGS

During refueling, two drain plugs are placed in the refueling cavity to permit flooding for refueling operations. If both plugs remain installed when the plant is placed back in service, during accident sequences requiring containment pressure control, the water pumped from the containment sump by the containment spray system would be retained in the refueling cavity in the upper containment compartment, thus depleting the inventory available in the containment sump for further core and containment cooling. This would result in a failure of the emergency core cooling system and containment spray functions in the recirculation mode. As the screening value for human error to fail to restore the system to normal configuration following this temporary plant alteration leads to its appearance as a significant contributor to core melt, it is subjected to the more detailed analysis described below.

The drain plugs are replaced by vortex eliminators following drainage of the refueling cavity and verified in accordance with the following procedures:

1. **TVA WBN Maintenance Instruction MI-068.1 Removal and Replacement of Reactor Pressure Vessel Head and Attachments, Revision 12.** Paragraph 7.8 (7 steps) directs that the drain plug be unbolted and removed from the refueling cavity for storage. It also directs that the top hat assemblies (referred to as vortex eliminators in other procedures) be installed and bolted into place. The instruction control sheet has second-person verification signoff requirement that no debris are in the pipes and the top hat assemblies are installed.

2. **TVA WBN Fuel Handling Instruction FHI-8 Recovery from Fuel Loading, Revision 24.** Section 5, Step 21 directs verification that the drain plugs (termed blind flanges) have been removed and the vortex eliminators installed per SI-6.28. This step has a specific space to initial completeness.

3. **TVA WBN Surveillance Instruction SI-6.28 Containment Refueling Cavity Drains, Revision 8.** The sole purpose of this procedure is to ensure that the drain plugs are removed, the vortex eliminators are in place, and the drain is free of debris. No other checks are performed.

   Technical Specifications Requirement 3.6.14 specifically calls for this verification to be done.

   Section 1.3 of the procedure requires that the inspection be done prior to increasing the reactor coolant system temperature above 200°F after each partial or complete filling of the cavity with water, **and** at least once per 92 days after initial verification.

   The procedure requires first-person signoff of each of the two performance steps to verify the drain plugs are removed.

A visual inspection of drain plugs, vortex eliminators, and refueling cavity area indicates the following:

- The drain plug locations are clearly visible from the upper compartment floor. The configuration of the vortex eliminators is sufficiently different from the drain plugs so that the two items will not be confused for each other from the upper compartment by any competent operator.

- The vortex eliminators cannot be installed while the drain plugs are in place, as they use the same studs. In addition, the eliminator fins extend into the drain penetration. The vortex eliminator cannot even be placed over the top of the plugs since the intersection of the four eliminator fins would have to be balanced on the lifting ring of the plug.

Given the above facts and observations, calculations contained in Table B-3 estimate the mean likelihood of the plugs remaining in place following a refueling outage to be approximately 2×10^{-7}. If the plugs were inadvertently left in the refueling cavity, this condition is judged to last for only a maximum of 92 days, at which time there is a high likelihood that the separate verification of another test per Surveillance Instruction SI-6.28 will detect the condition. Consequently, the mean unavailability of the drain, based on an 18-month refueling outage, is estimated to be approximately 4×10^{-8} per demand. The distribution associated with this error rate is assigned the variable name WHESUM in the basic event database.

Although realistic in accounting for the specific procedures addressing drain plug removal, the above estimate is still judged to be high. The location and visibility of the plug make it highly likely that its presence at the end of a refueling outage would be noticed. For example, the refueling cavity is washed down as part of the recovery from refueling. This presents another opportunity to notice that the drain plugs are still in place. Finally, the drain plugs will be clearly visible to anyone looking down into the refueling cavity as the missile shields are being installed or during any final check of the upper containment compartment. These combinations of circumstances, for which no credit was taken in the estimate, make the continued overlooking of the drain plug so unlikely as to be almost incredible.

B.4 METHODOLOGY FOR EVALUATION OF DYNAMIC OPERATOR ACTIONS

Dynamic operator actions that take place following an initiator are identified and qualitatively described during the construction of the plant model event trees. They are then presented to teams of licensed plant operators for evaluation and feedback.

Section B.4.1 describes the qualitative process by which the actions are identified and described. Section B.4.2 describes the procedure used to elicit operator evaluations within the context of the success likelihood index methodology (SLIM) (Reference B-3). Finally, Sections B.4.3 and B.4.4 summarize the quantification process.

B.4.1 QUALITATIVE EVALUATION

The purposes of the qualitative evaluation are to:

- Identify dynamic operator actions to include in the event sequence evaluation.
- Ensure that the impact of the success or failure of those actions is properly modeled.
- Develop descriptions of those actions in a form that will facilitate operator evaluation.

During event tree construction, a variety of operator tasks are considered for inclusion in the event sequence model. These include:

- Manual actions required in emergency procedures to bring the plant to a safe shutdown following an initiating event.
- Control of preferred cooling systems.
- Backup of automatically actuated and controlled systems.
- Immediate response to failures of active systems.

To assist the identification process, event sequences diagrams (ESD) chart the flow of operator actions required by the emergency procedures. This process is discussed in Section 3.1.2.

Once individual actions are identified for evaluation, the action boundary conditions, success criteria, and event scenario timing are identified and recorded on the Operator Response Form for each action. The Operator Response Form follows the format shown in Table B-4. The purpose of this form is to provide a consistent format to convey the context of the action to the operator teams who will evaluate its degree of difficulty and a short summary of what is required to accomplish it. Thermodynamic calculations supporting the timing considerations and arguments supporting engineering judgments regarding timing are contained in Appendix C.

The first two sections of the form set up the situation for the operators. They describe where in the event sequence model this action will take place and to which indications the operators are expected to respond in the control room. The next two sections describe what is involved in accomplishing the action, and those factors that compete for the operators' attention or divert them from the task. Two sections are then provided to describe what happens in the event sequence model if the action succeeds or fails. Finally, the time frame over which the action can be expected to be accomplished is addressed.

Plant-human dependencies are described explicitly on the Operator Response Form, both in the section that relates the action to the plant model and in the discussion of required actions and competing factors. This permits the assessment teams to understand the

context of the action during the quantification of the action so that the dependencies can be reflected properly in the final error frequency.

The Operator Response Form presents human-human dependencies by asking the assessment teams to identify with the situation at hand and to consider how an operating team may have made previous errors from which they must recover. They are then asked to identify ways to recognize and recover from previous errors when quantifying the dependent action.

The completed Operator Response Forms are reviewed by the plant operations staff. Review comments can both change the requirements of the action and generate modifications to the event sequence model. In addition, the relationship between the Operator Response Form and the plant event sequence model is explained to the operator evaluation teams during their initial briefing.

B.4.2 QUANTITATIVE EVALUATION

TVA uses an adaptation of SLIM to elicit the operator judgment and to convert their evaluations into quantitative error frequencies. SLIM is based on the following assumptions:

- The likelihood of operator error in a particular situation depends on the combined effects of a relatively small set of performance-shaping factors (PSF) that influence the operator's ability to accomplish the action successfully.
- Evaluators can address each of these PSFs independently so that the overall evaluation can be expressed as the sum of the results of each PSF to form a numerical likelihood index.
- The actual quantitative error rate is related to the numerical likelihood index by a logarithmic relationship.
- The logarithmic relationship can be calibrated on a situational basis by use of appropriately selected calibration tasks having generally accepted error rates.

The basis for the logarithmic relationship between the likelihood index and error rate is documented in References B-3 through B-5. Each of the other assumptions is addressed in the implementation procedure below.

TVA has adapted SLIM by defining a small set of generic PSFs that are judged to encompass the major focuses of cognitive activity. These PSFs were chosen after a review of both the instructions and examples of the SLIM documentation and the

discussion of performance-shaping factors in Reference B-2. Seven PSFs have been chosen to relate the impact of

- Conditions of the work setting under which the action must be accomplished. The PSFs are as follows:

  - Significant preceding and concurrent actions.
  - Plant interface and indications.
  - Adequacy of time to accomplish the action.

- Requirements of the task itself. The PSFs are as follows:

  - Procedural guidance.
  - Complexity of the task relative to resources, coordination, and location.

- Psychological and cognitive condition of the operators. The PSFs are as follows:

  - Training and experience relative to the action.
  - Stress due to the situation and environmental conditions.

Performance-shaping factors are rated against two criteria:

- A **score** relates the degree to which the conditions of PSF help or hinder the operator to perform the action.

- A **weight** relates the relative influence of each PSF on the likelihood of the success of the action.

The evaluation of dynamic human errors with SLIM is made consistent across operator evaluation teams by the development of a set of forms and instructions to explain and expand on the rating procedures for the PSFs.

- Table B-5 provides detailed guidance regarding the definition, interpretation, and application of each PSF and the thought process that could lead to a specific degree of difficulty score.

- Table B-6 provides a summary of the definition of each PSF and detailed guidance regarding the thought process that could lead to a relative influence weight.

- Table B-7 summarizes the relationship between the scoring and weighting processes. The score addresses the actual conditions under which the action must be accomplished. The weight is equivalent to the operators stating how much the conditions relative to a specific PSF actually impact the potential for success or failure of the action. If it is not a factor that controls their ability to do the action, it is weighted low or insignificant.

The SLIM methodology has been modified so that the operators scale the degree of difficulty, rather than the potential for success, when they score the action. This change in orientation produces a failure likelihood index (FLI) rather than a success likelihood index. This approach has the advantage of quantitatively highlighting the causes of

operator difficulty. A high score combined with a high weight produces a large FLI compared to other ratings. This permits efficient analysis of the operator's judgment regarding potential problem areas and trends, which is addressed in Section B.5.5.

The independence of the PSFs is addressed by the definition at the top of each form that emphasizes the different aspects of the cognitive process that each PSF is intended to address. The human action analyst explains the purpose and use of these forms to the operators during the initial evaluation session. In addition, he provides guidance and feedback to the operators during the evaluation sessions when it appears by the discussion that their interpretation of the PSFs may be losing focus.

Another major premise of the SLIM methodology is that the evaluation team can rate the weight and score independently. The thought process necessary to distinguish between these two orientations of the rating process is stressed in both Table B-7 and the initial training of the raters. In addition, the human actions analyst provides feedback regarding the broad qualitative interpretation of their ratings to the raters during the evaluation process.

During their evaluation of the actions, the operators are requested to consider a number of possible errors. These include:

- **Nonresponse Errors, Also Called Errors of Omission.** This would include problems generated by both the plant interface and the competition of other actions.

- **Time and Resource Limitations.** For certain actions, the operators are requested to identify the number of people and the coordination required to get the job done. The degree of difficulty will then be impacted by the personnel and communications they have available.

- **Nonviable Errors.** Under some conditions, the operators may correctly diagnose the accident scenario but select the wrong response. These errors are believed to be governed by operator slips; e.g., selecting the wrong controls for the tasks. The operators are requested to consider control room feedback problems that could keep such errors from being detected.

B.4.3 QUANTIFICATION PROCESS

The quantification process is done in a series of stages.

First, a normalized weight for each PSF is obtained by dividing the weight assigned by the group by the total of all of the weights for that particular action.

The FLI is calculated by multiplying the normalized weight of the PSF by its score and adding that result to similar results for the other PSFs, or

$$FLI = \sum w_i S_i$$

where

i = PSF that has an influence on the error rate of the action.

w_i = weight of PSF_i, normalized so that $\sum w_i = 1$.

S_i = degree of difficulty score for PSF_i, from 0 to 10.

The normalized weights are then sorted to obtain groups of actions having similar PSF weight profiles. The actions are grouped by the following procedure:

- Actions are sorted by order of the precedence, starting with the PSF that has the highest average weight.
- Cut points are established between groups where the pattern of weight changes appears to shift the most. As a rule of thumb, one would like to obtain average differences in weights between groups of at least 5% to 10% for three of the PSFs.
- Grouping stops when the difference between the top and bottom weight within the sorted PSFs is less than .12.
- Minor adjustments and consolidations can be made after sorting based on consistency reviews and the availability of the calibration tasks needed for quantification (see below).

A separate quantification is done for each group of actions generated in the sorting process. The error rate of each action is estimated by comparing the overall FLI to a correlation that follows the relationship:

$$\text{Logarithm (Human error rate)} = A + B(FLI)$$

The coefficients of the correlation are obtained from a least squares fit of the FLI of calibration actions that have reasonable or generally accepted error rates in the industry. The calibration actions for a particular group are chosen to match the actions in the group using similarity of PSF weights as the selection criterion.

To provide error rates that are consistent with other studies, the calibration of the human error rate model uses well-defined actions obtained from evaluations for other PRAs and other statistical or analytical evidence of failure frequencies for these actions. A human interaction database that encompasses these sources provides this documented evidence (Reference B-6). The calibration procedure should ensure that the numerical error rate estimates are realistic and consistent with available data, observed human behavior, and the results from comparable expert evaluations of similar activities.

The use of some combinations of calibration actions may produce human error rates of 1.0 per demand for FLI values of less than 10. When this occurs, all actions with an FLI above that value are quantified as being guaranteed to fail.

A series of spreadsheets is used to accomplish the quantification process. An example of the spreadsheet showing the resulting human error rates estimated for one group of actions is given in Table B-8.

B.4.4 COMBINING ESTIMATES OF EVALUATION GROUPS

Uncertainty distributions are developed for each evaluated human action error frequency by assigning a range factor to each group's estimate and merging the estimates of the individual groups together. The uncertainty bounds of the individual groups are established following the recommendations of Swain and Guttman (Reference B-2, Table 7-2) for nonroutine circumstances, which are judged to be representative of the transient situations to which the actions apply.

Swain and Guttman (Reference B-2) recommend a lognormal distribution with the following range factors:

Estimated Error Rate	Range Factor
> .001	5
< .001	10

The combined judgment of all of the groups is obtained by merging the distributions of the individual groups, giving equal weight to each group. The computer program BARP (Reference B-7) is used for this purpose. The merging process not only retains the uncertainty associated with the individual quantifications but also allows the uncertainty to increase when there is disagreement among the groups.

B.4.5 SUMMARY

The composite error rate resulting from the evaluation and the quantification of all of the operator groups is displayed in tabular format in Section B.5, along with tables and analyses of the ratings that produced them. This permits easy review, comparison, and identification of the most important factors influencing each assessment.

It is important to recognize that the quantification of human error rates is only a small portion of the information obtained from the SLIM approach. The trends of weights and scores provide much valuable information about the operator's judgment regarding the focus of safety-related actions and the difficulties involved in accomplishing them. The use of more than one group to do the evaluation shows how the perspective of actions can vary from group to group. The discussion within the group and the comments provided by them provide valuable insights that lead to more practical-oriented risk models. These points are expanded in the discussion of the evaluation results.

B.5 RESULTS OF DYNAMIC HUMAN ACTIONS ANALYSIS

The event sequence and systems evaluations identified the operator actions that were listed in Table B-9 as being potentially important influences for the mitigation of severe core damage sequences. The reasoning for their explicit inclusion in the event sequence models is discussed in the description of the event sequence diagrams and the definition of the event tree top events in Sections 3.1.2 through 3.1.4. This section presents the

- Qualitative description of the tasks required to accomplish the actions successfully, and the conditions under which they must be accomplished,
- Quantitative evaluation of performance-shaping factors reflecting the operators' judgments regarding the degree of difficulty for successfully accomplishing the actions.
- Distributions of the human error rates derived from the quantification evaluation using the adaption of the SLIM methodology discussed in Section B.4.
- Insights gained from the evaluation process to include a comparison of group evaluation perspectives and a trend analysis of the PSF ratings.

B.5.1 QUALITATIVE DESCRIPTION OF THE DYNAMIC HUMAN ACTIONS

Table B-10 presents the Operator Response Forms for each evaluated dynamic human action. The descriptions on the forms were developed by the human action analyst and licensed operators serving on the PRA team, with information provided by the event sequence analysts regarding the conditions under which each action is demanded. The forms are written in accordance with the guidelines contained in Section B.4.1. Sufficient detail is provided to permit the operator groups evaluating the actions to recognize the context of the action. However, detailed evaluation of the performance-shaping factors is purposely omitted so that the operators can form their own judgments. The justifications of the time windows for the actions are presented in the top event definitions and in Appendix C.

The dynamic human actions were also qualitatively evaluated by the three groups of licensed plant operators who performed the quantitative evaluation. These groups discussed the context of each action among themselves before quantitatively evaluating it. In some cases, the groups provided practical comments that assisted the event sequence analyst to improve the plant model. Wherever appropriate to clarify the evaluations, the operator comments are included in the group comparison and trend analysis.

B.5.2 QUANTITATIVE EVALUATIONS

The three operator groups quantitatively assessed the weight and degree of difficulty score of the seven PSFs in accordance with the guidelines in Section B.4.2 as summarized in Tables B-5 and B-6. These evaluations are summarized in Tables B-11 and B-12.

Each group's FLI evaluations are converted into human error rate estimates independently of the other two groups in accordance with the procedures outlined in Section B.4.3.

After the failure rates for the individual groups are obtained, they are merged together, giving equal weight to each evaluation group.

The individual actions are grouped by similarity of weights into groups for quantitative evaluation against calibration actions. Calibration actions obtained from evaluations in other PRAs are used to benchmark the failure rates of each group. The identification of each calibration action, the basis for its failure frequency, and source of the calibration PSF weights and scores are documented in a calibration action database (Reference B-6). To keep the differences in judgments explicit, no adjustment is made to the normalized weights or individual PSF rating of either the rated actions or the calibration actions during this process. The resulting evaluations are given by individual rating group in Tables B-13 through B-15.

The operator groups at Watts Bar took advantage of the flexibility provided them for weighting the individual PSFs of the human actions by varying the weight profiles of individual actions considerably, rather than looking for similarities in focus between actions, as suggested in the guidance forms. This led to a wide variety of weight profiles, some of which have no calibration actions with similar profiles. Consequently, some weight profile groups are converted to HERs using the best fit to weight profiles available. A notation is made on the evaluation form where judgment was used to find the best available fit.

The HERs used in the PRA are obtained from merging the individual groups of operator evaluations into composite quantitative estimates using the procedures outlined in Section B.4.4. These composite error rates are given in Table B-16. Because of time limitations, individual operator groups did not evaluate every action. The results tables state which groups contributed to the final evaluation of each action.

The estimates have large range factors because of both the assignment of uncertainty to the derived error rate of each group and the variability of ratings among the groups. Recall that the **minimum** range factor for any composite error rate must be at least 10 if any of the estimates derived from the group evaluations have a median value of less than 10^{-3} per demand, and 5 otherwise. When the estimates derived from the group evaluations diverge, the merging process produces broad distributions whose mean values tend to reflect the most conservative of the group evaluations. However, the entire distribution is retained so that the uncertainty can be accounted for explicitly if the human action appears in risk-dominant sequences that are subjected to uncertainty analysis

The remainder of this section compares the evaluations of the groups and summarizes significant comments made during the elicitation process.

B.5.3 COMPARISON OF EVALUATION GROUPS

The average and the range of the FLIs assessed by the three operator groups are as follows:

Group	Average FLI	Highest FLI	Lowest FLI
1	4.77*	8.56*	1.57
2	5.32**	9.86**	2.20
3	5.14	8.20	2.11

*Excluding two actions assessed as guaranteed to fail due to inadequacy of time to accomplish during the accident sequence.
**Excluding three actions assessed as guaranteed to fail due to inadequacy of time to accomplish during the accident sequence.

Although not subjected to statistical tests, the average value and distribution of the ratings are considered to be in reasonably close agreement and indicate that the three evaluation groups interpreted the scaling guidance consistently.

B.5.4 DISCUSSION OF SIGNIFICANT DIFFERENCES IN EVALUATIONS

Each operator group brought its own perspective to the evaluation process. For some actions, this perspective produced a wide divergence among the error rates derived from the group evaluations. This section highlights some of these differences and discusses the variation in perspective among the groups that caused them.

The following actions revealed divergence among the groups sufficient enough to produce a range factor of greater than 30 in the composite distribution. The discussion below compares the parts of the evaluations that influence the results. To better understand the context of each action, refer to the Operator Response Forms contained in Table B-10. The criteria against which the operators evaluated the actions are contained in Tables B-5 and B-6, and the actual evaluations are contained in Tables B-11 through B-15. If these actions appear in scenarios that are significant contributors to risk, the resolution of the points of view that produced the uncertainty is presented in the discussion of the results.

- **HACH2 — Transfer Spray from RWST to Sump, Given RHR Swapover was not Successful.** Groups 1 and 2 considered that the set preceding and concurrent actions in which this action would be required could present difficulties when this action is required, and this was an important consideration for both groups. Each of these groups saw an important hinderance in one other PSF as well. As a result, their evaluations produced median HERs in the mid 10^{-3} per demand range.

  Group 3 saw no particular difficulty in performing this action, resulting in a median HER of 6×10^{-5} per demand.

- **HACT1 — Refill the CST during Non-LOCA Events.** Groups 1 and 2 found no particular difficulty in accomplishing this action, as it could be easily accomplished

during the time available. As a result, their evaluations produced median HERs in the mid 10^{-5} per demand range.

Group 3 assigned high weights to both time and stress for this action, and it scored both PSFs in the neutral range of degree of difficulty. However, no specific comment was recorded to explain its reasoning. Its evaluation produced an HER of 7×10^{-3} per demand.

- **HADS2 — Cool Down and Depressurize RCS To Match Break Flow and Then to RHR Cut in Temperature and Pressure, Following an SGTR with Successful Steam Generator Isolation.** The group 2 and 3 evaluations of this action produced HERs in the high 10^{-4} to low 10^{-3} per demand range. Group 2 consistently rated the complexity and plant interface PSFs of all of the depressurization actions as presenting difficulties to the operators. Although the group 2 FLI was lower, it produced the higher HER because that group placed a considerable amount of importance on training for accomplishing the action. This placed it in a calibration group with higher HERs.

  Group 1 saw no difficulty in performing this action, resulting in a median HER of 3×10^{-5} per demand. This lower rating produced the larger uncertainty.

- **HAOS3 — Manually Start AFW, Given Reactor Trip Not Requiring Initiation of Safety Injection.** Groups 1 and 3 rated this as presenting no difficulty, resulting in median HERs in the 10^{-5} per demand range.

  Group 2 rated this action as being difficult to accomplish because of the preceding and concurrent actions also occurring when it would be required. As a result, its evaluation produced a median HER of 4×10^{-3} per demand.

- **HARD1 — Place RHR in Service Following a Steam Generator Tube Rupture.** Group 1 and 3 evaluations produced median HERs in the mid 10^{-3} per demand range. Both groups weighted complexity heavily and indicated that factors associated with that PSF presented difficulties. Both also rated the training/experience PSF in the hindering range.

  Group 2 saw no difficulty in performing this action, resulting in a median HER of 9×10^{-5} per demand. This lower rating produced the larger uncertainty.

- **HARH1 — Transfer to Hotleg Recirculation, Given LOCA > 2-Inch Diameter.** The overall FLIs assessed by the three groups were close together, which normally produces a low uncertainty range factor. The uncertainty in this HER is due primarily to the weighting of the PSFs by group 3. That group placed heavy importance on procedures for accomplishing the action, which placed it in a calibration group corresponding to procedures being important. Even though group 3 actually scored the procedures as being very favorable, there is an implication that they depend on following the procedures to accomplish the task. The calibration tasks associated with actions in which procedures are important for successful completion have high error rates.

- **HARS1 — Place RHR Spray in Service, Given More Than 1 hour into Event and Containment Pressure High.** Groups 1 and 3 rated this action so that the median HERs were in the high 10^{-5} per demand range. This action is required well into an event, and tens of minutes are available to accomplish it, so that evaluation appears to be reasonable.

  The evaluation of group 2 was roughly consistent with the other two groups, with the exception that it placed heavy weight on stress and also were of the opinion that scenarios severe enough to produce high containment pressure could also produce conditions that might be hindering its ability to function at that point in time. In fact, the performance-shaping factor trend evaluation in the next section indicates that its evaluation of HARS1 produced the 4th highest stress FLI of rated by any of the operator groups on all of the actions. As a result, the HER associated with its evaluation had a median value of 8×10^{-3} per demand.

B.5.5 EVALUATION OF PERFORMANCE-SHAPING FACTOR TRENDS

Table B-17 displays the operators' evaluations of the 20 highest degree of difficulty rating with respect to each performance-shaping factor category. The contribution of each PSF to the total FLI is established by multiplying the normalized weight of each PSF by its score. When the individual PSF FLIs are sorted, they can provide information regarding the types of actions the operators consider to present them with the most difficult problems with respect to that performance-shaping factor. These trends are discussed below in order from the overall highest to the lowest PSF contributor to the overall FLI. More than 20 ratings may be displayed when more than 1 evaluation produced the 20th highest PSF FLI. For these cases, the list was simply extended to encompass all of the actions having that same FLI.

- **Significant Preceding and Concurrent Actions (Average Contribution to FLI = 0.94).** Two trends are worth comment:

  — Eight actions are associated with manual backup of actuation systems. The operators judged that a major difficulty in accomplishing these actions will be recognizing that manual backup is necessary when a wide variety of things are going on.

  — Six actions referred to recovery from failures of support systems. Of these, five actions also received high scores for the degree of difficulty due to both the quality of the indications to assist them in recognizing the failure and the training/experience.

  Support system failures are currently included in most training scenarios on the simulator. As there is a wide variety of support system failures, it would be good practice to make a checklist of support system failures that could be integrated into training scenarios as time permits. This can assist in ensuring that various combinations of failures and the patterns of indications necessary to recognize them in the noise of everything else that is going on get addressed periodically.

- **Stress (Average Contribution to FLI = 0.90).** The major contributor to the stress PSF appears to be a requirement for manipulation of equipment outside the control room. Of the top 20 ratings, 9 ratings of actions (encompassing CI1, AF1, RE2, and DS6) fell explicitly into this category, and 5 additional actions (MU - makeup to the RWST) required TSC coordination to determine feasibility of alternate alignments. These appear to be reasonable reflections of stressful situations.

  The relative position of stress as second in importance as a contributor to the FLI may be because Watts Bar has not yet operated. Consequently, the operators' ratings may be reflect their concern about their reactions once the plant does start up. In any case, they can be taken as a show of respect by the operators for the problems they could potentially face.

- **Adequacy of Time To Accomplish Action (Average Contribution to FLI = 0.84).** The review of the actions in the top 20 revealed that a variety of actions appear, depending on the perceptions of the rating groups.

  The highest single PSF FLI rating appeared in this PSF. Group 1 gave time adequacy a weight of .25 and a score of 10 to the action MR1, manually insert rods, given ATWS, for a total contribution to the FLI of 2.50. However, their other ratings indicated that the action is actually quite easy to do, so if there is time available before ATWS conditions exist, they are confident that they can accomplish the action. It is interesting to note that the other two groups rated MR1 with a lower degree of difficulty in relationship to time but, for other reasons, each produced a higher total FLI than group 1.

- **Task Complexity (Average Contribution to FLI = 0.77)**

  - The control and depressurization actions (Top Events OF, AF, and DS) were rated high in complexity because of their long duration and the number of other activities going on that could compete for resources. These constituted 9 of the top 20 ratings.

  - A second group of actions (Top Events RE and MU) that require coordination with and direction from the TSC was also rated as having a high degree of difficulty.

  - HAAF1 was rated high by all groups because of the heavy requirements for manpower during a total loss of AC power. It did not appear for group 2 because they weighted the PSF lower than the other two groups.

- **Training and Experience (Average Contribution to FLI = 0.68).** Three trends appeared regarding training:

  - Group 2 rated all of the depressurization actions high because they had not experienced much direct practice of the actual depressurization process on the simulator. The other two groups considered other related training and experience sufficient to make them confident about their functions during the process.

[As failure to depressurize errors does not appear in a sequence having an occurrence rate of greater than 10^{-7} per year, the risk model indicates no need to increase the training frequency of these actions.]

- A variety of actions that are normally associated with backing up failed support systems appeared six times. These included actions from Top Events AC, AE, and MU.

  Support system failures are currently included in most training scenarios on the simulator. As there is a wide variety of support system failures, it would be good practice to make a checklist of support system failures that could be integrated into training scenarios as time permits.

- One trend appeared regarding the operator groups. Of the 21 actions listed, 14 were the result of group 2 ratings. It appears that this group may not have taken credit for training and experience closely related to the actions when they evaluated their actions. Recall that the definition of training and experience is, "This performance shaping factor measures the effect of the familiarity and confidence the operators have about the actions." This confidence can come from a variety of sources, and the evaluation guideline form for this PSF can be improved to make this more clear to the evaluation teams.

- **Plant Man-Machines Interfaces and Indications of Condition (Average Contribution to FLI = 0.65)**

  - This PSF appeared to show a trend in the rating patterns of the operator groups. The top six ratings were all due to group 3. The next seven were all due to group 2. The remaining evaluations were mixed. It appears that this is due to the high weight given to plant interfaces by group 3, as opposed to groups 1 and 2. Group 1 did not weight this PSF greater than 0.20 for any action. Group 2 did weight some actions greater than .20; however, in all instances, the plant interfaces assisted them to accomplish those actions.

  - Six of the evaluations involved recognition of support system failures. These involve Top Events AC, SE, and AE. Actions HASE2 and HAAE2 appeared in the top 20 for operator groups 2 and 3. Problems with plant indications that could assist the operator in identifying the problem were the major contributor to operators' FLI for these actions for those two groups. Group 1 also rated this PSF as hindering but did not give it sufficient weight to appear on the list.

    The highest two ratings (AC1 and SE2) involved recognition of an CCS failure that could impact the RCPs. Action HASE2 is appearing in accident sequences that are significant contributors to risk. Therefore, the implications of the high FLI ratings for plant interface are discussed in Section 6.1.

- Seven ratings of depressurization actions have high plant interface FLIs. These actions involve long-term control during depressurization and may refer to plant indications of a drift from nominal conditions. However, no specific comments regarding these actions were recorded.

- **Procedural Guidance (Average Contribution to FLI = 0.38).**

  - In general, the operators rated the procedures as the most favorable performance-shaping factor. In fact, 2 of the top 20 were actually in the favorable range, and appeared only because of the heavy weight given to procedures.

  - Three actions (HAAE2, HACI1, and HARE2) were rated by one group each to have no directly applicable procedures that address the context of the action modeled in the PRA. For these three actions, the contribution of procedures to the overall FLI is minor. Nevertheless, it may be worthwhile to review these procedures with the evaluation groups to obtain their specific suggestions for improvement.

B.6 RECOVERY ACTIONS

First, the key actions to be evaluated as recovery actions are identified by reviewing the sequences contributing to the core damage frequency. Both procedural-guided and nonprocedural-guided actions may be identified.

The nonprocedural-guided actions are discussed with plant operations representatives. The PRA team presents the scenarios of interest and describes when, in the course of the scenario, the existing procedures do not apply. The intent here is to ensure that only actions that are compatible with the operating philosophy are considered. Based on the comments of the operations representatives, the action boundary conditions, success criteria, and event scenario timing are identified for each response. The remainder of the qualitative model descriptions are then prepared to document all important factors affecting operator response. These qualitative descriptions will then be sent to the plant for review by plant operations staff. Review comments are incorporated and the necessary changes made to the decision models.

The quantitative models used for recovery actions involving manual backup or realignment tasks are the same as those identified earlier for operator dynamic actions considered in the first quantification.

The recovery actions involving repair and restoration of electric power during station blackout scenarios are modeled to account for the time-dependent likelihood of power recovery prior to core damage following a loss of all power. These actions are discussed in Section 3.3.4.

A scenario-specific analysis of the duration of repair versus the time available for repair is performed. For example, the likelihood of electric power recovery is computed as a function of time following the initial loss of AC power, which is then convoluted with the time available for repair before core damage occurs to determine the probability of successful recovery.

B.7 RESULTS OF RECOVERY ANALYSIS

The quantification of the plant model and subsequent analysis of the dominant sequences produced a number of opportunities for operator recovery actions, as summarized in Table B-18. The reasoning for their explicit inclusion in the event sequence models is discussed in the description of the support system and front line event trees in Sections 3.1.2 through 3.1.4.

The actions listed in Table B-18 exclude those accomplished to recover offsite power. Those actions are accounted for directly in the electric power recovery model, which is presented in Section 3.3.4.

This section presents the:

- Qualitative description of the tasks required to accomplish the actions successfully, and the conditions under which they must be accomplished,
- Quantitative evaluation of PSFs reflecting the operators' judgments regarding the degree of difficulty for successfully accomplishing the actions.
- Distributions of the human error rates derived from the quantitative evaluation using the adaption of the SLIM methodology discussed in Section B.4.
- Insights gained from the evaluation process.

B.7.1 QUALITATIVE DESCRIPTION OF THE DYNAMIC HUMAN ACTIONS

Table B-19 presents the Operator Response Forms for each evaluated recovery action. The descriptions on the forms were developed by the human action analyst and licensed operators serving on the PRA team, with information provided by the event sequence analysts regarding the conditions under which each action is demanded. The forms are written in accordance with the guidelines contained in Section B.4.1. Sufficient detail is provided to permit the operator group evaluating the actions to recognize the context of the action. However, detailed evaluation of the performance-shaping factors is purposely omitted so that the operators can form their own judgments. The justifications of the time windows for the actions are presented in the top event definitions and Appendix C.

The recovery actions were also qualitatively evaluated by the group of licensed plant operators who performed the quantitative evaluation. This group discussed the context of each action among themselves before quantitatively evaluating it. In some cases, the group provided practical comments that assisted the event sequence analyst to improve the plant model. Wherever appropriate to clarify the evaluations, the operator comments are discussed in the Operator Response Forms.

B.7.2 QUANTITATIVE EVALUATIONS

Only one group of licensed operators quantitatively assessed the recovery actions. This group consisted of a composite of the licensed operator PRA team members from both the Watts Bar and Sequoyah Nuclear Plants, plus one additional operator from the Watts Bar Plant. This mix of operators took advantage of the fact that the recovery actions for the

two plants are very similar. The group assessed the actions using the same procedure followed for the dynamic human actions. These evaluations are summarized in Table B-20.

The group's FLI evaluations are converted to human error rate estimates in accordance with the procedures outlined in Section B.4.3. The individual actions are grouped by similarity of weights into groups for quantitative evaluation against calibration actions. Calibration actions obtained from evaluations in other PRAs are used to benchmark the failure rates of each group. The identification of each calibration action, the basis for its failure frequency, and source of the calibration PSF weights and scores are documented in a calibration action database (Reference B-7). To keep the differences in judgments explicit, no adjustment is made to the normalized weights or individual PSF rating of either the rated actions or the calibration actions during this process. The resulting evaluations are given in Table B-21.

The uncertainty of the evaluation group's estimates are established following the recommendations of Swain and Guttman (Reference B-2, Table 7-2) for nonroutine circumstances, which is judged to be representative of the transient situations to which the actions apply. The uncertainty in the range from .001 to .01 is broadened to a range factor of 7 to provide a better transition. The resulting range factors are:

HER Median Value	Range Factor
HER ≥ .01	5
.01 > HER ≥ .001	7
.001 > HER	10

The resulting distributions are given in Table B-22.

B.7.3 DISCUSSION OF RESULTS

The evaluation of the recovery actions indicated that the operators can be strongly influenced by the plant situation they face when they must recover from failures. The comparison of assigned weight and scale ratings of the individual actions provides this insight. For example, in some cases the previous failure makes it obvious to the operators that they must take some action. When the requirement for the action is clear, as in backup of the start of the TDAFP during loss of offsite power events (TPR1), the operators' evaluations state that they will give it priority and are confident that they can start the pump despite the complexity of the action to do it. On the other hand, actions addressing consequences that evolve very slowly, such as all those addressing recovery of ventilation, can have an error rate almost as high or even higher than some of the more urgent actions, because the operators judge that it could get continually pushed to the "back burner," as reflected in the "Concurrent Actions" rating.

One recovery action suggested by the PRA team, FLAB3RR — Isolate a Leak in the Discharge Header of the RWST, was evaluated as being implausible by the licensed operators. The operators commented that the isolation valves are located some distance down the discharge piping from the RWST. Consequently, they would not have the ability to isolate a large fraction of the breaks that might occur in that line. As a result of this feedback, this action is rated to be a guaranteed failure, and it is not included in the plant model.

In conclusion, the evaluation of the PSF ratings and the resulting HERs supports the judgment of the PRA team that the operators have made reasonable judgments regarding their ability to mitigate against some of the scenarios identified during the quantification of the plant model.

B.8 REFERENCES

B-1. PLG, Inc., "Database for Probabilistic Risk Assessment of Light Water Nuclear Power Plants," PLG-0500, Volume 5, Revision 1 (to be published).

B-2. Swain, A. D., and H. E. Guttman, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications," prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-1278, August 1983.

B-3. Embrey, D. E., "The Use of Performance Shaping Factors and Quantified Expert Judgement in the Evaluation of Human Reliability: An Initial Appraisal," Brookhaven National Laboratory, prepared for the U.S. Nuclear Regulatory Commission, NUREG/CR-2986, May 1983.

B-4. Embrey, D. E., et al., "SLIM-MAUD: An Approach to Assessing Human Error Probabilities Using Structured Expert Judgment," Brookhaven National Laboratory, prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-3518, Vols. 1 - 2, March 1984.

B-5. Rosa, E. A., et al., "Application of SLIM-MAUD: A Test of an Interactive Computer-Based Method for Organizing Expert Assessment of Human Performance and Reliability," Brookhaven National Laboratory, prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-4016, September 1985.

B-6. Dykes, A. A., W.G. He, J. W. Stetkar, and G. A. Tinsley, "Database of Dynamic Human Actions for the Conversion of Failure Likelihood Indexes to Human Error Rates," PLG-0882, (to be published).

B-7. PLG, Inc., "BARP (Bayesian Reliability Program)," PLG-0625, Release 2, May 1991.

Table B-1 (Page 1 of 2). Generic Database Variables Used for System Analysis Screening of Preinitiating Event, Routine Human Error Caused, Undetected Unavailability following Maintenance and Testing

Location of Surveillance	Complexity (See Note 1 on Page 2)	Verification (See Note 2 on Page 2)	Type of Action					
			Realignment Using Manual Controls and Switches Provided by the Design		Realignment from Jumpered Circuits or Other Temporary Plant Modification		Calibrations Left Misaligned or at Unresponsive Setpoints	
			Variable (Note 3)	Mean	Variable	Mean	Variable	Mean
Control Room Area (Includes backs of panels and/or associated equipment)	Low	Yes	ZHERCL	2.0-3	ZHEJCL	1.8-3	ZHECCL	4.9-3
		No	*		*		*	
	Medium	Yes	ZHERCM	5.9-3	ZHEJCM	4.9-3	*	
		No	*		*		*	
	High	Yes	*		*		*	
		No	*		*		*	
Local (single location exterior to the control room area)	Low	Yes	ZHERLL	3.4-3	ZHEJLL	3.2-3	ZHECLL	6.2-3
		No	*		*		*	
	Medium	Yes	ZHERLM	1.5-2	ZHEJLM	1.2-2	*	
		No	*		*		*	
	High	Yes	*		*		*	
		No	*		*		*	
Multiple Locations (excluding the control room area)	Low	Yes	ZHERML	1.0-2	ZHEJML	9.6-3	ZHECML	1.6-2
		No	*		*		*	
	Medium	Yes	ZHERMM	3.2-2	ZHEJMM	2.7-2	*	
		No	*		*		*	
	High	Yes	*		*		*	
		No	*		*		*	

*Refer assessments not having a generic variable associated with it to the human action analyst for a system-specific evaluation. The bases and derivation of the distribution of each generic database variable is contained in Reference B-1.

Note: Exponential notation is indicated in abbreviated form; 2.0-3 = 2.0×10^{-3}.

Table B-1 (Page 2 of 2). Generic Database Variables Used for System Analysis Screening of Preinitiating Event, Routine Human Error Caused, Undetected Unavailability following Maintenance and Testing

Notes:

1. Complexity Guidance:

   Select low complexity only if it is clear that all criteria are satisfied.
   Select medium complexity only if no more than two low complexity criteria are out of tolerance.

   Low: Single objective.
   Very clear procedures (one action/step with individual checkoff, outline or columnar form, easy to interpret).
   Less than 10 closely associated calibrations and/or restorations.
   Items clearly marked and separated.
   Small team working directly with each other.

   Medium: Repetitive or coordinated objectives.
   Clear procedures (one action/step, "critical steps" having checkoff, narrative form, easy to interpret).
   Less than 10 restorations of varying types.
   Items clearly marked in same general area.
   Team in more than one location with dedicated communication.

   High:* Diverse objectives.
   More than 10 restorations.
   Items ambiguously marked or in close proximity.
   Team in multiple locations with intermittent communication.
   Any consideration that make assignment of either low or medium complexity uncertain.

2. Verification Guidance:

   Yes: Second person verifies and signs off in a separate space provided for that purpose (low dependency between checker and testers).
   No: Two people working together verify realignment, or less.* (Moderate or high dependency between checker and testers.)

3. Legend:

   ZHERLL

   Complexity (low)
   Location (single local)
   Type of Action (realignment with controls)

*Refer assessments not having a generic variable associated with it to the human action analyst for a system-specific evaluation.

Table B-2. Summary of Routine Human Errors Included in the Systems Analyses To Account for Preinitiating Event, Routine Human Error Caused, Undetected Unavailability following Maintenance and Testing

System Notebook	Top Event	Test Number	Test Name	Database Variable	Description of Error
AFW	AF	SI-7.45	AFW Valve Operability Test	ZHEJLM	Failure to remove jumpers after test.
CONT	SU	SI-6.28	Containment Refueling Canal Drains, Rev 8	WHESUM	Operators fail to remove refueling canal drain plugs following refueling. (Plant specific analysis, see App B, Section B.3.2)
CS	CSA(B)	SI-4.0.5.72.P.1(2).A(B).0	Quarterly Performance Test	ZHERLL	Following completion of text, the potential that the operator fails to properly realign the CCS train for normal configuration exits.
EPS	GAIV	SI-8.1 Rev. 19	Diesel Generator Start and Load Test	ZHEJLL	Pair of fuses are removed and may not be reinstalled at conclusion of test.
EPS	GAIV	SI-8.1	Diesel Generator Start and Load Test	ZHEJLL	Failure to reinstall fuses after test
RHR	RA, RABX	SI-4.0.5.74.V.1.A.0	Valve Full Stroke Exercising During Plant Operation - Residual Heat Removal Train A (or B)	ZHERCL	Handswitches of the RHR suction isolation valve and pump miniflow valve have potential to be left in closed position not AUTO position.
RHR	RABX	SI-4.0.5.74.V.2.B.0	Valve Full Stroke Exercising During Plant Operation - Residual Heat Removal Train B (or A)	ZHERCL	Handswitches of the RHR suction isolation valve and pump miniflow valve have potential to be left in closed position not Auto position.
SIS	S1, SP	SI-4.0.5.63.V.1.A.0	Valve Full Stroke Exercision During Plant Operation - Safety Injection System (Train A)	ZHERCL	The pump control switch of the SIS pump has the potential of being left in the PULL-TO-LOCK position instead of AUTO position.
SIS	S1, SP	SI-4.0.5.63.V.1.A.0	Valve Full Stroke Exercising During Plant Operation - Safety Injection System (Train A)	ZHERCL	The pump control switch of the SIS pump has the potential of being left in the PULL-TO-LOCK position instead of AUTO position.
SIS	SP	SI-4.0.5.63.V.2.B.0	Valve Full Stroke Exercising During Plant Operation - Safety Injection System (Train B)	ZHERCL	The pump control switch of the SIS pump has the potential of being left in the PULL-TO-LOCK position instead of the AUTO position.

Table B-3. Assessment of Likelihood that Drain Plugs are Left in Refueling Canal Following Refueling

Procedure/Step	Critical Tasks	Median HEP	Range Factor	NUREG/CR-1278 Table (item)	Reasoning
MI-068.1					
7.8	Remove both drain plugs from refueling canal.	0.003	3	Table 20-7 (2)	Checkoff step in a procedure > 10 steps.
	Total Unrecovered HEP	0.003	3		
Procedure/Step	**Recovery Factors**	**Recovery Factor**	**Range Factor**	**NUREG/CR-1278 Table (item)**	**Reasoning**
FHI-8					
Step 10	Verify drain plug removed and vortex eliminator installed.	0.025	5	Table 20-22 (3 and 11)	Special one-of-a-kind check by operator of maintenance activity. No credit taken for difference in time and procedrue.
SI-6.28					
Para 4.1	Verfiy drain plug removed and vortex eliminator installed and drain free of debris. (This verification is the only objective of the test.)			Zero depend-ence with previous check.	Surveillance by different people at separate time.
	Accomplish surveillance.	.001	5	Table 20-6 (4) (abnormal operating condition)	Administrative control that test is done during recovery from refueling with mode 4 checklist.
	Product of Recovery Factors	2.5×10^{-5}	10		

Assessed HEP = Total HEP*Recovery Factors
- Assessed HER (Median) 7.5E-8 Range Factor = 13
- Assessed HER (Mean) 2.4E-7
- Assessed HER (95th Percentile) 9.4E-7

Average unavailability given SI-6.28 is performed quarterly with an 18-month refueling cycle (divide by 6)
- Assessed Median Unavailability = 1.3E-08 per demand
- Assessed Mean Unavailability = 4.1E-08 per demand
- Assessed 95th Unavailability = 1.6E-07 per demand

Table B-4. Guidance Regarding Information To Include in Operator Response Forms

TASK IDENTIFIER with the summary reproduced from operation action summary table.

PRECEDING EVENTS
- List initiating events after which action may be required.
- Briefly summarize sequence of events leading to action.
  - Base the sequences on the event sequence diagrams (ESD) and event tree descriptions.
  - Bound the range of possibilities (identify if influenced by initiating event).
- Identify any abnormal plant responses that may complicate the situation.

INDICATIONS OF PLANT CONDITION
- List what the operating crew sees that permits diagnosis that the action is required.
- Estimate how long the condition could exist before indications sufficient for diagnosis are available to the operators.
- Describe parallel indications that can mask the action requirement.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Reference the procedure and steps that will be followed.
- State whether the task is an immediate memorized action.
- Briefly summarize the aspects of the action that could influence the operators' ability to diagnose and accomplish it.
- Identify considerations in addition to procedures that could influence likelihood of success.

CONCURRENT ACTIONS/COMPETING FACTORS
- Identify concurrent actions that could compete for attention.
- Briefly describe alarms, environmental conditions, and other distractions that could impact the operating shift's concentration and produce stress.
- Discuss important aspects of the operator team interactions.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Characterize plant state upon completion based on ESD and event tree success criteria.
- Describe how the operators can determine they have been successful.

FAILURE IMPACT
- Characterize the plant condition following failure to accomplish based on ESD and event tree success criteria.
- Identify later actions the operators have available to respond with once the plant has made a transition to the failed condition.

TIME CONSTRAINTS
- List thermal/hydraulic and physical/equipment response considerations that influence time available before transition to failed condition.
- Summarize what is known about time required to both diagnose and accomplish the tasks.

Table B-5 (Page 1 of 7). Guidance for Scoring the Degree of Difficulty Presented by Each PSF Associated with Each Dynamic Human Action

PSF: Task Complexity

Definition: This performance-shaping factor rates the effect of multiple requirements on task success. It can range through the entire gamut of coordination, multiple locations, remote operations, variety of tasks, and communications requirements. It also rates the availability of resources.

Scaling Guidance: Compare different types of complexity, or lack of complexity, by judging how much the operator is helped or hindered. Consider how the system is designed to avoid error if complex actions must be accomplished. Also consider the availability of resources to accomplish the various parts of the action.

Rating	Example of Thought Process That Might Produce This Rating
- 0	Very clearly understood and straightforward task with no interpretation of current situation required.
- 1	
- 2	Skill-based response by one operator with SRO concurrence that can be performed and verified at one location.
- 3	
- 4	
- 5	Series of tasks accomplished under direct control of one operator with SRO concurrence with a rule-based response.
- 6	
- 7	Knowledge-based response.
- 8	Tasks involving coordination of more than one operator at more than one location.
- 9	Tasks with contingencies that require coordinating decisions during different stages of the transient event and among multiple operators at multiple locations.
- 10	

Notes:

Table B-5 (Page 2 of 7). Guidance for Scoring the Degree of Difficulty Presented by Each PSF Associated with Each Dynamic Human Action

PSF: Plant Man-Machine Interface and Indications of Conditions

Definition: This performance-shaping factor relates the impact of the man-machine interface on the likelihood of success. It measures the degree to which the instruments, alarms and controls available to the operators at the time when the action must be accomplished assist them to preform the action.

Scaling Guidance:

Rating	Example of Thought Process That Might Produce This Rating
- 0	Awide variety of instruments and/or alarms focus the operators' attention on the blatant need to act and provide an easy method to do so. Feedback on success is obvious.
- 1	
- 2	Alarms and indications are clear and easily interpreted. Feedback is readily available close to the point of action.
- 3	
- 4	
- 5	Indications for this action are found within a familiar pattern of alarms, which operators are trained to diagnose.
- 6	
- 7	
- 8	Action requires that two or more operators work together because of controls and indications that are far apart.
- 9	
- 10	Indications confuse the operators and cause actions that could be wrong or inappropriate.

Notes:

Table B-5 (Page 3 of 7). Guidance for Scoring the Degree of Difficulty Presented by Each PSF Associated with Each Dynamic Human Action

PSF: Adequacy of Time To Accomplish Action

Definition: Measure of time required to act compared with the time available and the effect on success. The rating reflects the operator's confidence that the task can be accomplished in time to avert a change to a failed state.

Scaling Guidance: Judgment should be based on the time required compared with the time available to recognize, diagnose, and accomplish the action. Judgment about the length of these times may be reflected by noting the task description times. Both the absolute difference in time and the ratios of the time may be useful for making these judgments.

Rating	Example of Thought Process That Might Produce This Rating
- 0	Adequate time to accomplish action, bring in assistance if necessary, and correct errors.
- 1	Time is on the operator's side.
- 2	Enough time to complete procedures carefully and methodically with some outside assistance.
- 3	Enough time to complete procedures carefully and methodically if no outside assistance needed
- 4	
- 5	Enough time to complete at a normal speed and to verify results, but with limited time to correct significant errors.
- 6	
- 7	Success requires rapid, practiced operator actions with little time to correct anything but a small slip. Requires skillful and well-trained actions for success with any problem endangering the chance for success.
- 8	
- 9	
- 10	Time required about the same as time available. Operators can complete the task, but it will be a very close call.

Notes: If the time required to complete the action exceeds time available, the action is guaranteed to fail. Under these circumstances the reason why the action can not be done is documented and no PSF evaluation is required.

Table B-5 (Page 4 of 7). Guidance for Scoring the Degree of Difficulty Presented by Each PSF Associated with Each Dynamic Human Action

PSF: Significant Preceding and Concurrent Actions

Definition: Preceding and concurrent actions set the stage for the modeled action and make it necessary and obvious to the operators. They can also divert the operators' attention from this action or even cause failure. (If necessary, some strongly dependent failures may be accounted for by specific split fractions in the event trees.) Lack of preceding actions may create a surprise effect that should be accounted for in this performance-shaping factor.

Scaling Guidance:

Rating	Example of Thought Process That Might Produce This Rating
- 0	Previous actions focus operators on the urgent need to act.
- 1	There are no distractions from this action; it could also get close supervision and follow-up, if necessary.
- 2	
- 3	Operators are alerted to the need for possible action and are expecting it.
- 4	Another step in standard or procedure-based responses.
- 5	Action is not a surprise, but previous actions create some competition for operator attention.
- 6	
- 7	This is one of many concurrent actions and could possibly be overlooked. Operator is taking recovery actions from one or two previous problems.
- 8	Operators are busy with other work and this is an unexpected, unusual transient.
- 9	Previous operator problems create an unusual situation.
- 10	The need to accomplish this action is unexpected and inconsistent with previous actions.

Notes:

Table B-5 (Page 5 of 7). Guidance for Scoring the Degree of Difficulty Presented by Each PSF Associated with Each Dynamic Human Action

PSF: Procedural Guidance

Definition: This performance-shaping factor accounts for the extent to which plant procedures enhance the operator's ability to perform the action. The operator may have available not only step-by-step instructions but also guidance on when the action has been correctly done.

Scaling Guidance:

Rating	Example of Thought Process That Might Produce This Rating
- 0	Procedures are clear and definite. Operators can easily follow them.
- 1	
- 2	Procedures are clear and definite. Operators can easily follow them but clarity could be impacted by recent changes or other modifications.
- 3	
- 4	
- 5	Procedures are available. Some operator interpretation of procedures required to perform specific actions.
- 6	Sequence of steps in procedure may require operators to return a place that has been passed (eg. continuous action (WHEN) or retainment override steps)
- 7	Procedures are being used but because of the need to act, the operator can use them only as a backup check.
- 8	Action is a chance event for which procedures can give only vague guidance.
- 9	Procedures are poorly written and may be misleading.
- 10	There are no procedures for this action.

Notes:

Table B-5 (Page 6 of 7). Guidance for Scoring the Degree of Difficulty Presented by Each PSF Associated with Each Dynamic Human Action

PSF: Training and Experience

Definition: This performance-shaping factor measures the effect of the familiarity and confidence the operators have about the actions.

Scaling Guidance:

Rating	Example of Thought Process That Might Produce This Rating
- 0	Action is normally carried out during plant trip situations. Operators are thoroughly familiar with this action and competent at it.
- 1	Action is repeatedly carried out during simulator training. Operators are thoroughly familiar with this action and competent at it.
- 2	Actions that are normally carried out during typical plant trip situations can be easily applied to this situation. Operators are well trained.
- 3	Action is part of focus on safety functions. It is subject to thorough and repeated training.
- 4	Action receives emphasis during normal training.
- 5	Action is part of normal training, but receives no particular emphasis. Same action is used during surveillance testing.
- 6	Nonroutine action that is included in annual training. Surveillance test routinely carried out has different steps than the required action.
- 7	Nonroutine action that is included in annual training
- 8	Nonroutine action that is an option in annual or biannual training.
- 9	Nonroutine action that gets no simulator training
- 10	Action is unfamiliar or contrary to normal operational practice; e.g., defeating a safety system and no procedures.

Notes:

Table B-5 (Page 7 of 7). Guidance for Scoring the Degree of Difficulty Presented by Each PSF Associated with Each Dynamic Human Action

PSF: Stress

Definition: This performance-shaping factor accounts for the impact of adverse environmental conditions and situations that may endanger the operator or damage or contaminate either the plant or the environment. Depending on its nature and level, stress can serve as an incentive to accomplish the action, or provide a diversion of attention that increases the likelihood of failure.

Scaling Guidance: Rating should focus on how the presence of stress will affect the concentration of the operator on successfully accomplishing the action. In this context, stress can have both beneficial and detrimental effects, and it is the judge's responsibility to assess the relative importance of the two.

Rating	Example of Thought Process That Might Produce This Rating
- 0	Stress level has made the operators alert, but they are not yet threatened; provides best incentive to act.
- 1	
- 2	Stress level is enough to keep the operators alert.
- 3	
- 4	Stress level is moderate; operators are aware of potential consequences; situation is typical of training or experience.
- 5	Stress level is moderate; operators are aware of potential consequences; situation is unusual.
- 6	Concern about possible outcome is increasing.
- 7	Fatigue or the tediousness effect performance.
- 8	Potential loss is high if action is not successful; situation is unfamiliar. Consequences are high enough to create physical tension.
- 9	Action must be done under severe environmental conditions of heat and humidity, loud noise, or significant vibration.
- 10	Operators fight fear, tension and uncertainty while acting. Consequence could be high radiation exposure, significant release, core damage, or threat to life.

Notes:

Table B-6 (Page 1 of 7). Guidance for Assigning Relative Weights to the PSF Scores Associated with Each Dynamic Human Action

Significant Preceding and Concurrent Actions: The rating evaluates the impact of the preceding scenario and other concurrent actions for either focusing the operators on or distracting them from accomplishing the action.

The weight relates whether the above factors have any influence on the potential for the successful completion of this action.

Weight	Example of Thought Process
0 Insignificant	Other PSFs, such as time and indications, are so important to the success of this action that what else has previously occurred or is going on has no influence on the success of this action.
1 Low	Other PSFs, such as time and indications, are so important to the success of this action that what else has previously occurred or is going on has little influence on the success of this action.
2 Normal	The action must be accomplished in the context of what else is going on. We have no reason for considering it more or less important than other PSFs.
4 High	The context in which the requirement for this action arises is a prime influence in our potential for successfully completing it.

Table B-6 (Page 2 of 7). Guidance for Assigning Relative Weights to the PSF Scores Associated with Each Dynamic Human Action

Plant Man-Machine Interface and Indications of Conditions: Scaled on the ability of the man-machine interface to provide the information necessary to make the action a success.

The weight measures whether the above factors have any influence on the potential for the successful completion of this action.

Weight	Example of Thought Process
0 Insignificant	Other factors dominate so much that I don't care how bad or good the indications are because they are not going to change the likelihood of the success of this particular action.
1 Low	This is a skill-based action done in response to many alarms, with little or no diagnosis required. I can easily verify my action in a variety of ways.
2 Normal	Patterns of indications are required to take action and verify proper plant response, but no sophisticated diagnostics or control are required.
4 High	The success of the action is not possible without the proper response to feedback from the plant instruments. We must use specific parameters to diagnose the problem and/or control the plant.

Table B-6 (Page 3 of 7). Guidance for Assigning Relative Weights to the PSF Scores Associated with Each Dynamic Human Action

Adequacy of Time To Accomplish Action: Measure of how the relationship between the time required to recognize and to accomplish the action to the time available can influence the likelihood of success.

The weight relates whether the above factors have any influence on the potential for the successful completion of this action.

Weight	Example of Thought Process
0 Insignificant	Events evolve so gradually that the relationship between available and required time does not matter. If we fail to do the action, it will be due to reasons other than time.
1 Low	A slowly evolving situation in which there should be sufficient time to act. Under these circumstances, other PSFs would tend to be more important for determining the potential for successful accomplishment.
2 Normal	Task must be done within a fairly well-understood period of time that has some flexibility.
4 High	Time frame in which we must accomplish the action is well defined. The transitions that present the initial requirement to accomplish the action are not gradual. If the action is not accomplished, something definite will happen at a well-understood point in the transient.

Table B-6 (Page 4 of 7). Guidance for Assigning Relative Weights to the PSF Scores Associated with Each Dynamic Human Action

Procedural Guidance: The rating evaluates the extent to which the written procedures enhance the operator's ability to perform the task correctly.

The weight relates whether the above factors have any influence on the potential for the successful completion of this action.

Weight	Example of Thought Process
0 Insignificant	Immediate action task in which the operators do not have time, nor are expected, to refer to the procedure before acting.
1 Low	Specific skill-based actions for which procedures provide only general guidance regarding options.
2 Normal	Operators are tracking and responding to plant status using procedures, indications, and other cognitive resources.
4 High	Tasks that would be very difficult to accomplish without procedures.

Table B-6 (Page 5 of 7). Guidance for Assigning Relative Weights to the PSF Scores Associated with Each Dynamic Human Action

Task Complexity: The rating evaluates how the presence or the lack of the following influences the potential for the success of this action: available resources, multiple objectives, coordination, communication, location of action, and sequencing of tasks.

The weight relates whether the above factors have any influence on the potential for the successful completion of this action.

Weight	Example of Thought Process
0 Insignificant	Other PSFs dominate the considerations of the action so much that the complexity (or lack of complexity) of this action has little or no influence on the potential for its failure.
1 Low	Other PSFs control the likelihood for the success of this action, but complexity does have some influence.
2 Normal	The number and sequencing of tasks and coordination necessary to accomplish them, along with other factors definitely have an influence.
4 High	It makes a big difference to us that this type of action is simple and straightforward, of normal complexity, or really hard to accomplish without communication, coordination, sequencing, etc.

Table B-6 (Page 6 of 7). Guidance for Assigning Relative Weights to the PSF Scores Associated with Each Dynamic Human Action

Training and Experience: The rating evaluates the degree to which familiarity, skill level, and confidence that the operators have regarding an action can influence its success.

The weight relates whether the above factors have any influence on the potential for the successful completion of this action.

Weight	Example of Thought Process
0 Insignificant	
1 Low	Simple actions that we are confident of being able to do when other factors are controlling whether we can do them.
2 Normal	Training and experience will have an influence on our ability to do this action, but many other factors are of similar importance.
4 High	Skill- or knowledge-based task for which the operators must rely on their training and experience to be successful.

Table B-6 (Page 7 of 7). Guidance for Assigning Relative Weights to the PSF Scores Associated with Each Dynamic Human Action

Stress. The rating evaluates the impact of the state of mind of the operators as they attempt to accomplish the action or their ability to successfully concentrate on the requirements summarized in the other six PSFs.

The weight relates whether the above factors have any influence on the potential for the successful completion of this action.

Weight	Example of Thought Process
0 Insignificant	
1 Low	Other PSFs are so important to the success of this action that our frame of mind has little influence.
2 Normal	Operators are tracking plant status and required responses during a transient.
4 High	Because of the nature of the situation (either environmental or threat), our frame of mind will have a strong impact on our ability to focus on the other PSFs that influence success.

Table B-7. Summary of the Relationship between the Scoring and Weighting Processes

Score: With respect to the things addressed by this PSF, are the conditions under which the action must be accomplished helping or hindering us to successfully complete it? In other words, we are rating the impact of the conditions on our ability to succeed in accomplishing the action. Interpretation of the range of scores

0-3 Helps

4-6 Is Neutral

7-10 Hinders

Weight: Does a variation between helping and hindering have more influence on the probability that we will successfully complete it than other PSFs? In other words, is this PSF a focus of the action? Do we key in on the things addressed by this PSF?

0 Insignificant compared to other PSFs.

1 Low: unimportant compared to other PSFs.

2 Normal: about the same as other PSFs.

4 High: much more important than other PSFs.

Weighting Thought Process

1. Initially set the weights of every PSF equal to 2.

2. Adjust weights of the PSFs only if you believe that their importance for judging the ease or difficulty of accomplishing the action is significantly (a factor of 2) greater or less than the other PSFs. The weights will be normalized so that the maximum overall failure likelihood index will be a 10, so the effect of increasing all of the weights is the same as increasing none.

3. Generally, actions requiring similar types of skills have the same PSF weights. Some examples of groups of actions where differences in the focus may require different PSF weights are as follows:

   - Immediate recognition and reaction.
   - Actions where diagnosis of need would dominate success.
   - Actions requiring a long sequence of manipulations.
   - Local actions involving coordination of activities.
   - Adjusting or controlling against indications.

Impact of Weight on How the Failure Likelihood Index Changes

Weight	Rating Change Producing the Same Change in the FLI
1	1 → 9
2	3 → 7
4	4 → 6

Table B-8. Example of a Spreadsheet Showing the Resulting Human Error Rates Estimated from the FLI of One Group of Dynamic Human Actions

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: A - All Performance Shaping Factors Equally Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.72	1.0E+00	0.00
DS3	0.14	5	0.14	7	0.14	5	0.14	3	0.14	8	0.14	3	0.14	5	5.14	1.2E-03	-2.92
CH1	0.17	3	0.17	2	0.08	3	0.17	2	0.08	2	0.17	1	0.17	4	2.42	2.2E-05	-4.66
DS5	0.14	5	0.14	8	0.14	5	0.14	3	0.14	8	0.14	3	0.14	6	5.43	1.8E-03	-2.74
CS1	0.18	7	0.18	5	0.18	5	0.09	2	0.09	4	0.09	3	0.18	5	4.82	7.4E-04	-3.13
RR1	0.14	5	0.14	2	0.14	5	0.14	2	0.14	2	0.14	3	0.14	3	3.14	6.3E-05	-4.20
RR2	0.14	7	0.14	5	0.14	5	0.14	3	0.14	3	0.14	3	0.14	4	4.29	3.4E-04	-3.47
DS2	0.15	5	0.15	7	0.08	4	0.15	3	0.15	8	0.15	3	0.15	4	4.92	8.6E-04	-3.06
DS4	0.14	5	0.14	8	0.14	5	0.14	3	0.14	8	0.14	3	0.14	6	5.43	1.8E-03	-2.74
RS1	0.15	3	0.15	3	0.15	4	0.15	0	0.15	3	0.08	8	0.15	5	3.38	9.0E-05	-4.05
AE1	0.18	8	0.18	2	0.18	3	0.09	0	0.09	1	0.09	4	0.18	5	3.73	1.5E-04	-3.83
WC1	0.15	5	0.15	2	0.15	4	0.15	1	0.08	5	0.15	3	0.15	5	3.46	1.0E-04	-4.00
OS3	0.14	8	0.14	5	0.14	3	0.14	1	0.14	2	0.14	3	0.14	2	3.43	9.6E-05	-4.02
CH2	0.15	3	0.15	2	0.15	5	0.15	4	0.08	2	0.15	1	0.15	4	3.08	5.7E-05	-4.24
MIN															0.00	6.2E-07	-6.21
Calibration Actions																	
Seabrook ON	0.14	0	0.14	0	0.14	2	0.16	0	0.17	1	0.17	0	0.08	0	0.45	1.0E-06	-6.00
Plant B OR(1A)	0.14	5	0.14	5	0.14	4	0.16	5	0.17	5	0.17	5	0.08	5	4.86	1.0E-04	-4.00
Oyster Crk ZHEMU1	0.17	7	0.13	5	0.15	2	0.18	5	0.12	5	0.15	4	0.10	6	4.84	4.0E-03	-2.40
STP HEOD03	0.14	6	0.14	6	0.15	8	0.14	5	0.15	6	0.14	6	0.14	9	6.58	3.0E-02	-1.52
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-6.20
Std Err of Y Est	0.732
R Squared	0.923
No. of Observations	5
Degrees of Freedom	3
X Coefficient(s)	0.6389
Std Err of Coef.	0.1061

Table B-9 (Page 1 of 4). Summary Descriptions of Dynamic Human Actions Evaluated for the Watts Bar PRA

Top Event	Database Variable	Definition of Action	Time Constraints	Mean HER /Demand
AC	HAAC1	Start Standby CCS Pump, Given Running Pump Fails during Non-SI Events.	Two minutes to avoid overheating the Reactor Coolant Pumps.	0.025100
AC	HAAC2	Isolate CCS Train A from Spent Fuel Pool Heat Exchanger	Not time sensitive - assume 45 minutes for heatup of cooled equipment.	0.014100
AE	HAAE1	Start Standby ERCW Pump, Given Running Pump Fails During Non-Safety Injection Events	Not time sensitive - assume 45 minutes for heatup of cooled equipment lower ERCW flow.	0.001500
AE	HAAEIE	Start Standby ERCW Pump To Avert Plant Trip, Given Running Pump Fails during Normal Opertions	Not time sensitive - assume 45 minutes for heatup of cooled equipment at lower ERCW flow.	0.000387
AF	HAAF1	Locally Operate TDAFW Valve, Given Loss of All AC power	Approximately 1 hour to steam generator dryout.	0.156000
CH	HACH1	Transfer Spray From RWST to Sump, Given RHR Swapover was Successful	Four minutes from 8% RWST level until loss of suction to containment spray pumps.	0.000055
CH	HACH2	Transfer Spray from RWST to Sump, Given RHR Swapover Failed	Four minutes from 8% RWST level until loss of suction to containment spray pumps.	0.006930
CI	HACI1	Backup Containment Isolation	Not time sensitive - assume approx. 3 hrs to avoid containment conditions that could result in radioactive releases to the environment	0.113000
CSA CSB	HACS1	Backup CS Pump Initiation, Given Containment Pressure > 2.81 psig	Approx. 20 min. after signal to avoid containment conditions that could result in release of radioactive materials in the environment.	0.002160
CTMU	HACT1	Refill CST during Non-LOCA Events	CST can provide up to 16 hours of makeup if initially at 190,000 gallons.	0.003630
DS	HADS1	Cool Down and Depressurize RCS, Normal Cooldown	Approximately 16 hours before makeup to CST required.	0.002680
DS	HADS2	Cool Down and Depressurize RCS, Given an SGTR with Successful Isolation	Approximately 16 hours before makeup to CST required.	0.001930
DS	HADS3	Cool Down and Depressurize RCS, Given SGTR with Successful Isolation, but High Head Safety Injection Failed	Approximately 16 hours before makeup to CST required.	0.015000

Table B-9 (Page 2 of 4). Summary Descriptions of Dynamic Human Actions Evaluated for the Watts Bar PRA

Top Event	Database Variable	Definition of Action	Time Constraints	Mean HER /Demand
DS	HADS4	Cool Down and Depressurize RCS, Given SGTR when Unable To Isolate Ruptured Steam Generator	Approximately 16 hours before makeup to CST required.	0.021500
DS	HADS5	Cool Down and Depressurize RCS, Given SGTR when Unable To Isolate Ruptured S/G and High Head SI Failed	Gain control of leakage within 30 minutes to avoid core uncovery, 16 hours of inventory in CST.	0.061500
DS	HADS6	Cool Down and Depressurize RCS, Given Loss of All AC Power	Initiate as soon as possible to avoid seal LOCA. Seal damage in approx. 1 hour if RCS temperature not lowered by then.	0.101000
DS	HADS7	Cool Down and Depressurize RCS, Given SLOCA with Loss of High Head Safety Injection	Initiate within 30 minutes. Reach RHR setpoints within 2 hours, for a total of 3 hours to avoid sump swapover.	0.034700
EB	HAEB1	Trip CRD MG Power and Initiate Boration, Given ATWS	Approximately 10 minutes.	0.034800
HH	HAHH1	Place Hydrogen Ignitors in Service	Not time sensitive.	0.002720
MR	HAMR1	Manually Insert Control Rods, Given ATWS	One minute or less.	0.008930
MU	HAMU1	Make Up RWST Inventory Following a SGTR Event	Approximately 8 hours of inventory available when RWST = 70%.	0.024600
MU	HAMU2	Make Up RWST Inventory, Given LOCA with Loss of Recirculation	Approximately 10 minutes to empty RWST. Approximately 20 minutes to core uncovery.	0.441000
MU	HAMU3	Make Up RWST, Given LOCA with Loss of Recirculation and Containment Spray	Approximately 10 minutes to empty RWST. Approximately 20 minutes to core uncovery.	0.721000
OB	HAOB1	Establish RCS Feed and Bleed, Given Insufficient Secondary Heat Sink	Approximately 50 minutes to S/G dryout and RCS pressure increase to above PORV setpoint, given RCPs continue.	0.025200
OF	HAOF1	Restore MFW, Given AFW Failed During General Tranisient Not Requiring SI	Approximately 33 minutes to S/G WR < 25%, which requires feed and bleed.	0.038800
OF	HAOF2	Restore Main Feedwater, Given AFW Failed During Transient Requiring SI - SLOCA	Approximately 30 minutes to S/G WR < 25%, which requires feed & bleed.	0.048500
OS	HAOS1	Align ECCS for Core Cooling, Given ESFAS Fails Following a MLOCA or LLOCA	Approximately one minute to mitigate cladding failure.	0.036200

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Table B-9 (Page 3 of 4). Summary Descriptions of Dynamic Human Actions Evaluated for the Watts Bar PRA

Top Event	Database Variable	Definition of Action	Time Constraints	Mean HER /Demand
OS	HAOS2	Align ECCS for Core Cooling, Given OSFAS Fails, Given a MSLBOC, SGTR, or SLOCA	Bounded by 30 minutes to cladding damage during SLOCA.	0.031700
OS	HAOS3	Manually Start AFW, Given Reactor Trip with No SI Required	Approximately 50 minutes before steam generator dryout.	0.002090
OS	HAOS4	Start AFW, Given ATWS with AMSAC Failure	One minute to steam generator dryout.	0.012200
OS	HAOS5	Backup Restart Timers, Given LOSP and D/G Startup	Approximately 1 hour before steam generator dryout.	0.128000
OT	HAOT1	Place Containment Spray in Standby and Reset Signal	Within 5 minutes of pressure reduction to permissible limits.	0.001650
PR PI	HAPI1	Isolate Open PORV by Closing Block Valve after Depressurizing Using the PORV.	Approximately 5 minutes to PRT disk rupture	0.001430
PR PI	HAPR1	Isolate Open PORV by Closing Block Valve after SI Actuated	Approximately 5 minutes to PRT disk rupture.	0.001430
PR	HAPR2	Isolate Open PORV by Closing Block Valve Prior to Depressurizing to 1,870 psig SI Initiation Signal	Within 30 seconds to avoid SI actuation.	0.005390
RD	HARD1	Place RHR Cooling in Service Following SGTR	Approximately 2 hours available after RHR entry conditions reached until RWST makeup required.	0.006150
NOT USED	HARE1	Shed DC Bus Loads, Given Loss of All AC Power	At least 2 hours [without recharging under normal bus loads] before batteries are depleted.	0.169000
NOT USED	HARE2	Locally Restore RHR Sump Recirculation, When Unable to Transfer From Control Room	Core damage assumed to begin 45 minutes after switchover fails.	0.715000
RH	HARH1	Transfer To Hotleg Recirculation, Given LOCA > 2-Inch Diameter	Not time sensitive - action is required before the time blockage occurs.	0.001780
RR	HARR1	Align High Pressure Recirculation, Given Auto Swapover Succeeds	Approximately 20 minutes from swapover to core uncovery if swapover not completed.	0.001860
RR	HARR2	Align High Pressure Recirculation, Given Auto Swapover Fails	Approximately 20 minutes from swapover to core uncovery if swapover not completed.	0.001860

Table B-9 (Page 4 of 4). Summary Descriptions of Dynamic Human Actions Evaluated for the Watts Bar PRA

Top Event	Database Variable	Definition of Action	Time Constraints	Mean HER /Demand
RS	HARS1	Place RHR Spray in Service, Given more than 1 Hour into Event and Containment Pressure High	Tens of minutes available before pressure alters containment conditions.	0.004670
RT	HART1	Manually Trip Reactor, Given SSPS Fails	Within one minute.	0.001510
SE	HASE1	Stop RCPs on Phase B Isolation, Given a Non-LOCA Initiator	Operators evaluated the condition that RCPs will run for 2 minutes before initiation of seal damage. Actually at least 10 min. avail.	0.030600
SE	HASE2	Stop RCPs on Loss of Train A CCS or RCP Cooling Path	At least 10 minutes before RCP damage begins.	0.024100
SL	HASL1	Identify and Isolate Ruptured Steam Generator	40 minutes available before steam generator overfill, given offset rupture of one tube.	0.001750
WC	HAWC1	Control SI To Prevent Water Challange of PORVs	Dependent on fill rate - assume no more than 5 minutes to recognize and react.	0.003720

Table B-10 (Page 1 of 47). Qualitative Descriptions of Dynamic Human Actions

HAAC1: Start Standby CCS Pump, Given Running Pump Fails during Non-Safety Injection Events

PRECEDING EVENTS
- Reactor trip not requiring safety injection.
- Normal shutdown.
- Normally running CCS pump 1A-A trips.

INDICATIONS OF PLANT CONDITION
- Alarm — all lights on affected pump switch lit.
- Decreasing header pressure and flow.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- AOI-15.
- Identify failed pump.
- Verify autostart of backup pump.
- Manually start (turn switch) if not started.

CONCURRENT ACTIONS/COMPETING FACTORS
- Immediate action response to other concurrent alarms, if any (consider relative frequency of multiple verses single alarms).

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Header pressure and flow return to normal.
- Standby pump indication — RED.

FAILURE IMPACT
- Heatup and eventual failure of affected equipment.
- Loss of CCS train A.

TIME CONSTRAINTS
- Two minutes.

Table B-10 (Page 2 of 47). Qualitative Descriptions of Dynamic Human Actions

HAAC2: Isolate CCS Train A from Spent Fuel Pit Heat Exchanger

PRECEDING EVENTS
- Small LOCA initiating event.
- U-1 reactor trip and safety injection with all automatic actions successful.
- CCS pump 1B is tagged out for maintenance.
- Transfer to containment sump successful.
- SFP cooling heat exchangers are being supplied from U-1 train A CCS.

INDICATIONS OF PLANT CONDITION
- Several high temperature alarms are received referencing U-1 train A ESF equipment.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Align the U-2 train A CCS to the SFP cooling heat exchangers.
- Isolate the U-1 train A CCS to the SFP cooling heat exchangers while monitoring CCS surge tank levels.

CONCURRENT ACTIONS/COMPETING FACTORS
- Monitoring sump recirculation.
- Balancing flows on RHR heat exchangers.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Flow returns to normal on U1 train A.

FAILURE IMPACT
- Heatup and eventual failure of cooled equipment.

TIME CONSTRAINTS
- Not time sensitive. Assume tens of minutes for heatup of cooled equipment.

Table B-10 (Page 3 of 47). Qualitative Descriptions of Dynamic Human Actions

HAAE1: Initiate Standby ERCW Pump, Given Running Pump Fails during Nonsafety Injection Events

PRECEDING EVENTS

- Unit trip from full power with all automatic system responses normal.
- Two train A ERCW pumps running with two in standby.
- Train A ERCW header pressure at approximately 108 psig.
- One train A ERCW pump trips.

INDICATIONS OF PLANT CONDITION

- Motor trip out alarm and white light indicated on pump.
- Train A ERCW header pressure decreasing.
- Flow indicator shows low flow on header.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- AOI-13A.
- Start standby ERCW pump (Immediate operator action).
- Ensure header pressure and flow return to normal.

CONCURRENT ACTIONS/COMPETING FACTORS

- Monitoring status trees.
- Proceeding to hot standby in preparation for restart.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- Header pressure and flow return to normal.

FAILURE IMPACT

- Overheating of cooled components.
- Failure of cooled components due to overheating.

TIME CONSTRAINTS

- Not time sensitive. Assume tens of minutes for heatup of lower ERCW flow.

Table B-10 (Page 4 of 47). Qualitative Descriptions of Dynamic Human Actions

HAAE2: Initiate Standby ERCW Pump, Given Only One Diesel Generator Available during LOSP

PRECEDING EVENTS

- Loss of grid and two offsite lines.
- Unit 1A and 2B diesel generators failed to start.
- CCP 1B failed to start following SD board loading.
- After some time pressure starts rising in containment.
- Safety injection initiates.
- Decision to cooldown and depressurize, successful to limit of safety injection pumps.
- Phase B isolation, with containment spray initiation.
- RWST level low, switchover to sump recirculation.

INDICATIONS OF PLANT CONDITION

- Containment radiation alarm.
- ERCW low flow.
- ERCW low discharge pressure.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- AOI-35.
- Evaluate current load on diesel generator.
- Shed unnecessary loads.
- Initiate standby ERCW pump on running diesel.

CONCURRENT ACTIONS/COMPETING FACTORS

- Containment pressure rising.
- Limited onsite power (only one diesel).
- All supporting agencies on emergency power, if any.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- RCS temperature and press continue to decline.

FAILURE IMPACT

- Pump initiation without load evaluation has a potential for loss of D/G.
- Failure to initiate pump:
  - Degradation of ultimate heat sink.
  - Increasing RCS/containment temp and press leading the increased likelihood of core melt and containment failure.

TIME CONSTRAINTS

- Tens of minutes, over which RCS/containment temp and press is rising.

NOTES

- Potential load shedding error: must recover before diesel generator lugs to a stall.

Table B-10 (Page 5 of 47). Qualitative Descriptions of Dynamic Human Actions

HAAEIE: Start Standby ERCW Pump To Avert Plant Trip, Given Running Pump Fails during Normal Operation

PRECEDING EVENTS
- Unit at 100% power during normal operations.

INDICATIONS OF PLANT CONDITION
- Alarm: ERCW header pressure low.
- One ERCW pump status indication "WHITE."

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Same as HAAE1.

CONCURRENT ACTIONS/COMPETING FACTORS
- Primary focus of attention.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- ERCW header pressure returns to normal and equipment remains cooled.

FAILURE IMPACT
- Gradual heatup of cooled equipment and plant trip with reduced ERCW.

TIME CONSTRAINTS
- Not time sensitive. Tens of minutes for heatup of cooled equipment.

NOTES:

- As this action was identified as being important during the final quantification, the following reasoning is used to establish an HER for it.

  The evaluation of potential support system initiating events indicates that action HAAE1 (Start standby ERCW pump, given running pump fails during non-SI events) is required during normal operations to avoid a plant trip. Under non-transient conditions, the operators will have far less competition from their emergency response requirements to distract them from the task. Consequently, it is expected that the degree of difficulty of the action will decrease, resulting in a lower HER than that expected when they must respond to the support system failure during a transient.

  As a result of the above considerations, the action HAAE1 was reevaluated by changing the ratings for the following PSFs to '2' corresponding to a favorable condition for accomplishing the action.

  Preceding and concurrent actions: If an ERCW pump fails at power, the operators will respond to the alarm immediately and be motivated to align the spare to avoid heatup of supported equipment and plant trip.

  Training and Experience: This is the type of action that the operators take while the plant is at power. They are experienced and confident about identifying a failed item of equipment based on alarms and indications.

  Stress: The sounding of alarms during normal operations without a trip will be primarily an incentive to act.

Table B-10 (Page 6 of 47). Qualitative Descriptions of Dynamic Human Actions

HAAF1: Locally Operate Turbine-Driven AFW Level Control Valve, Given Loss of All AC Power

PRECEDING EVENTS
- LOSP occurs, reactor/turbine trip.
- Diesel generators fail to start.
- ECA-0.0 "Loss of All AC Power" is implemented.
- Control air is lost, turbine-driven AFW pump running.
- Cooldown of RCS is required.

INDICATIONS OF PLANT CONDITION
- Turbine-driven AFW LCV are closed due to loss of air.
- Steam generator levels < 25%, AFW flow < 440 gpm.
- RCS temperature increasing.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- ECA-0.0, step 3.
- Verify turbine-driven AFW pump running, flow > 440 gpm.
- Steam generator levels returning to normal program.
- Isolate air and bleed off pressure from LCVs.
- Control steam generator level/flow by throttling the hand wheels on top of the LCVs.

CONCURRENT ACTIONS/COMPETING FACTORS
- Restarting diesel generator.
- Small LOCA in progress from RCP seals.
- Man the TSC.
- Environment in area of valve very hot.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Steam generator levels returning to program.
- AFW flow established.
- RCS cooling established.

FAILURE IMPACT
- Loss of secondary heat sink.
- Size of LOCA increases.
- RCS heats up, pressurizes PORVs opens increases LOCA rate.

TIME CONSTRAINTS
- Approximately 1 hour to steam generator dryout.

Table B-10 (Page 7 of 47). Qualitative Descriptions of Dynamic Human Actions

HACH1: Transfer Spray from RWST to Sump, Given RHR Swapover was Successful

PRECEDING EVENTS
- Reactor/turbine trip as a result of a LOCA.
- Phase B isolation.
- Containment spray pumps are running.
- RWST level < 29%.
- Containment sump level > 11.25%.
- Transfer to RHR containment sump complete for RHR, CCPs, and safety injection pumps.

INDICATIONS OF PLANT CONDITION
- RWST level ≤ 8%.
- Containment pressure ≥ 2.81 psig.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- ES-1.2, steps 5-8.
- Stop, pull-to-lock, both containment spray pumps.
- Close suction from RWST, open suction from sump.
- Align ERCW to containment spray heat exchangers.
- Verify alignment and start spray pumps.
- Ensure flow.

CONCURRENT ACTIONS/COMPETING FACTORS
- Dedicated operator — only action.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Pumps aligned and spray flow established.
- RWST level steady.

FAILURE IMPACT
- Failure of Containment spray pumps.

TIME CONSTRAINTS
- Five minutes from RWST 8% level until loss of suction to containment spray pumps.
- Containment spray pumps assumed to fail after pumping dry.

Table B-10 (Page 8 of 47). Qualitative Descriptions of Dynamic Human Actions

HACH2: Transfer Spray from RWST to Sump, Given RHR Swapover was Not Successful

PRECEDING EVENTS

- Reactor/turbine trip as a result of a LOCA.
- Phase B isolation.
- Containment spray pumps are running.
- RWST level < 29%.
- Containment sump level > 11.25%.
- Transfer of RHR suction to containment sump tripped RHR pumps for unknown causes.

INDICATIONS OF PLANT CONDITION

- RWST level =< 8%.
- Containment pressure >= 2.81 psig.
  Containment sump level > 40%.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- ECA -1.1 step 6 & 7 ES-1.2.
- Stop, pull-to-lock, both containment spray pumps.
- Close suction from RWST, open suction from sump.
- Align ERCW to containment spray heat exchangers.
- Verify alignment and start spray pumps.
- Ensure flow.

CONCURRENT ACTIONS/COMPETING FACTORS

- RHR sump swapover failed.
- Making up to the RWST.
- Maintaining RWST level >8% by using containment spray recirculation line.
- Returning to limited ECCS injection mode.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- Pumps aligned and spray flow established.
- RWST level steady.

FAILURE IMPACT

- Failure of Containment spray pumps.

TIME CONSTRAINTS

- Five minutes from RWST 8% level until loss of suction to containment spray pumps.
- Containment spray pumps assumed to fail after pumping dry.

Table B-10 (Page 9 of 47). Qualitative Descriptions of Dynamic Human Actions

HACI1: Backup Containment Isolation, Given Loss of All AC Power

PRECEDING EVENTS
- A station blackout occurs causing a reactor/turbine trip at full power.
- Diesel generators fail to start, and no AC power is available.
- Control air is lost.
- Emergency procedures are implemented, with transition to ECA-0.0, "Loss of All AC Power," completed.

INDICATIONS OF PLANT CONDITION
- Containment Isolation Panel 6K and 6L indicate RED lights on both trains.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- ECA-0.0, steps 9, 21.
- Ensure phase A and containment vent isolation.
- Notify TSC to evaluate any isolation valve that has failed to close.
- If safety injection actuated, reset safety injection after 90 second time delay.
- Close isolation valves that failed to close by local manipulation.
- Isolate RCP seal cooling.
- Locally close RCP seal injection and return valves using "reach rods."

CONCURRENT ACTIONS/COMPETING FACTORS
- Actions require TSC/OSC coordination.
- Isolate RCP seal cooling per ECA-0.0.
- Cooling down with AFW, steam generator PORVs.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Train A and train B and CUI Panels indicate GREEN lights.

FAILURE IMPACT
- Containment bypass path to outside containment.

TIME CONSTRAINTS
- Not time sensitive. Assume approximately 3 hours to containment challenge.

Table B-10 (Page 10 of 47). Qualitative Descriptions of Dynamic Human Actions

HACS1: Backup CS Pump Initiation, Given Containment Pressure is > 2.81 psig

PRECEDING EVENTS
- Reactor/turbine trip and ESFAS actuation at full power.
- E-0 actions completed and transition to E-1.
- Phase B isolation has occurred.

INDICATIONS OF PLANT CONDITION
- Containment spray pumps in standby.
- Containment pressure indicates 3 psig.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- FR-Z.1.
- Recognize requirement to initiate spray.
- Verify at least one train containment spray operable.
- Manipulate controls to initiate, if not functioning.
- Verify containment isolation (check monitor lights).

CONCURRENT ACTIONS/COMPETING FACTORS
- Monitor status trees for higher level ORANGE path or RED path.
- Containment pressure remains low, then rises fast when ice melts.
- Containment isolation becomes RED path at 15 psig.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Containment pressure rise stops.
- Containment spray pumps running.
- Outlet valves open and spray flow indicated.

FAILURE IMPACT
- Containment failure when ice melts.

TIME CONSTRAINTS
- Approximately 20 minutes after signal before containment challenged.

Table B-10 (Page 11 of 47). Qualitative Descriptions of Dynamic Human Actions

HACT1: Refill the CST during Non-LOCA Events

PRECEDING EVENTS

- Reactor/turbine trip from full power.
- Transient either caused by low CST level or placed a demand on CST; e.g.,
  - Chem lab has reported the CST and condensate system just barely out of chemistry limits and recommends feed and bleed with DI water to correct the chemistry. Feed and bleed operations were initiated, but a miscommunication terminates the feed, while the bleed continues to the station sump from the hotwell pump discharge. Auto makeup from the CST continues unnoticed and the unit trips due to loss of hotwell level.
  - Emergency procedures are implemented and while ES-0.1 is being performed, RCS pressure, temperature and pressurizer level decreases uncontrolled. SIS is actuated and E-0 is implemented. The operators correctly diagnose and isolate a stuck open steam generator PORV and have transitioned to ES-0.3 "SI termination"

INDICATIONS OF PLANT CONDITION

- CST level < 200,000 gallons.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- Recognize condition.
- Initiate makeup to the CST.

CONCURRENT ACTIONS/COMPETING FACTORS

- Addressing requirements of current procedures.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- CST level rises.

FAILURE IMPACT

- CST unavailable as source of inventory for secondary systems.

TIME CONSTRAINTS

- CST can provide up to 6 hours of makeup if initially at 190,000 gallons.

Table B-10 (Page 12 of 47). Qualitative Descriptions of Dynamic Human Actions

HADS1: Cooldown and Depressurize RCS to RHR Cut in Temperature and Pressure, Normal Cooldown

PRECEDING EVENTS

- Loss of Condenser Vacuum.
- Reactor trip from full power.
- All automatic functions successful.
- RCS stable at 557°F and 2,230 psig.
- Transitional from ES-0.1 to GOI-3.
- Decision made to proceed to cold shutdown for turbine/condenser work or other maintenance and/or repair.
- Steam blocking clearance to be issued.

INDICATIONS OF PLANT CONDITION

- CST level at 370,000 gallons.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- E-0 to ES-0.1 to GOI-3.
- Cool down using steam generator PORVs.
- Depressurize RCS using pressurizer sprays and pressurizer PORVs.
- Block automatic safety injection signals, pressurizer low press and steam line low pressure.
- Do not exceed cooldown limits per SI-4.11.

CONCURRENT ACTIONS/COMPETING FACTORS

- Main activity.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- RCS < 350°F and 380 psig.

FAILURE IMPACT

- Makeup to CST required.

TIME CONSTRAINTS

- CST level minimum is 190,000 gallons (6 hours available to cold shutdown).
- Maximum cooldown rate based on cooldown limits <100°F per hour per SI-4.11 and <50°F per hour per GOI-3B.

Table B-10 (Page 13 of 47). Qualitative Descriptions of Dynamic Human Actions

HADS2: Cooldown and Depressurize RCS To Match Break Flow and then to RHR Cut in Temperature and Pressure, Following a SGTR with Successful Steam Generator Isolation

PRECEDING EVENTS

- Reactor trip from full power.
- All automatic functions successful.
- Ruptured steam generator successfully isolated (SL1).
- RCS stable at 557°F and 1870 psig and decreasing.
- Decision made to proceed to cold shutdown to repair steam generator.

INDICATIONS OF PLANT CONDITION

- CST level at 370,000 gallons.
- Condenser available.
- Pressurizer level decreasing.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- E-3 step 12-14; ES-3.2 step 4,9.
- Cool down using steam dumps and/or steam generators PORVs.
- Depressurize RCS using pressurizer sprays and pressurizer PORVs.
- Block automatic safety injection signals, pressurizer low pressure and steam line low pressure.
- Do not exceed cooldown limits per SI-4.11.

CONCURRENT ACTIONS/COMPETING FACTORS

- Main activity.
- Safety injection should be terminated in a timely manner to prevent pressurizer overfill.
- In REP.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- RCS < 350°F and 380 psig.

FAILURE IMPACT

- Makeup to CST required.
- Steam generator overfill.
- Atmosphere dump valves and safety challenge.

TIME CONSTRAINTS

- CST level minimum is 190,000 gallons (6 hours available to cold shutdown).
- Maximum cooldown rate based on cooldown limits < 100°F per hour per SI-4.11 and < 50°F per hour per GOI-3B.

Table B-10 (Page 14 of 47). Qualitative Descriptions of Dynamic Human Actions

HADS3: Cooldown and Depressurize RCS to RHR Cut in Temperature and Pressure, following a SGTR with Successful Steam Generator Isolation, but Failure of High Head Safety Injection

PRECEDING EVENTS

- Reactor trip from full power.
- Both CCPs fail to inject.
- Ruptured steam generator successfully isolated (SL1).
- Decision made to proceed to cold shutdown to repair steam generator.

INDICATIONS OF PLANT CONDITION

- CST level at 370,000 gallons.
- RCS temperature and pressure dropping slowly.
- CCP not running.
- Both safety injection pumps running on miniflow recirculation.
- Condenser available.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- E-3 step 12-14; ES-3.2 step 4,9.
- Cool down using steam dumps and/or steam generators PORVs.
- Depressurize RCS using pressurizer sprays/pressurizer PORVs to <1,500 psig.
- Block automatic safety injection signals, pressurizer low pressure and steam line low pressure.
- Do not exceed cooldown limits per SI-4.11.

CONCURRENT ACTIONS/COMPETING FACTORS

- Main activity.
- In REP.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- RCS < 350°F and 380 psig.

FAILURE IMPACT

- Makeup to CST required.
- Steam generator overfill.
- Atmosphere dump valve or safety challenge.

TIME CONSTRAINTS

- CST level minimum is 190,000 gallons (6 hours available to cold shutdown).
- Maximum cooldown rate based on cooldown limits <100°F per hour per SI-4.11 and < 50°F per hour per GOI-3B.

Table B-10 (Page 15 of 47). Qualitative Descriptions of Dynamic Human Actions

HADS4: Cooldown and Depressurize RCS to RHR Cut in Temperature and Pressure, following a SGTR when Unable To Isolate Ruptured Steam Generator

PRECEDING EVENTS
- Reactor trip from full power.
- All automatic functions successful.
- Unable to isolate ruptured steam generator.
- MSIV fails to close on ruptured S/G.

INDICATIONS OF PLANT CONDITION
- CST level at 370,000 gallons.
- Condenser initially available, but lost on S/G isolation.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- ES-1.1, steps 8-10,13,22; E-3 step 12-14; ES-3.2 step 4,9.
- Cool down using steam generator PORVs.
- Depressurize RCS using pressurizer sprays or pressurizer PORVs.
- Block automatic safety injection signals, pressurizer low pressure and steam line low pressure.
- Do not exceed cooldown limits per SI-4.11.

CONCURRENT ACTIONS/COMPETING FACTORS
- Isolating intact steam generators and condenser per E-3 step 8 RNO.
- Checking MSIV signal paths?
- Losing water through the ruptured steam generator tube.
- In REP.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- RCS < 350°F and 380 psig.

FAILURE IMPACT
- Secondary side rupture providing leak path to atmosphere.
- Steam generator overfill.
- Atmosphere dump valve or safety challenge.

TIME CONSTRAINTS
- CST level minimum is 190,000 gallons (6 hours available to cold shutdown).
- Maximum cooldown rate based on cooldown limits < 100°F per hour per SI-4.11 and < 50°F per hour per GOI-3B.

Table B-10 (Page 16 of 47). Qualitative Descriptions of Dynamic Human Actions

HADS5: Cool Down and Depressurize RCS to RHR Cut in Temperature and Pressure, following a SGTR when Unable To Isolate Ruptured Steam Generator and Loss of High Head Injection

PRECEDING EVENTS

- Charging pump 1B-B unavailable due to maintenance.
- Reactor trip from full power due to SGTR (one tube).
- Charging pump 1A-A fails on motor tripout.
- Automatic SI initiation on low RCS pressure.
- Unable to isolate ruptured steam generator (MSIV failed to close).

INDICATIONS OF PLANT CONDITION

- CST level at 370,000 gallons.
- Condenser initially available, but lost on S/G isolation.
- Steam line monitors, blowdown monitors, condenser vacuum exhaust radiation — HIGH and increasing.
-

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- E-0 step 20 transition to E-3; ES-3.2 step 4,9.
- Cool down using steam generator PORVs.
- Depressurize RCS using pressurizer sprays and pressurizer PORVs.
- Block automatic safety injection signals, pressurizer low pressure and steam line low pressure.

CONCURRENT ACTIONS/COMPETING FACTORS

- Isolating intact steam generators and condenser per E-3 step 8 RNO.
- Trying to reestablish charging pump flow.
- Trouble shooting MSIV that failed to close.
- Losing water through the ruptured steam generator tube.
- In REP.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- Phase 1: Safety injection injecting to RCS.
- Phase 2: RCS < 350°F and 380 psig.

FAILURE IMPACT

- Phase 1: Core uncovery prior to safety injection pressure.
- Phase 2: Secondary side rupture providing leak path to atmosphere.

TIME CONSTRAINTS

- Phase 1: Approximately 30 minutes before core uncovery.
- Phase 2: CST level minimum is 190,000 gallons (6 hours available to cold shutdown).

Table B-10 (Page 17 of 47). Qualitative Descriptions of Dynamic Human Actions

HADS6: Cooldown and Depressurize, Given Loss of All AC Power

PRECEDING EVENTS
- Loss of off site power causes reactor trip from full power.
- Emergency diesel generators fail to start.
- Turbine driven AFW functional (AF1 succeeded).
- Transition from E-0 to ECA-0.0 complete.

INDICATIONS OF PLANT CONDITION
- CST level at 370,000 gallons.
- Both shutdown boards deenergized.
- Steam generator level is > 10%.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- ECA-0.0.
- Isolate RCP seal cooling.
- Isolate CST from hotwell.
- Cooldown RCS using turbine-driven AFW pump.
- Open S/G PORV manually.
- Inject cold leg accumulators.
- Select recovery guideline based on RCS subcooling and pressurizer level.

CONCURRENT ACTIONS/COMPETING FACTORS
- Actions to restore AC power.
- Refer to AOI-35.
- Try to restart diesel generators and energize shutdown board.
- Place equipment in pull-to-lock.
- Check DC bus loads.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- RCS < 350°F and 380 psig.

FAILURE IMPACT
- Seal leakage and seal degradation.

TIME CONSTRAINTS
- Initiate cooldown as soon as possible.
- Seal degradation inversely proportional to primary temperature and pressure, so time available depends on how fast action initiated.
- Seal damage is approximately 1 hour if temperature is not lowered.

Table B-10 (Page 18 of 47). Qualitative Descriptions of Dynamic Human Actions

HADS7: Cooldown and Depressurize RCS to RHR Cut in Temperature and Pressure, following a SLOCA With Failure of High Head Safety Injection

PRECEDING EVENTS

- One CCP tagged out for maintenance.
- Small LOCA initiating event.
- Manual reactor trip from full power on decreasing uncontrolled pressurizer level.
- Operators increase operating CCP flow as directed by AOI-6.
- Operating CCP trips on overcurrent.

INDICATIONS OF PLANT CONDITION

- AFW operational.
- RWST level at 370,000 gallons.
- RCS pressure > 1,500 psig and decreasing.
- Pressurizer level at 58% and decreasing.
- Both safety injection pumps running on miniflow recirculation.
- Phase B isolation has occurred and RCPs have been turned off.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- E-1 step 23; ES-1.1 steps 8, 9, 10, 17, and 18.
- Initiate cool down to cold shutdown using steam generator PORVs.
- Continue RCS depressurization to RHR setpoints.
- Block automatic safety injection signals.
- Do not exceed cooldown limits per SI-4.11.

CONCURRENT ACTIONS/COMPETING FACTORS

- Main activity.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- On RHR before sump swapover.

FAILURE IMPACT

- Sump recirculation required.

TIME CONSTRAINTS

- Initiate cooldown within one hour and reach RHR setpoints within two additional hours.
- Maximum cooldown rate based on cooldown limits <100°F per hour per SI-4.11 and < 50°F per hour per GOI-3B.

Table B-10 (Page 19 of 47). Qualitative Descriptions of Dynamic Human Actions

HAEB1: Trip CRD Motor-Generator Power and Initiate Boration, Given ATWS

PRECEDING EVENTS

- Conditions exist that require a reactor trip.
- Automatic and manual trip signals fail to initiate a reactor trip.
- Manual rod insertion initiated (Action MR1).
- Turbine tripped but reactor did not.

INDICATIONS OF PLANT CONDITION

- Indication requiring trip present with associated alarms.
- Reactor is at 100% of full power.
- Reactor trip breakers indicate closed.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- FR-S.1, step 1,2.
- Verify auto/manual rod insertion.
- Dispatch operator to trip breaker in MG Set Room, Auxiliary Building 759.
  - Identify correct breakers.
  - Trip and verify breakers open.
- Dispatch operator to trip breakers at 480V Unit Boards A and B.
  - Identify correct breakers.
  - Trip and verify breakers open.
- Borate RCS using BIT, RWST, emergency borate valve.

CONCURRENT ACTIONS/COMPETING FACTORS

- Ensure all AFW pumps running.
- Actions to bring RCS press to < 2,335 psig.
- Verify dilution paths isolated.
- Monitor steam generator levels and pressure.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- Power range <5%.
- Intermediate range — negative startup rate.

FAILURE IMPACT

- No reactivity control — core melt.

TIME CONSTRAINTS

- Time critical of 3 minutes assuming AUO is dispatched from TB AUO office (JPM #79).
- Time available of 10 minutes based on Westinghouse analysis.
- Time required to get to remote locations.

Table B-10 (Page 20 of 47). Qualitative Descriptions of Dynamic Human Actions

HAHH1: Place Hydrogen Igniters In Service

PRECEDING EVENTS
- Reactor/turbine trip with ESFAS actuation.
- E-0 completed, with transition to E-1, Loss of Reactor or Secondary Coolant.

INDICATIONS OF PLANT CONDITION
- Containment radiation high.
- Containment pressure and temperature high.
- Sump level increasing.
- Chem Lab results read 5% hydrogen concentration.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- E-1, step 15; FR-Z.1, step 9.
- Recognize condition.
- Energize hydrogen igniters (panel M-10).

CONCURRENT ACTIONS/COMPETING FACTORS
- Procedures in effect.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Hydrogen analyzers indicate decreasing hydrogen concentration.

FAILURE IMPACT
- Potential for hydrogen explosion.

TIME CONSTRAINTS
- Dependent on core damage scenario, but not time critical.

Table B-10 (Page 21 of 47). Qualitative Descriptions of Dynamic Human Actions

HAMR1: Manually Insert Controls Rods, Given ATWS

PRECEDING EVENTS
- Condition resulting in loss of MFW; e.g., inadvertent loss of MFW.
- Turbine trip.
- No automatic reactor trip.
- Reactor trip breakers will not open when manual reactor trip switches are actuated.

INDICATIONS OF PLANT CONDITION
- Power level remaining steady at 100% power (worse case assumed).
- Plant alarms regarding to cause of trip.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- FR-S.1, step 1.
- Verify the control rods are stepping in > 48 steps per minute.
- Recognize lack of clicking sound and visual indications.
- Place the bank selector switch to manual.
- Operate the IN-HOLD-OUT switch to the IN position.

CONCURRENT ACTIONS/COMPETING FACTORS
- Initial cause of trip still present.
- Trip CRD motor-generator sets and initiate emergency boration (HRAEB1).

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Reactor power reduction to < 5%.
- RCS pressure peaks and decreases.

FAILURE IMPACT
- High pressure relief challenge.

TIME CONSTRAINTS
- Initiate within 1 minute of requirement to trip.

Table B-10 (Page 22 of 47). Qualitative Descriptions of Dynamic Human Actions

HAMU1: Makeup up RWST Inventory Following a SGTR Event

PRECEDING EVENTS
- Reactor/turbine trip and ESFAS actuation at full power.
- #3 steam generator has been identified as faulted after closure of the MSIVs.

INDICATIONS OF PLANT CONDITION
- #3 steam line radiation monitor indicates high.
- AFW is successful.
- Containment pressure is normal.
- RWST level is < 70%.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- ECA-3.2, step 1 per SOI-62.2.
- Initiate normal makeup to the RWST.
- Align and initiate makeup from one of the following sources:
  - Spent fuel pit.
  - Unaffected unit's RWST.
  - Holdup tank.
  - Containment sump using containment spray pump recirculation.

CONCURRENT ACTIONS/COMPETING FACTORS
- Cooldown and depressurization underway.
- Monitoring function restoration trees.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- RWST returns to normal level.

FAILURE IMPACT
- Loss of primary inventory through secondary.

TIME CONSTRAINTS
- Approximately 5 hours* of inventory available when RWST = 70%.

*The time calculated in Appendix C provides the operators with 8 hours to accomplish this action. The difference in time constraints is judged to have no significant impact on their evaluation.

Table B-10 (Page 23 of 47). Qualitative Descriptions of Dynamic Human Actions

HAMU2: Makeup RWST Inventory, Given LOCA with Loss of Sump Recirculation

PRECEDING EVENTS

- 1B-B RHR pump tagged out for service.
- Reactor/turbine trip from full power.
- Containment spray initiated on high radiation, pressure and temperature.
- E-0 completed and transition to ES-1.2.
- RHR pump 1A-A trip on overcurrent during transition and fails to restart.

INDICATIONS OF PLANT CONDITION

- Containment high radiation, pressure and temperature.
- RHR pumps not running.
- RWST level dropping.
- Sump level increasing.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- Transition to ECA-1.1, step 2.
- Initiate normal makeup to the RWST.
- Align and initiate makeup from one of the following sources:
  - Spent fuel pit.
  - Unaffected unit's RWST.
  - Holdup tank.
  - Containment sump with containment pump recirculation line.
- Reduce to 1 train of ECCS

CONCURRENT ACTIONS/COMPETING FACTORS

- Attempting to restore RHR operability per ECA-1.1, step 1.
- At RWST < 8%, PULL TO LOCK any pumps taking suction from the RWST.
- Possibly in FR-Z.1 or FR-C.1.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- RWST level increasing.

FAILURE IMPACT

- Loss of inventory for core cooling.

TIME CONSTRAINTS

- Approximately 10 minutes to empty RWST.
- Approximately 20 minutes to core uncovery.

Table B-10 (Page 24 of 47). Qualitative Descriptions of Dynamic Human Actions

HAMU3: Makeup RWST Inventory, Given LOCA With Loss of Recirculation and Containment Spray

PRECEDING EVENTS

- Reactor/turbine trip from full power.
- Containment spray initiated on high radiation, pressure and temperature, but fails to operate.
- E-0 completed and transition to ES-1.2.
- Sump swapover valves fail on automatic initiator.
- RHR sump swapover valves fail to open.

INDICATIONS OF PLANT CONDITION

- Containment high radiation, pressure and temperature.
- RHR pumps not running.
- RWST level.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- Transition to ECA-1.1, step 2.
- Initiate normal makeup to the RWST.
- Align and initiate makeup from one of the following sources:
  - Spent fuel pit.
  - Unaffected unit's RWST.
  - Holdup tank.
  - Containment sump using containment spray pump recirculation.

CONCURRENT ACTIONS/COMPETING FACTORS

- Attempting to restore RHR operability per ECA-1.1, step 1.
- At RWST < 8%, PULL TO LOCK any pumps taking suction from the RWST.
- Possibly in FR-Z.1 or FR-C.1.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- RWST level.

FAILURE IMPACT

- Loss of inventory for core cooling.

TIME CONSTRAINTS

- Approximately 10 minutes to empty RWST.
- Approximately 20 minutes to core uncovery.

Table B-10 (Page 25 of 47). Qualitative Descriptions of Dynamic Human Actions

HAOB1: Establish RCS Feed and Bleed, Given Inadequate Secondary Heat Sink

PRECEDING EVENTS
- Motor driven AFW pump 1B tagged out for maintenance.
- Reactor trip due to "low-low steam generator levels."
- Transition from E-0 to ES-0.1 complete.
- TB AUO reports a large condensate pipe break in the area of the main feedwater pumps.
- Condensate pumps have been shut down to conserve CST inventory.

INDICATIONS OF PLANT CONDITION
- Turbine driven AFW pump fails to start.
- Motor driven AFW pump 1A starts.
- All steam generators at 15% wide range level.
- AFW running with a total flow of 300 gpm.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Status trees, ES-0.1, step 4; FR-H.1.
- Stop all RCPs.
- Actuate OA isolation.
- Ensure CCPs injecting through BIT or safety injection pumps running.
- Open both pressurizer PORV and block valves.

CONCURRENT ACTIONS/COMPETING FACTORS
- Establish condensate and main feedwater.
- If RWST level decreases to < 29%, align ECCS suction to the containment sump using ES-1.2.
- Restore RWST level.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Narrow range level in at least one steam generator > 10% (25% for adverse containment conditions).
- Core exit thermocouples decreasing.
- T-hot decreasing.
- Not a condition (termination criteria) but must maintain > 40°F during termination.

FAILURE IMPACT
- Core uncovers leading to core damage.

TIME CONSTRAINTS
- Approx 1 hour before steam generator dryout and RCS pressure increases above PORV setpoint.

Table B-10 (Page 26 of 47). Qualitative Descriptions of Dynamic Human Actions

HAOF1: Restore Main Feedwater, Given AFW Failed during General Transient Not Requiring Safety Injection

PRECEDING EVENTS
- Reactor/turbine trip from full power.
- Station service transfer successful.
- MFW isolation complete.
- Steam generator level declined to < 8% narrow range.

INDICATIONS OF PLANT CONDITION
- AFW total flow < 470 gpm, status light RED.
- Steam generator = 60% WR.
- Shutdown boards energized by offsite power.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Status tree FR-H.1, step 1,5-13.
- Verify AFW flow < 470 gpm while steam generator NR level < 10% (E-0).
- Check steam generator WR levels to determine if 1 steam generator ≥ 25% WR.
  - Yes: Establish secondary heat sink.
  - No: Establish bleed and feed.
- Verify safety injection cleared or blocked, reset MFW isolation.
- Start MFW, condensate pumps, and align valves.

CONCURRENT ACTIONS/COMPETING FACTORS
- ES-0.1 actions.
- Monitoring status trees.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Steam generator level remains above 25% WR and stabilizes in acceptable range.
- Secondary heat sink reestablished.

FAILURE IMPACT
- Transition to feed and bleed (Actions OB1, OB2).

TIME CONSTRAINTS
- Approximately 45 minutes to steam generator WR level <25%, which requires transition to feed and bleed.

Table B-10 (Page 27 of 47). Qualitative Descriptions of Dynamic Human Actions

HAOF2: Restore Main Feedwater, Given AFW Failed during Transient Requiring Safety Injection; e.g., small LOCA

PRECEDING EVENTS
- Reactor/turbine trip from full power.
- Station service transfer successful.
- MFW isolation complete.
- Steam generator level declined to < 8% narrow range.

INDICATIONS OF PLANT CONDITION
- AFW flow shows 0 gpm, status light GREEN.
- Steam generator = 60% WR.
- Shutdown boards energized by offsite power.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- E-0 step 8 transition to FR-H.1.
- Verify AFW flow < 470 gpm while steam generator NR level < 10% (E-0).
- Check steam generator WR levels to determine if 1 steam generator > 25% WR.
  - Yes: Establish secondary heat sink .
  - No: Establish bleed and feed.
- FR-H.1 steps 5-13.
- Try to reestablish AFW, verify failed.
- Clear/block/reset safety injection and MFW isolation signals.
- Start MFW, condensate pumps, and align valves.

CONCURRENT ACTIONS/COMPETING FACTORS
- Monitoring status tree actions.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Steam generator level remains above 25% WR and stabilizes in acceptable range.
- Secondary heat sink restored.

FAILURE IMPACT
- Transition to feed and bleed (Actions OB1, OB2).

TIME CONSTRAINTS
- Approximately 30 minutes to steam generator WR level < 25%, which requires transition to feed and bleed.

Table B-10 (Page 28 of 47). Qualitative Descriptions of Dynamic Human Actions

HAOS1: Align ECCS to Protect Core, Given ESFAS Fails Following a LOCA Break larger Than 2-Inch Diameter Hole

PRECEDING EVENTS
- Reactor/turbine trip from full power.
- RCCAs fully inserted and neutron flux decreasing.
- Output relay of logic cards fails both trains of ESFAS.

INDICATIONS OF PLANT CONDITION
- Pressurizer pressure < 1,870 psig and decreasing.
- Containment pressure > 3 psid and increasing.
- Containment radiation increasing.
- AFW, ECCS, and CS in standby.
- Shutdown boards energized from offsite power and no diesel generator running.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- E-0, steps (this action and concurrent actions).
- Start align, and verify operation of at least one train of ECCS.
- Start and align AFW.
- Manually align Phase A and B containment isolation alignment.

CONCURRENT ACTIONS/COMPETING FACTORS
- Verify containment spray pumps running.
- Verify CCS and ERCW pumps running.
- Verify MFW isolation.
- Emergency start diesel generators.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- At least one train of ECCS injecting into core.
- At least one train Phase A containment isolation.
- At least one train CS in service.

FAILURE IMPACT
- Core uncovers.
- Loss of containment integrity

TIME CONSTRAINTS
- SI: Approximately one minute from time of break (LLOCA) to mitigate cladding failure and regain containment integrity.
- AFW: Tens of minutes to prevent S/G from boiling dry.
- Containment Isolation: Assume one hour.

Table B-10 (Page 29 of 47). Qualitative Descriptions of Dynamic Human Actions

HAOS2: Align ECCS to Protect Core, Given ESFAS Fails Following a LOCA Break less Than 2-Inch Diameter Hole

PRECEDING EVENTS
- Reactor/turbine trip from full power.
- RCCAs fully inserted and neutron flux decreasing.
- Output relay of logic cards fails both trains of ESFAS.

INDICATIONS OF PLANT CONDITION
- Pressurizer pressure < 1,870 psig and decreasing.
- Containment pressure > 3 psig and increasing.
- Containment radiation increasing.
- AFW, ECCS, and CS in standby.
- Shutdown boards energized from offsite power and no diesel generator running.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- E-0, steps (this action and concurrent actions).
- Start align, and verify operation of at least one train of ECCS.
- Start and align AFW.
- Manually align Phase A and B containment isolation alignment.

CONCURRENT ACTIONS/COMPETING FACTORS
- Verify containment spray pumps running.
- Verify CCS and ERCW pumps running.
- Verify MFW isolation.
- Emergency start diesel generators.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- At least one train of ECCS injecting into core.
- At least one train Phase A containment isolation.
- At least one train CS in service.

FAILURE IMPACT
- Core uncovers.
- Loss of containment integrity.

TIME CONSTRAINTS
- SI: Approximately 30 minutes from time of break (SLOCA) to mitigate cladding failure and regain containment integrity.
- AFW: Tens of minutes to prevent S/G from boiling dry
- Containment Isolation: Assume one hour.

Table B-10 (Page 30 of 47). Qualitative Descriptions of Dynamic Human Actions

HAOS3: Manually Start AFW, Given Reactor Trip Not Requiring Initiation of Safety Injection

PRECEDING EVENTS

- Reactor/turbine trip from full power.
- RCCAs fully inserted and neutron flux decreasing.
- Verified safety injection not required and transitioned to ES-0.1.

INDICATIONS OF PLANT CONDITION

- Pressurizer press < 2,200 psig, and stable.
- Containment pressure normal.
- Containment radiation normal.
- Steam generator level <33% and decreasing.
- AFW, ECCS, and CS in standby.
- Shutdown boards energized from offsite power and no diesel generator running.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- ES 0.1 step 4, 6.
- Recognize conditions requiring actuation of AFW.
- Manually actuate AFW.

CONCURRENT ACTIONS/COMPETING FACTORS

- Immediate actions.
- Checking T_{avg}.
- Verify MFW isolation.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- Steam generator level stabilized.

FAILURE IMPACT

- If AFW or MFW can not be established go to FR-H.1 (OB1).
- High pressure transient and safety injection actuation if steam generator dries out.

TIME CONSTRAINTS

- Approximately 45 minutes before steam generator dryout.

Table B-10 (Page 31 of 47). Qualitative Descriptions of Dynamic Human Actions

HAOS4: Start AFW, Given ATWS with AMSAC Failure

PRECEDING EVENTS
- Condition requiring turbine trip and MFW isolation from full power.
- Turbine trips as required.
- RCCAs fail to insert, leaving reactor at 100% power.

INDICATIONS OF PLANT CONDITION
- Pressurizer pressure > 2,500 psig, and increasing.
- Containment pressure normal.
- Containment radiation normal.
- S/G level <8% NR and decreasing.
- AFW, ECCS, and CS in standby.
- Shutdown boards energized from offsite power and no diesel generator running.
- PRT level, pressure, and temperature rising.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- FR-S.1, step 3,7.
- Recognize conditions requiring actuation of AFW.
- Manually actuate AFW.

CONCURRENT ACTIONS/COMPETING FACTORS
- FR-S.1, steps 1-4 and 1-5 to shut down reactor.
- Addressing threat to pressure boundary.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Steam generator level stabilized > 25% and < 50%.
- Steam generator pressure stable or increasing.

FAILURE IMPACT
- Steam generator dryout and loss of adequate heat sink.
- Excessive RCS overpressure resulting in core damage (vessel break, LLOCA).

TIME CONSTRAINTS
- One minute to steam generator dryout.

Table B-10 (Page 32 of 47). Qualitative Descriptions of Dynamic Human Actions

HAOS5: Backup Restart Timers, Given LOSP with Diesel Generator Startup

PRECEDING EVENTS

- Loss of offsite grid and power.
- Reactor/turbine trip from full power assumed to result.
- RCCAs fully inserted and neutron flux decreasing.
- One CCP out of service for maintenance.
- Normally running CCP failed to restart following D/G startup.

INDICATIONS OF PLANT CONDITION

- Pressurizer press < 2,200 psig, and stable.
- Containment pressure normal.
- Containment radiation normal.
- Steam generator level <33% and decreasing.
- CCP, AFW, ECCS, and CS in standby.
- Shutdown boards energized and all diesel generators running.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- E-0, steps 3-12 (this action and concurrent actions), ES 0.1 step 4, 6.
- Check safety injection actuated.
- Verify safety injection not required.
  - Evaluate situation.
  - Start pump.
  - Maintain diesel generator loading sequence per AOI-35.
- Recognize conditions and actuate CCP.

CONCURRENT ACTIONS/COMPETING FACTORS

- Verify MFW isolation.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- Able to maintain high pressure injection.

FAILURE IMPACT

- Steam generator dryout.
- Safety injection signal.

TIME CONSTRAINTS

- Approximately 1 hour before steam generator dryout.

Table B-10 (Page 33 of 47). Qualitative Descriptions of Dynamic Human Actions

HAOT1: Place Containment Spray in Standby and Reset Signal

PRECEDING EVENTS
- Reactor/turbine trip and ESFAS actuation resulting from a small LOCA.
- Containment Phase B isolation has initiated and containment spray pumps are running (CS1 successful).

INDICATIONS OF PLANT CONDITION
- Containment pressure has decreased to 1.9 psig.
- Containment sump level rising.
- RWST level decreasing.
- RCPs stopped on Phase B and Natural Circulation established.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- E-1, step 8 (should be a flagged continuous action step).
- Check containment pressure less than (containment spray signal reset pressure).
- Place containment spray pumps in standby.

CONCURRENT ACTIONS/COMPETING FACTORS
- Monitoring status trees for higher priority actions.
- Monitoring RCS level and pressure.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- RWST level maintained.
- Sump level increases at lower rate.

FAILURE IMPACT
- Earlier requirement for RHR and spray swapover.

TIME CONSTRAINTS
- Within 5 minutes of pressure reduction to permissible level.

Table B-10 (Page 34 of 47). Qualitative Descriptions of Dynamic Human Actions

HAPI1,HAPR1: Isolate Open PORV by Closing Block Valve After SI Actuated

PRECEDING EVENTS
- Pressure increases and peaks on PORV opening.
- E-0 verified ESFAS actuation.

INDICATIONS OF PLANT CONDITION
- RCS pressure decreasing.
- Subcooling < 40°F and decreasing.
- PORV acoustic monitor alarms and indication of open.
- PORV tailpipe temp increasing.
- PRT temp, pressure and level increasing.
- PORV open/close indicating — RED.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- E-0, step 15.
- Recognize need based on indications and move switch to "CLOSE".

CONCURRENT ACTIONS/COMPETING FACTORS
- E-0 immediate actions.
- Not monitoring alarms during immediate actions.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Pressure stabilized.
- Subcooling recovered.

FAILURE IMPACT
- LOCA superimposed on transient.
- Rupture of PRT rupture disk leading to
  - Containment spray initiation.
  - Sump recirculation required.

TIME CONSTRAINTS
- LOCA conditions - assume PRT disk ruptures approximately 5 minutes after PORV fails to close.
- Once need is recognized action can be done in seconds.

Table B-10 (Page 35 of 47). Qualitative Descriptions of Dynamic Human Actions

HAPR2: Isolate Open PORV by Closing Block Valve Prior to SI Activation

PRECEDING EVENTS
- Reactor/turbine trip from full power.
- Primary pressure increase terminated by PORVs.

INDICATIONS OF PLANT CONDITION
- RCS pressure decreasing - alarm RCS pressure.
- Subcooling < 40°F and decreasing.
- PORV acoustic monitor alarms and indication of open.
- PORV tailpipe temp increasing.
- PRT temperature, pressure and level increasing.
- PORV open/close indicating — RED.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- ES-0.1, step 8.
- Recognize need based on indications.
- Identify stuck open PORV and move block valve switch to "CLOSE."

CONCURRENT ACTIONS/COMPETING FACTORS
- Must transition from E-0 immediate actions.
- Not monitoring alarms during immediate actions.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Pressure stabilized.
- Subcooling recovered.

FAILURE IMPACT
- Safety injection actuation signal if pressure < 1,870 psig.
- LOCA superimposed on transient if not caught at all.
- Rupture of PRT rupture disk leading to
  - Containment spray initiation.
  - Sump recirculation required.

TIME CONSTRAINTS
- Safety injection actuation in approx 30 seconds.
- Assume PRT disk ruptures approximately 5 minutes after PORV fails to close.
- Once need is recognized action can be done in seconds.

Table B-10 (Page 36 of 47). Qualitative Descriptions of Dynamic Human Actions

HARD1: Place RHR in Service Following a Steam Generator Tube Rupture

PRECEDING EVENTS

- Ruptured steam generator successfully isolated (SL1).
- Safety injection has been terminated following the SGTR per ES-3.1.
- Depressurization and cooldown in progress.
- ES-3.2 has been performed through step 12 (balancing steam generator, pressurizer levels and subcooling as RCS temperature and pressure decline) (DS1).
- No other failures have occurred.

INDICATIONS OF PLANT CONDITION

- RCS temperature < 350°F and pressure < 380 psig.
- RHR system in standby/available.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- ES-3.2, step 13 per SOI-74.1; also ES-3.3, step 15.
- Align valves correctly.
- Verify RHR is warmed to same temperature as RCS.
- Ensure RHR boron concentration > RCS boron concentration.

CONCURRENT ACTIONS/COMPETING FACTORS

- Cooldown of ruptured steam generator by backfill in progress.
- Must maintain RCS pressure ≤ ruptured steam generator pressure.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- RHR in service on cooldown.
- RCS depressurized to limit leakage to steam generator.

FAILURE IMPACT

- Depressurization of RCS to minimize/stop leakage is delayed.
- RWST makeup required (action MU1).
- Boration of RCS required.

TIME CONSTRAINTS

- Not time sensitive. Approximately 2 hours after RHR entry conditions reached until RWST makeup required.

Table B-10 (Page 37 of 47). Qualitative Descriptions of Dynamic Human Actions

HARE1: Shed DC Bus Loads or 120 VAC loads, Given Loss of All AC Power

PRECEDING EVENTS

- Loss of offsite power resulting in a unit trip from full power.
- Emergency diesel generators fail to start on Unit 1
- D/Gs on other units start.
- Emergency procedures are implemented and the operators have transitioned to ECA-0.0 "Loss of Shutdown Power."
- Air compressors fed from other unit are restarted.

INDICATIONS OF PLANT CONDITION

- No AC power.
- DC instrumentation available.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- ECA-0.0 directs the operators to:
  1. Try to restore power to the shutdown boards — refer to AOI-35.
  2. Shed nonessential DC loads.
- Determine the cause(s) of the power loss and initiate actions necessary to restore voltage to the shutdown boards from the emergency diesel generators or an offsite source.
- Evaluate DC loads and open the breakers supplying the unnecessary loads.

CONCURRENT ACTIONS/COMPETING FACTORS

- Emergency actions to maintain core cooling.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- Maintenance of DC power maintained until return of AC power.

FAILURE IMPACT

- Earlier loss of steam generator level instrumentation, resulting in loss of steam generator control.

TIME CONSTRAINTS

- At least 2 hours before batteries are depleted under full load conditions.

Table B-10 (Page 38 of 47). Qualitative Descriptions of Dynamic Human Actions

HARE2: Restore RHR Sump Recirculation by Manually Opening FCV-63-72 and FCV-63-73

PRECEDING EVENTS

- Small break LOCA is in progress with all ESF equipment operating as designed.
- RWST level has reached 20% and containment sump level is 42%.
- Automatic transfer to containment sump has not occurred and actions taken from the control room and the reactor MOV boards fail to open FCV-63-72 or FCV-63-73.
- Electrical logic drawings indicate that all interlocks required to open the valves are satisfied.

INDICATIONS OF PLANT CONDITION

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- Contact the TSC.
- Initiate action to remove the bolts from the sump valve hatches and open the hatches to allow manual operation of the valves. After access is gained to the valve hatch, the operators are required to manually open the valves, complete transfer to containment sump operations, and monitor proper operation of ESF equipment.

CONCURRENT ACTIONS/COMPETING FACTORS

- This action requires coordination with maintenance, radcon, operations, and plant management.
- Authorization to exceed radiation dose limits may also be required from the site emergency director.
- At RWST <8% stop any pumps taking suction from the RWST.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- Recirculation achieved.

FAILURE IMPACT

- Core damage.
- High radiation doses to operators in the area.

TIME CONSTRAINTS

- Estimate: 45 minutes after switchover fails.

Table B-10 (Page 39 of 47). Qualitative Descriptions of Dynamic Human Actions

HARH1: Transfer to Hotleg Recirculation, Given LOCA > 2-Inch Diameter

PRECEDING EVENTS
- Large LOCA with successful ECCS initiation and short term functioning.
- ECCS transferred to containment sump.
- Core cooling successful for first 12 hours since LOCA initiating event.

INDICATIONS OF PLANT CONDITION
- RCS boron concentration decreasing.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- ES-1.2, step 10; ES-1.3.
- Align RHR train A or B for hot leg recirculation.
- Align safety injection pumps for hot leg recirculation.
- Verify system alignment and status.

CONCURRENT ACTIONS/COMPETING FACTORS
- Maintain a 12 hour continuous action step.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Hot leg flow indicated for RHR (FI-63-173).
- Hot leg flow indicated for safety injection trains A and B (FI-63-151 and FI-63-20).

FAILURE IMPACT
- Flow blockage from boron precipitate, resulting in core damage.
- Core exit boiling.

TIME CONSTRAINTS
- Not time sensitive. Action required before blockage occurs.

Table B-10 (Page 40 of 47). Qualitative Descriptions of Dynamic Human Actions

HARR1: Align High Pressure Recirculation, Given Automatic Swapover Succeeds

PRECEDING EVENTS
- Small break LOCA has occurred.
- ECCS successfully initiated.
- Immediate actions successfully completed along with E-1 through step 23.

INDICATIONS OF PLANT CONDITION
- RHR pumps taking suction from containment sump.
- Containment spray is operating.
- CCPs and SIPs suction indication from RWST.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- ES-1.1 transition to ES-1.2 at RWST < 29%.
- ES-1.2.
- Verify RHR switchover. (This includes restarting RHR pumps if they were shut down due to RCS high pressure during injection mode.)
- Align CCP and SIP suction to RHR pump discharge.
- Isolate suction and recirculation paths from RWST.
- Verify alignment with checklist.

CONCURRENT ACTIONS/COMPETING FACTORS
- Low-low RWST alarm: immediately stop pumps taking suction from RWST.
- Establish ERCW to containment spray heat exchangers.
- Continuous actions per ES-1.2 Appendix A.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Proper alignment and operating indications from RHR, containment spray.

FAILURE IMPACT
- Loss of RHR recirculation.
- Loss of containment cooling.

TIME CONSTRAINTS
- Stop pumps before RWST goes dry (approximately 10 minutes at 29% level with spray pumps running.
- Approximately 20 from swapover to core uncovery if swapover not completed.

Table B-10 (Page 41 of 47). Qualitative Descriptions of Dynamic Human Actions

HARR2: Align High Pressure Recirculation, Given Automatic Swapover Fails

PRECEDING EVENTS
- Small break LOCA has occurred.
- ECCS successfully initiated.
- Immediate actions successfully completed along with E-1 through step 23.

INDICATIONS OF PLANT CONDITION
- All ECCS pumps in service are still taking suction from RWST.
- RWST level indication decreasing and approaching 25%.
- Containment sump level 12% and increasing.
- Containment spray is operating.
- RED lights on hand switches for green lights FCV-74-21.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- ES-1.2; E-1, step 26.
- Verify RHR switchover.
- Recognize FCV-63-72/73 fail-to-open (GREEN).
- Remotely manually align FCV-63-72/73, verify (RED lights).
- Verify FCV-74-3/21 closing (GREEN lights).
- Align CCP and SIP suction to RHR pump discharge.
- Isolate suction and recirculation paths from RWST.
- Verify alignment with checklist.

CONCURRENT ACTIONS/COMPETING FACTORS
- Low-low RWST alarm: immediately stop pumps taking suction from RWST.
- Establish ERCW to containment spray heat exchangers.
- Continuous actions per ES-1.2 Appendix A.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Proper alignment and operating indications from RHR, containment spray.

FAILURE IMPACT
- Loss of RHR recirculation.
- Loss of containment cooling.

TIME CONSTRAINTS
- Stop pumps before RWST goes dry (approximately 10 minutes at 29% level with spray pumps running.
- Approximately 20 minutes from swapover to core uncovery if swapover not completed.

Table B-10 (Page 42 of 47). Qualitative Descriptions of Dynamic Human Actions

HARS1: Place RHR Spray in Service, Given More Than 1 hour into Event and Containment Pressure High

PRECEDING EVENTS

- Small break LOCA has occurred.
- E-0 completed and transition to E-1.
- 1.5 hours into event.
- Containment pressure has been rising at increasing pace.

INDICATIONS OF PLANT CONDITION

- Containment pressure — 10 psig.
- CCPs and safety injection pumps in service.
- RHR suction aligned to containment sump.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- FR-Z.1, step 10.
- Place one train of RHR in service, train B preferred.

CONCURRENT ACTIONS/COMPETING FACTORS

- Continuous action steps of FR-Z.1 if conditions not met.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- Containment pressure declines.

FAILURE IMPACT

- Containment failure.

TIME CONSTRAINTS

- Tens of minutes available before pressure threatens containment integrity.

Table B-10 (Page 43 of 47). Qualitative Descriptions of Dynamic Human Actions

HART1: Manually Trip Reactor, Given That SSPS Fails

PRECEDING EVENTS
- Condition requiring reactor trip; e.g., loss of a reactor coolant pump.
- Reactor first out panel annunciates.

INDICATIONS OF PLANT CONDITION
- Alarms associated with condition requiring trip.
- Bottom lights - OFF.
- Reactor trip breakers - CLOSED.
- Reactor power level - 100%.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- E-0, step 1.
- Recognize situation.

CONCURRENT ACTIONS/COMPETING FACTORS
- Immediate action upon alarms.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Bottom lights - ON.
- Reactor trip breakers - OPEN.
- Reactor power level < 5%.

FAILURE IMPACT
- Transition to ATWS.

TIME CONSTRAINTS
- Within one minute of requirement to trip.

Table B-10 (Page 44 of 47). Qualitative Descriptions of Dynamic Human Actions

HASE1: Stop RCPs on Phase B Isolation, Given a Non-LOCA Initiator; e.g., Steam Line Break

PRECEDING EVENTS
- Reactor/turbine trip at full power.
- ECCS actuated.

INDICATIONS OF PLANT CONDITION
- Containment press > 3 psig and increasing.
- Phase B isolation actuated.
- Containment radiation steady.
- #3 steam generator 250 psig below other 3 and decreasing.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- E-0, step 24; E-FOP, RCP Trip Criteria; E-1 step 1, FR-Z.1 E-0 step 18.
- Recognize phase B signal present.
- Stop all RCPs.

CONCURRENT ACTIONS/COMPETING FACTORS
- E-2 faulted steam generator isolation.
- E-0 immediate actions and verification of immediate actions.
- Verify containment spray initiation.
- Establish natural circulation.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Containment radiation remains steady.

FAILURE IMPACT
- RCP bearing failure loss of RCPs.
- Seal LOCA initiated in addition to main steam line break.

TIME CONSTRAINTS
- Estimate that RCPs can run 2 minutes prior to seal damage.

Table B-10 (Page 45 of 47). Qualitative Descriptions of Dynamic Human Actions

HASE2: Stop RCPs on Loss of Train A CCS or RCP Cooling Path

PRECEDING EVENTS
- Reactor power 100% with all systems initially normal.

INDICATIONS OF PLANT CONDITION
- Low CCS surge tank level alarm.
- Reactor building CCS supply header flow high, return header off scale low.
- RCP oil coolers indicate no CCS flow.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- AOI-15, steps 1-4.
- Recognize condition.
- Isolate leak and maintain flow.
- Ensure reactor trip per AOI-15, Section 3.6.
- Stop all RCPs.

CONCURRENT ACTIONS/COMPETING FACTORS
- E-0 immediate actions.
- Establish natural circulation.
- Other equipment supported by CCS also impacted and requires attention.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Containment radiation remains steady.

FAILURE IMPACT
- RCP bearing failure — loss of RCPs.
- Seal LOCA initiated in addition to current transient.

TIME CONSTRAINTS
- RCPs can run at least 10 minutes after loss of CCS without damage.

Table B-10 (Page 46 of 47). Qualitative Descriptions of Dynamic Human Actions

HASL1: Identify and Isolate Ruptured Steam Generator

PRECEDING EVENTS

- Reactor/turbine trip from full power.
- Auto SI initiation due to low RCS pressure <1,870 psig.

INDICATIONS OF PLANT CONDITION

- Containment conditions normal.
- AFW available.
- #1 steam generator level increasing.
- MFW to #1 steam generator decreasing.
- Loop #1 radiation monitor indicates higher radiation levels than other loops by a factor of 10.
- Pressurizer level decreasing uncontrolled

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- E-0 step 20;E-3 step 4.
- Recognize steam generator tube rupture event and identify #1 steam generator.
- Isolate ruptured steam generator (close MSIV, MSIV bypass, and steam generator blowdown valves).
- Isolate AFW if >10% narrow range level.
- Transfer turbine-driven AFW pump steam supply to #4 steam generator.
- Verify steam generator PORVs closed when steam generator pressure < 1,125 psig (set controller to 86%).

CONCURRENT ACTIONS/COMPETING FACTORS

- In REP.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

- MSIV, MSIV bypass valves and steam generator blowdown valves indicate closed.
- #1 steam generator level increase slows.

FAILURE IMPACT

- Steam generator overfill.
- Water relief through steam generator PORVs or safety valves.
- Fill steam lines with water.

TIME CONSTRAINTS

- Assume 50 minutes to steam generator overfill, given offset rupture of one tube.

Table B-10 (Page 47 of 47). Qualitative Descriptions of Dynamic Human Actions

HAWC1: Control Safety Injection to prevent water challenge to pressurizer PORVs

PRECEDING EVENTS
- Reactor/turbine trip and ESFAS actuation at full power.
- The operators have correctly identified and isolate a faulted #3 steam generator.
- #3 steam generator has boiled dry.

INDICATIONS OF PLANT CONDITION
- Containment pressure and radiation levels normal.
- All safety injection termination criteria exists.
- Pressurize level is increasing rapidly.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Verify safety injection termination criteria met.
- E-1, step 11.
- ES-0.2 (E-1, step 12).
  Stop safety injection pumps, RHR pumps, 1 CCP.
- Verify ECCS not required — pressurizer level > 20%, subcooling > 740°F.
- Establish normal charging.
- Establish letdown.

CONCURRENT ACTIONS/COMPETING FACTORS
- Control cooldown.
- Monitor status trees.
- Avoid FR-P.1 if possible.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- Pressurizer level: stable or decreasing.
- RCS pressure: stable or increasing.

FAILURE IMPACT
- Water challenge through pressurizer PORVs.

TIME CONSTRAINTS
- Safety injection must be terminated prior to the pressurizer going solid water to prevent a water challenge to the pressurizer PORVs and a possible cold overpressure condition.
- Dependent on fill rate. Assume no more than 5 minutes to recognize and react.

Table B-11 (Page 1 of 3). Raw Weights and Scores of Actions Evaluated by the Three Groups of Licensed Watts Bar Operators

WBN Group 1 Human Action Evaluations - Raw Weights

ID	Actions		Interface		Time		Procedure		Complex		Training		Stress		Tot
Code	W	S	W	S	W	S	W	S	W	S	W	S	W	S	Wgt
AC1	4	6	2	2	2	7	2	1	2	2	2	1	2	3	16
AC2	3	3	2	4	2	3	2	3	2	4	2	9	2	4	15
AE1	2	3	2	0	2	1	0	0	4	1	2	1	2	4	14
AE2	3	8	2	7	2	6	2	6	3	7	2	6	2	7	16
AF1	4	7	2	9	3	6	2	1	4	10	2	4	4	9	21
CH1	2	3	2	2	2	3	2	0	2	2	2	2	2	2	14
CH2	4	7	2	5	4	7	2	1	2	2	2	1	2	4	18
CI1	4	8	2	5	2	1	2	10	4	8	2	9	2	6	18
CS1	4	5	2	2	2	4	2	1	2	2	2	5	2	5	16
CT1	2	7	2	5	2	1	2	1	2	5	2	1	2	0	14
DS1	2	2	2	2	2	2	2	2	2	6	2	4	2	4	14
DS2	2	5	2	2	2	1	2	0	2	5	2	4	2	2	14
DS3	3	5	2	6	2	2	2	2	2	6	2	6	2	4	15
DS4	4	5	2	8	4	9	2	1	4	9	2	2	2	10	20
DS5	4	7	2	8	4	10	2	1	4	10	2	2	2	10	20
DS6	4	7	3	9	3	10	2	2	4	10	2	2	3	10	21
DS7	3	5	2	2	2	5	2	1	2	6	2	2	2	5	15
EB1	2	0	2	8	4	7	2	0	4	9	3	2	2	5	19
HH1	2	5	2	7	2	2	2	0	2	2	2	5	2	4	14
MR1	2	0	2	2	4	10	2	1	2	2	2	1	2	4	16
MU1	3	8	2	8	2	1	2	4	2	6	2	6	2	2	15
MU2	2	4	2	8	4	10	1	8	2	9	4	6	2	9	17
MU3	2	7	2	8	4	F	1	9	1	9	4	9	4	10	18
OB1	4	5	2	3	2	5	2	1	2	5	2	5	3	8	17
OF1	2	5	2	7	3	5	1	7	4	9	3	7	2	5	17
OF2	2	7	2	7	3	6	1	2	4	9	3	7	2	5	17
OS1	2	8	2	8	4	6	4	5	2	8	4	7	3	8	21
OS2	2	8	2	8	4	6	4	5	2	8	4	7	3	8	21
OS3	2	3	2	2	2	2	2	2	2	2	2	2	2	2	14
OS4	4	7	2	3	4	9	2	3	2	2	2	3	2	5	18
OS5	4	8	4	8	4	10	1	10	4	8	4	9	4	8	25
OT1	3	5	2	2	1	1	2	0	2	2	2	1	2	4	14
PR1	4	8	2	3	4	4	3	0	2	2	2	1	2	5	19
PR2	3	8	2	3	4	9	3	0	2	2	2	1	2	6	18
RD1	3	5	2	6	2	1	2	4	4	7	2	8	2	5	17
RE1	4	8	2	8	2	5	1	8	3	8	2	7	3	6	17
RE2	2	8	2	7	4	F	2	10	4	10	2	10	4	10	20
RH1	2	3	2	2	2	2	2	0	2	2	2	6	2	4	14
RR1	4	3	2	2	2	5	2	0	2	2	2	1	2	4	16
RR2	2	6	2	2	3	5	2	3	2	4	2	8	2	5	15
RS1	2	4	2	2	2	5	2	0	2	2	2	5	2	4	14
RT1	1	4	2	2	3	7	0	0	4	2	4	0	2	0	16
SE1	4	7	2	9	4	7	2	0	2	2	4	1	2	4	20
SE2	4	6	2	9	4	10	2	5	4	8	2	8	2	6	20
SL1	2	2	2	1	3	5	2	1	2	5	3	1	2	4	16
WC1	2	5	2	3	4	6	2	2	2	3	2	1	2	4	16

* Each action identifier code is preceded by an "HA" in the basic event database.

Table B-11 (Page 2 of 3). Raw Weights and Scores of Actions Evaluated by the Three Groups of Licensed Watts Bar Operators

WBN Group 2 Human Action Evaluations - Raw Weights

ID	Actions		Interface		Time		Procedure		Complex		Training		Stress		Tot
Code	W	S	W	S	W	S	W	S	W	S	W	S	W	S	Wgt
AC1	4	7	4	0	2	4	2	0	2	0	2	5	4	8	20
AC2	4	8	4	0	4	7	2	8	4	7	4	9	4	8	26
AE1	4	8	2	0	2	3	2	0	2	0	2	5	2	4	16
AE2	4	10	4	9	4	10	4	10	4	10	4	10	4	10	28
AF1	2	10	2	8	4	10	2	6	2	9	4	7	4	10	20
CH1	2	5	2	2	2	3	2	0	2	2	2	4	2	2	14
CH2	4	9	2	2	2	3	2	0	2	0	2	4	4	8	18
CI1	0	9	4	8	4	7	4	5	4	9	4	9	4	10	24
CS1	2	8	4	2	2	3	2	0	2	0	4	5	2	5	18
CT1	2	8	2	2	1	2	2	0	1	0	2	2	2	5	12
DS1	2	3	4	2	1	0	4	3	2	8	4	7	2	4	19
DS2	2	3	4	2	1	0	4	2	2	7	4	7	2	4	19
DS3	2	3	4	1	2	5	1	10	4	7	4	9	4	8	21
DS4	2	5	4	2	2	5	4	5	2	8	4	7	4	8	22
DS5	2	8	4	2	2	7	1	10	4	7	4	9	4	8	21
DS6	4	8	4	8	4	10	2	2	4	9	4	7	4	10	26
DS7	4	9	4	2	2	3	1	10	4	7	4	9	4	8	23
EB1	1	8	4	2	2	5	2	7	2	8	4	4	4	8	19
HH1	4	5	2	5	2	3	2	0	2	0	2	5	2	5	16
MR1	1	8	2	8	2	5	2	7	2	0	4	7	4	8	17
MU1	4	9	2	8	2	0	4	1	4	8	4	9	2	5	22
MU2	4	9	2	2	4	F	4	0	4	8	2	6	4	10	24
MU3	4	9	2	2	4	F	4	8	4	9	4	10	4	10	26
OB1	4	9	4	8	4	8	2	5	2	2	4	8	4	8	24
OF1	2	8	4	2	2	5	2	7	4	8	4	4	2	6	20
OF2	4	8	4	2	2	7	2	6	4	9	4	9	4	8	24
OS1	4	10	4	2	4	7	2	0	4	7	2	9	4	8	24
OS2	4	10	4	2	4	5	2	0	4	7	2	9	4	6	24
OS3	4	8	2	2	2	3	2	0	2	0	2	7	2	5	16
OS4	4	9	4	2	4	7	4	0	2	0	4	5	4	8	26
OS5	4	10	4	9	2	5	4	0	2	4	4	7	4	10	24
OT1	1	3	2	2	2	1	4	0	2	2	2	5	2	5	15
PR1	2	8	4	0	4	3	2	0	1	0	1	5	2	8	16
PR2	2	8	4	5	4	7	2	0	1	0	1	5	4	8	18
RD1	2	4	4	2	2	3	2	0	2	0	4	2	2	5	18
RE1	4	9	4	10	4	10	4	8	4	7	4	9	4	10	28
RE2	4	10	4	9	4	F	4	0	4	9	4	8	4	10	28
RH1	2	5	2	2	2	3	2	0	2	2	2	7	2	5	14
RR1	2	5	4	2	4	7	4	0	2	0	4	4	2	5	22
RR2	4	10	4	8	4	10	4	0	4	8	4	7	4	8	28
RS1	2	5	2	2	2	3	2	0	2	2	2	7	4	8	16
RT1	1	3	4	0	2	5	2	7	0	5	4	2	4	5	17
SE1	2	7	2	5	4	7	0	7	0	2	2	5	2	8	12
SE2	2	3	4	8	4	5	4	2	1	7	4	3	2	6	21
SL1	2	3	4	2	2	3	4	6	2	2	4	1	2	4	20
WC1	4	5	4	2	4	7	4	9	2	5	2	7	4	8	24

* Each action identifier code is preceded by an "HA" in the basic event database.

Table B-11 (Page 3 of 3). Raw Weights and Scores of Actions Evaluated by the Three Groups of Licensed Watts Bar Operators

WBN Group 3 Human Action Evaluations - Raw Weights

ID	Actions		Interface		Time		Procedure		Complex		Training		Stress		Tot
Code	W	S	W	S	W	S	W	S	W	S	W	S	W	S	Wgt
AC1	4	7	4	8	2	6	1	7	0	1	1	1	2	6	14
AC2	2	6	2	8	2	5	2	3	4	8	2	5	2	5	16
AE1	2	8	2	2	2	3	1	0	1	1	1	4	2	5	11
AE2	4	10	4	8	2	7	2	3	4	9	2	10	2	8	20
AF1	2	8	2	8	1	3	2	5	4	9	2	3	4	9	17
CH1	2	3	2	2	1	3	2	2	1	2	2	1	2	4	12
CH2	2	3	2	2	2	5	2	4	1	2	2	1	2	4	13
CI1	2	9	1	8	2	5	4	3	1	9	2	7	4	9	16
CS1	2	7	2	5	2	5	1	2	1	4	1	3	2	5	11
CT1	0	1	0	2	2	5	1	5	0	1	2	4	2	5	7
DS1	2	5	2	7	0	1	2	3	2	8	2	4	2	4	12
DS2	2	5	2	7	1	4	2	3	2	8	2	3	2	4	13
DS3	2	5	2	7	2	5	2	3	2	8	2	3	2	5	14
DS4	2	5	2	8	2	5	2	3	2	8	2	3	2	6	14
DS5	2	5	2	8	2	5	2	3	2	8	2	3	2	6	14
DS6	2	8	4	8	1	3	2	3	4	9	2	3	4	9	19
DS7	2	8	4	8	2	7	2	3	4	8	2	3	2	6	18
EB1	2	5	4	8	4	8	2	7	4	9	2	4	2	6	20
HH1	2	7	2	5	1	2	2	0	0	2	1	4	2	4	10
MR1	2	5	2	2	4	5	0	0	1	2	0	4	2	5	11
MU1	2	7	2	8	1	3	2	5	4	9	2	8	2	5	15
MU2	2	8	2	8	4	8	2	5	4	9	2	5	4	8	20
MU3	2	8	2	9	4	7	1	5	4	9	2	6	4	8	19
OB1	1	5	2	2	2	5	4	2	2	5	2	2	2	7	15
OF1	1	5	2	8	4	7	2	5	2	8	2	4	2	6	15
OF2	1	5	2	8	4	7	2	5	2	9	2	4	2	6	15
OS1	4	8	2	5	4	7	2	1	2	2	2	3	2	2	18
OS2	4	8	2	5	2	4	2	1	2	2	2	3	2	2	16
OS3	2	8	2	5	2	3	2	1	2	2	2	3	2	2	14
OS4	2	8	2	5	4	8	2	5	2	2	2	3	2	6	16
OS5	2	8	2	8	4	7	2	6	2	8	2	3	2	6	16
OT1	2	3	1	2	1	4	2	1	1	2	1	4	1	2	9
PR1	0	0	2	2	2	5	2	0	0	2	1	1	2	2	9
PR2	1	3	2	0	4	5	2	0	0	2	1	4	2	6	12
RD1	2	5	2	8	1	5	4	3	4	8	2	7	2	4	17
RE1	2	6	1	8	2	7	1	5	2	8	4	5	2	5	14
RE2	4	8	2	8	2	6	1	5	4	8	1	6	4	9	18
RH1	2	4	0	2	0	5	4	0	2	2	2	8	2	5	12
RR1	2	5	2	2	2	5	2	2	2	2	2	3	2	3	14
RR2	2	7	2	5	2	5	2	3	2	3	2	3	2	4	14
RS1	2	3	2	3	2	4	2	0	2	3	1	8	2	5	13
RT1	1	3	2	2	4	5	0	0	0	2	2	4	1	4	10
SE1	4	7	2	6	4	7	0	0	2	4	1	4	2	5	15
SE2	2	8	4	8	4	7	1	5	1	2	1	2	2	4	15
SL1	2	3	4	4	2	4	2	3	2	5	2	1	2	5	16
WC1	2	5	2	2	2	4	2	1	1	5	2	3	2	5	13

* Each action identifier code is preceded by an "HA" in the basic event database.

Table B-12 (Page 1 of 3). Normalized Weights and Scores of Actions Evaluated by the Three Groups of Licensed Watts Bar Operators

WBN Group 1 Human Action Evaluations - Normalized Weights

ID	Actions		Interface		Time		Procedures		Complex		Training		Stress		FLI
Code	W	S	W	S	W	S	W	S	W	S	W	S	W	S	
AC1	0.25	6	0.13	2	0.13	7	0.13	1	0.13	2	0.13	1	0.13	3	3.50
AC2	0.20	3	0.13	4	0.13	3	0.13	3	0.13	4	0.13	9	0.13	4	4.20
AE1	0.14	3	0.14	0	0.14	1	0.00	0	0.29	1	0.14	1	0.14	4	1.57
AE2	0.19	8	0.13	7	0.13	6	0.13	6	0.19	7	0.13	6	0.13	7	6.81
AF1	0.19	7	0.10	9	0.14	6	0.10	1	0.19	10	0.10	4	0.19	9	7.14
CH1	0.14	3	0.14	2	0.14	3	0.14	0	0.14	2	0.14	2	0.14	2	2.00
CH2	0.22	7	0.11	5	0.22	7	0.11	1	0.11	2	0.11	1	0.11	4	4.56
CI1	0.22	8	0.11	5	0.11	1	0.11	10	0.22	8	0.11	9	0.11	6	7.00
CS1	0.25	5	0.13	2	0.13	4	0.13	1	0.13	2	0.13	5	0.13	5	3.63
CT1	0.14	7	0.14	5	0.14	1	0.14	1	0.14	5	0.14	1	0.14	0	2.86
DS1	0.14	2	0.14	2	0.14	2	0.14	2	0.14	6	0.14	4	0.14	4	3.14
DS2	0.14	5	0.14	2	0.14	1	0.14	0	0.14	5	0.14	4	0.14	2	2.71
DS3	0.20	5	0.13	6	0.13	2	0.13	2	0.13	6	0.13	6	0.13	4	4.47
DS4	0.20	5	0.10	8	0.20	9	0.10	1	0.20	9	0.10	2	0.10	10	6.70
DS5	0.20	7	0.10	8	0.20	10	0.10	1	0.20	10	0.10	2	0.10	10	7.50
DS6	0.19	7	0.14	9	0.14	10	0.10	2	0.19	10	0.10	2	0.14	10	7.76
DS7	0.20	5	0.13	2	0.13	5	0.13	1	0.13	6	0.13	2	0.13	5	3.80
EB1	0.11	0	0.11	8	0.21	7	0.11	0	0.21	9	0.16	2	0.11	5	5.05
HH1	0.14	5	0.14	7	0.14	2	0.14	0	0.14	2	0.14	5	0.14	4	3.57
MR1	0.13	0	0.13	2	0.25	10	0.13	1	0.13	2	0.13	1	0.13	4	3.75
MU1	0.20	8	0.13	8	0.13	1	0.13	4	0.13	6	0.13	6	0.13	2	5.20
MU2	0.12	4	0.12	8	0.24	10	0.06	8	0.12	9	0.24	6	0.12	9	7.76
MU3	0.11	7	0.11	8	0.22	F	0.06	9	0.06	9	0.22	9	0.22	10	FAIL
OB1	0.24	5	0.12	3	0.12	5	0.12	1	0.12	5	0.12	5	0.18	8	4.82
OF1	0.12	5	0.12	7	0.18	5	0.06	7	0.24	9	0.18	7	0.12	5	6.65
OF2	0.12	7	0.12	7	0.18	6	0.06	2	0.24	9	0.18	7	0.12	5	6.76
OS1	0.10	8	0.10	8	0.19	6	0.19	5	0.10	8	0.19	7	0.14	8	6.86
OS2	0.10	8	0.10	8	0.19	6	0.19	5	0.10	8	0.19	7	0.14	8	6.86
OS3	0.14	3	0.14	2	0.14	2	0.14	2	0.14	2	0.14	2	0.14	2	2.14
OS4	0.22	7	0.11	3	0.22	9	0.11	3	0.11	2	0.11	3	0.11	5	5.33
OS5	0.16	8	0.16	8	0.16	10	0.04	10	0.16	8	0.16	9	0.16	8	8.56
OT1	0.21	5	0.14	2	0.07	1	0.14	0	0.14	2	0.14	1	0.14	4	2.43
PR1	0.21	8	0.11	3	0.21	4	0.16	0	0.11	2	0.11	1	0.11	5	3.68
PR2	0.17	8	0.11	3	0.22	9	0.17	0	0.11	2	0.11	1	0.11	6	4.67
RD1	0.18	5	0.12	6	0.12	1	0.12	4	0.24	7	0.12	8	0.12	5	5.35
RE1	0.24	8	0.12	8	0.12	5	0.06	8	0.18	8	0.12	7	0.18	6	7.18
RE2	0.10	8	0.10	7	0.20	F	0.10	10	0.20	10	0.10	10	0.20	10	FAIL
RH1	0.14	3	0.14	2	0.14	2	0.14	0	0.14	2	0.14	6	0.14	4	2.71
RR1	0.25	3	0.13	2	0.13	5	0.13	0	0.13	2	0.13	1	0.13	4	2.50
RR2	0.13	6	0.13	2	0.20	5	0.13	3	0.13	4	0.13	8	0.13	5	4.73
RS1	0.14	4	0.14	2	0.14	5	0.14	0	0.14	2	0.14	5	0.14	4	3.14
RT1	0.06	4	0.13	2	0.19	7	0.00	0	0.25	2	0.25	0	0.13	0	2.31
SE1	0.20	7	0.10	9	0.20	7	0.10	0	0.10	2	0.20	1	0.10	4	4.50
SE2	0.20	6	0.10	9	0.20	10	0.10	5	0.20	8	0.10	8	0.10	6	7.60
SL1	0.13	2	0.13	1	0.19	5	0.13	1	0.13	5	0.19	1	0.13	4	2.75
WC1	0.13	5	0.13	3	0.25	6	0.13	2	0.13	3	0.13	1	0.13	4	3.75

* Each action identifier code is preceded by an "HA" in the basic event database.

Table B-12 (Page 2 of 3). Normalized Weights and Scores of Actions Evaluated by the Three Groups of Licensed Watts Bar Operators

WBN Group 2 Human Action Evaluations - Normalized Weights

ID	Actions		Interface		Time		Procedure		Complex		Training		Stress		FLI
Code	W	S	W	S	W	S	W	S	W	S	W	S	W	S	
AC1	0.20	7	0.20	0	0.10	4	0.10	0	0.10	0	0.10	5	0.20	8	3.90
AC2	0.15	8	0.15	0	0.15	7	0.08	8	0.15	7	0.15	9	0.15	8	6.62
AE1	0.25	8	0.13	0	0.13	3	0.13	0	0.13	0	0.13	5	0.13	4	3.50
AE2	0.14	10	0.14	9	0.14	10	0.14	10	0.14	10	0.14	10	0.14	10	9.86
AF1	0.10	10	0.10	8	0.20	10	0.10	6	0.10	9	0.20	7	0.20	10	8.70
CH1	0.14	5	0.14	2	0.14	3	0.14	0	0.14	2	0.14	4	0.14	2	2.57
CH2	0.22	9	0.11	2	0.11	3	0.11	0	0.11	0	0.11	4	0.22	8	4.78
CI1	0.00	9	0.17	8	0.17	7	0.17	5	0.17	9	0.17	9	0.17	10	8.00
CS1	0.11	8	0.22	2	0.11	3	0.11	0	0.11	0	0.22	5	0.11	5	3.33
CT1	0.17	8	0.17	2	0.08	2	0.17	0	0.08	0	0.17	2	0.17	5	3.00
DS1	0.11	3	0.21	2	0.05	0	0.21	3	0.11	8	0.21	7	0.11	4	4.11
DS2	0.11	3	0.21	2	0.05	0	0.21	2	0.11	7	0.21	7	0.11	4	3.79
DS3	0.10	3	0.19	1	0.10	5	0.05	10	0.19	7	0.19	9	0.19	8	6.00
DS4	0.09	5	0.18	2	0.09	5	0.18	5	0.09	8	0.18	7	0.18	8	5.64
DS5	0.10	8	0.19	2	0.10	7	0.05	10	0.19	7	0.19	9	0.19	8	6.86
DS6	0.15	8	0.15	8	0.15	10	0.08	2	0.15	9	0.15	7	0.15	10	8.15
DS7	0.17	9	0.17	2	0.09	3	0.04	10	0.17	7	0.17	9	0.17	8	6.78
EB1	0.05	8	0.21	2	0.11	5	0.11	7	0.11	8	0.21	4	0.21	8	5.47
HH1	0.25	5	0.13	5	0.13	3	0.13	0	0.13	0	0.13	5	0.13	5	3.50
MR1	0.06	8	0.12	8	0.12	5	0.12	7	0.12	0	0.24	7	0.24	8	6.35
MU1	0.18	9	0.09	8	0.09	0	0.18	1	0.18	8	0.18	9	0.09	5	6.09
MU2	0.17	9	0.08	2	0.17	F	0.17	0	0.17	8	0.08	6	0.17	10	FAIL
MU3	0.15	9	0.08	2	0.15	F	0.15	8	0.15	9	0.15	10	0.15	10	FAIL
OB1	0.17	9	0.17	8	0.17	8	0.08	5	0.08	2	0.17	8	0.17	8	7.42
OF1	0.10	8	0.20	2	0.10	5	0.10	7	0.20	8	0.20	4	0.10	6	5.40
OF2	0.17	8	0.17	2	0.08	7	0.08	6	0.17	9	0.17	9	0.17	8	7.08
OS1	0.17	10	0.17	2	0.17	7	0.08	0	0.17	7	0.08	9	0.17	8	6.42
OS2	0.17	10	0.17	2	0.17	5	0.08	0	0.17	7	0.08	9	0.17	6	5.75
OS3	0.25	8	0.13	2	0.13	3	0.13	0	0.13	0	0.13	7	0.13	5	4.13
OS4	0.15	9	0.15	2	0.15	7	0.15	0	0.08	0	0.15	5	0.15	8	4.77
OS5	0.17	10	0.17	9	0.08	5	0.17	0	0.08	4	0.17	7	0.17	10	6.75
OT1	0.07	3	0.13	2	0.13	1	0.27	0	0.13	2	0.13	5	0.13	5	2.20
PR1	0.13	8	0.25	0	0.25	3	0.13	0	0.06	0	0.06	5	0.13	8	3.06
PR2	0.11	8	0.22	5	0.22	7	0.11	0	0.06	0	0.06	5	0.22	8	5.61
RD1	0.11	4	0.22	2	0.11	3	0.11	0	0.11	0	0.22	2	0.11	5	2.22
RE1	0.14	9	0.14	10	0.14	10	0.14	8	0.14	7	0.14	9	0.14	10	9.00
RE2	0.14	10	0.14	9	0.14	F	0.14	0	0.14	9	0.14	8	0.14	10	FAIL
RH1	0.14	5	0.14	2	0.14	3	0.14	0	0.14	2	0.14	7	0.14	5	3.43
RR1	0.09	5	0.18	2	0.18	7	0.18	0	0.09	0	0.18	4	0.09	5	3.27
RR2	0.14	10	0.14	8	0.14	10	0.14	0	0.14	8	0.14	7	0.14	8	7.29
RS1	0.13	5	0.13	2	0.13	3	0.13	0	0.13	2	0.13	7	0.25	8	4.38
RT1	0.06	3	0.24	0	0.12	5	0.12	7	0.00	5	0.24	2	0.24	5	3.24
SE1	0.17	7	0.17	5	0.33	7	0.00	7	0.00	2	0.17	5	0.17	8	6.50
SE2	0.10	3	0.19	8	0.19	5	0.19	2	0.05	7	0.19	3	0.10	6	4.62
SL1	0.10	3	0.20	2	0.10	3	0.20	6	0.10	2	0.20	1	0.10	4	3.00
WC1	0.17	5	0.17	2	0.17	7	0.17	9	0.08	5	0.08	7	0.17	8	6.17

* Each action identifier code is preceded by an "HA" in the basic event database.

Table B-12 (Page 3 of 3). Normalized Weights and Scores of Actions Evaluated by the Three Groups of Licensed Watts Bar Operators

WBN Group 3 Human Action Evaluations - Normalized Weights

ID	Actions		Interface		Time		Procedure		Complex		Training		Stress		FLI
Code	W	S	W	S	W	S	W	S	W	S	W	S	W	S	
AC1	0.29	7	0.29	8	0.14	6	0.07	7	0.00	1	0.07	1	0.14	6	6.57
AC2	0.13	6	0.13	8	0.13	5	0.13	3	0.25	8	0.13	5	0.13	5	6.00
AE1	0.18	8	0.18	2	0.18	3	0.09	0	0.09	1	0.09	4	0.18	5	3.73
AE2	0.20	10	0.20	8	0.10	7	0.10	3	0.20	9	0.10	10	0.10	8	8.20
AF1	0.12	8	0.12	8	0.06	3	0.12	5	0.24	9	0.12	3	0.24	9	7.24
CH1	0.17	3	0.17	2	0.08	3	0.17	2	0.08	2	0.17	1	0.17	4	2.42
CH2	0.15	3	0.15	2	0.15	5	0.15	4	0.08	2	0.15	1	0.15	4	3.08
CI1	0.13	9	0.06	8	0.13	5	0.25	3	0.06	9	0.13	7	0.25	9	6.69
CS1	0.18	7	0.18	5	0.18	5	0.09	2	0.09	4	0.09	3	0.18	5	4.82
CT1	0.00	1	0.00	2	0.29	5	0.14	5	0.00	1	0.29	4	0.29	5	4.71
DS1	0.17	5	0.17	7	0.00	1	0.17	3	0.17	8	0.17	4	0.17	4	5.17
DS2	0.15	5	0.15	7	0.08	4	0.15	3	0.15	8	0.15	3	0.15	4	4.92
DS3	0.14	5	0.14	7	0.14	5	0.14	3	0.14	8	0.14	3	0.14	5	5.14
DS4	0.14	5	0.14	8	0.14	5	0.14	3	0.14	8	0.14	3	0.14	6	5.43
DS5	0.14	5	0.14	8	0.14	5	0.14	3	0.14	8	0.14	3	0.14	6	5.43
DS6	0.11	8	0.21	8	0.05	3	0.11	3	0.21	9	0.11	3	0.21	9	7.11
DS7	0.11	8	0.22	8	0.11	7	0.11	3	0.22	8	0.11	3	0.11	6	6.56
EB1	0.10	5	0.20	8	0.20	8	0.10	7	0.20	9	0.10	4	0.10	6	7.20
HH1	0.20	7	0.20	5	0.10	2	0.20	0	0.00	2	0.10	4	0.20	4	3.80
MR1	0.18	5	0.18	2	0.36	5	0.00	0	0.09	2	0.00	4	0.18	5	4.18
MU1	0.13	7	0.13	8	0.07	3	0.13	5	0.27	9	0.13	8	0.13	5	7.00
MU2	0.10	8	0.10	8	0.20	8	0.10	5	0.20	9	0.10	5	0.20	8	7.60
MU3	0.11	8	0.11	9	0.21	7	0.05	5	0.21	9	0.11	6	0.21	8	7.74
OB1	0.07	5	0.13	2	0.13	5	0.27	2	0.13	5	0.13	2	0.13	7	3.67
OF1	0.07	5	0.13	8	0.27	7	0.13	5	0.13	8	0.13	4	0.13	6	6.33
OF2	0.07	5	0.13	8	0.27	7	0.13	5	0.13	9	0.13	4	0.13	6	6.47
OS1	0.22	8	0.11	5	0.22	7	0.11	1	0.11	2	0.11	3	0.11	2	4.78
OS2	0.25	8	0.13	5	0.13	4	0.13	1	0.13	2	0.13	3	0.13	2	4.13
OS3	0.14	8	0.14	5	0.14	3	0.14	1	0.14	2	0.14	3	0.14	2	3.43
OS4	0.13	8	0.13	5	0.25	8	0.13	5	0.13	2	0.13	3	0.13	6	5.63
OS5	0.13	8	0.13	8	0.25	7	0.13	6	0.13	8	0.13	3	0.13	6	6.63
OT1	0.22	3	0.11	2	0.11	4	0.22	1	0.11	2	0.11	4	0.11	2	2.44
PR1	0.00	0	0.22	2	0.22	5	0.22	0	0.00	2	0.11	1	0.22	2	2.11
PR2	0.08	3	0.17	0	0.33	5	0.17	0	0.00	2	0.08	4	0.17	6	3.25
RD1	0.12	5	0.12	8	0.06	5	0.24	3	0.24	8	0.12	7	0.12	4	5.71
RE1	0.14	6	0.07	8	0.14	7	0.07	5	0.14	8	0.29	5	0.14	5	6.07
RE2	0.22	8	0.11	8	0.11	6	0.06	5	0.22	8	0.06	6	0.22	9	7.72
RH1	0.17	4	0.00	2	0.00	5	0.33	0	0.17	2	0.17	8	0.17	5	3.17
RR1	0.14	5	0.14	2	0.14	5	0.14	2	0.14	2	0.14	3	0.14	3	3.14
RR2	0.14	7	0.14	5	0.14	5	0.14	3	0.14	3	0.14	3	0.14	4	4.29
RS1	0.15	3	0.15	3	0.15	4	0.15	0	0.15	3	0.08	8	0.15	5	3.38
RT1	0.10	3	0.20	2	0.40	5	0.00	0	0.00	2	0.20	4	0.10	4	3.90
SE1	0.27	7	0.13	6	0.27	7	0.00	0	0.13	4	0.07	4	0.13	5	6.00
SE2	0.13	8	0.27	8	0.27	7	0.07	5	0.07	2	0.07	2	0.13	4	6.20
SL1	0.13	3	0.25	4	0.13	4	0.13	3	0.13	5	0.13	1	0.13	5	3.63
WC1	0.15	5	0.15	2	0.15	4	0.15	1	0.08	5	0.15	3	0.15	5	3.46

* Each action identifier code is preceded by an "HA" in the basic event database.

Table B-13 (Page 1 of 10). Quantification of Operator Group 1 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 1
Action Grouping Logic: A - All Performance Shaping Factors Equally Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.72	1.0E+00	0.00
OS3	0.14	3	0.14	2	0.14	2	0.14	2	0.14	2	0.14	2	0.14	2	2.14	1.4E-05	-4.84
CT1	0.14	7	0.14	5	0.14	1	0.14	1	0.14	5	0.14	1	0.14	0	2.86	4.1E-05	-4.38
RS1	0.14	4	0.14	2	0.14	5	0.14	0	0.14	2	0.14	5	0.14	4	3.14	6.3E-05	-4.20
HH1	0.14	5	0.14	7	0.14	2	0.14	0	0.14	2	0.14	5	0.14	4	3.57	1.2E-04	-3.93
DS1	0.14	2	0.14	2	0.14	2	0.14	2	0.14	6	0.14	4	0.14	4	3.14	6.3E-05	-4.20
DS2	0.14	5	0.14	2	0.14	1	0.14	0	0.14	5	0.14	4	0.14	2	2.71	3.4E-05	-4.47
AF1	0.19	7	0.10	9	0.14	6	0.10	1	0.19	10	0.10	4	0.19	9	7.14	2.3E-02	-1.65
RH1	0.14	3	0.14	2	0.14	2	0.14	0	0.14	2	0.14	6	0.14	4	2.71	3.4E-05	-4.47
DS6	0.19	7	0.14	9	0.14	10	0.10	2	0.19	10	0.10	2	0.14	10	7.76	5.6E-02	-1.25
CH1	0.14	3	0.14	2	0.14	3	0.14	0	0.14	2	0.14	2	0.14	2	2.00	1.2E-05	-4.93
MIN															0.00	6.2E-07	-6.21
Calibration Actions																	
Seabrook ON	0.14	0	0.14	0	0.14	2	0.16	0	0.17	1	0.17	0	0.08	0	0.45	1.0E-06	-6.00
Plant B OR(1A)	0.14	5	0.14	5	0.14	4	0.16	5	0.17	5	0.17	5	0.08	5	4.86	1.0E-04	-4.00
Oyster Crk ZHEMU1	0.17	7	0.13	5	0.15	2	0.18	5	0.12	5	0.15	4	0.10	6	4.84	4.0E-03	-2.40
STP HE0D03	0.14	6	0.14	6	0.15	8	0.14	5	0.15	6	0.14	6	0.14	9	6.58	3.0E-02	-1.52
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-6.20
Std Err of Y Est	0.732
R Squared	0.923
No. of Observations	5
Degrees of Freedom	3
X Coefficient(s)	0.6389
Std Err of Coef.	0.1061

Table B-13 (Page 2 of 10). Quantification of Operator Group 1 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 1
Action Grouping Logic: B - Time Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.76	1.0E+00	0.00
WC1	0.13	5	0.13	3	0.25	6	0.13	2	0.13	3	0.13	1	0.13	4	3.75	1.2E-03	-2.93
RR2	0.13	6	0.13	2	0.20	5	0.13	3	0.13	4	0.13	8	0.13	5	4.73	3.5E-03	-2.45
MR1	0.13	0	0.13	2	0.25	10	0.13	1	0.13	2	0.13	1	0.13	4	3.75	1.2E-03	-2.93
MU2	0.12	4	0.12	8	0.24	10	0.06	8	0.12	9	0.24	6	0.12	9	7.76	1.1E-01	-0.97
MU3	0.11	7	0.11	8	0.22	0	0.06	9	0.06	9	0.22	9	0.22	10	6.89	4.0E-02	-1.40
MIN															0.00	1.7E-05	-4.77
Calibration Actions																	
Fermi HERS1	0.13	7	0.13	2	0.25	4	0.10	3	0.13	2	0.13	2	0.13	6	3.77	5.3E-04	-3.28
DC Cook ZHEOX1	0.13	1	0.13	2	0.25	7	0.10	2	0.13	5	0.13	3	0.13	6	4.16	3.2E-03	-2.49
STP HEOR05*	0.22	7	0.12	7	0.22	8	0.12	5	0.12	8	0.12	8	0.08	6	7.14	0.1000	-1.00
EST_MAX															10.00	9.0E-01	-0.05

* Poorly matched calibration action has a conservative impact on the quantification. See next sheet.

Regression Output:

Constant	-4.76
Std Err of Y Est	0.377
R Squared	0.955
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4885
Std Err of Coef.	0.0749

Table B-13 (Page 3 of 10). Quantification of Operator Group 1 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 1
Action Grouping Logic: B - Time Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	9.4E-01	-0.03
WC1	0.13	5	0.13	3	0.25	6	0.13	2	0.13	3	0.13	1	0.13	4	3.75	1.0E-03	-3.00
RR2	0.13	6	0.13	2	0.20	5	0.13	3	0.13	4	0.13	8	0.13	5	4.73	3.0E-03	-2.53
MR1	0.13	0	0.13	2	0.25	10	0.13	1	0.13	2	0.13	1	0.13	4	3.75	1.0E-03	-3.00
MU2	0.12	4	0.12	8	0.24	10	0.06	8	0.12	9	0.24	6	0.12	9	7.76	8.1E-02	-1.09
MU3	0.11	7	0.11	8	0.22	0	0.06	9	0.06	9	0.22	9	0.22	10	6.89	3.1E-02	-1.51
MIN															0.00	1.7E-05	-4.78
Calibration Actions																	
Fermi HERS1	0.13	7	0.13	2	0.25	4	0.10	3	0.13	2	0.13	2	0.13	6	3.77	5.3E-04	-3.28
DC Cook ZHEOX1	0.13	1	0.13	2	0.25	7	0.10	2	0.13	5	0.13	3	0.13	6	4.16	3.2E-03	-2.49
EST_MAX															10.00	9.0E-01	-0.05

Revised quantification with poorly matched calibration action (STP HER05) removed. The curve fit is slightly better and the median HER's decline by about 20%. As the original quantification uses the higher values, the original quantification will be used until a major revision to the model is made.

Regression Output:

Constant	-4.77
Std Err of Y Est	0.421
R Squared	0.968
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.4752
Std Err of Coef.	0.0854

Table B-13 (Page 4 of 10). Quantification of Operator Group 1 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 1
Action Grouping Logic: D - Time and Preceding and Concurrent Actions Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.75	1.0E+00	0.00
OS4	0.22	7	0.11	3	0.22	9	0.11	3	0.11	2	0.11	3	0.11	5	5.33	1.2E-02	-1.91
CH2	0.22	7	0.11	5	0.22	7	0.11	1	0.11	2	0.11	1	0.11	4	4.56	5.6E-03	-2.25
SE1	0.20	7	0.10	9	0.20	7	0.10	0	0.10	2	0.20	1	0.10	4	4.50	5.3E-03	-2.28
PR1	0.21	8	0.11	3	0.21	4	0.16	0	0.11	2	0.11	1	0.11	5	3.68	2.3E-03	-2.63
PR2	0.17	8	0.11	3	0.22	9	0.17	0	0.11	2	0.11	1	0.11	6	4.67	6.3E-03	-2.20
MIN															0.00	5.9E-05	-4.23
Calibration Actions																	
DC Cook ZHEOB1*	0.24	5	0.12	7	0.12	6	0.12	7	0.14	4	0.12	6	0.14	8	6.00	5.5E-02	-1.26
Fermi OE1	0.22	6	0.12	4	0.22	4	0.12	4	0.12	4	0.12	5	0.08	4	4.56	2.6E-03	-2.59
STP HEOR05	0.22	7	0.12	7	0.22	8	0.12	5	0.12	8	0.12	8	0.08	6	7.14	1.0E-01	-1.00
EST_MAX															10.00	9.0E-01	-0.05

* Poorly matched calibration action has a conservative impact on the quantification. See next sheet.

Regression Output:

Constant	-4.22
Std Err of Y Est	0.379
R Squared	0.912
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4340
Std Err of Coef.	0.0948

Table B-13 (Page 5 of 10). Quantification of Operator Group 1 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 1
Action Grouping Logic: D - Time and Preceding and Concurrent Actions Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.85	1.0E+00	0.00
OS4	0.22	7	0.11	3	0.22	9	0.11	3	0.11	2	0.11	3	0.11	5	5.33	8.1E-03	-2.09
CH2	0.22	7	0.11	5	0.22	7	0.11	1	0.11	2	0.11	1	0.11	4	4.56	3.5E-03	-2.45
SE1	0.20	7	0.10	9	0.20	7	0.10	0	0.10	2	0.20	1	0.10	4	4.50	3.3E-03	-2.48
PR1	0.21	8	0.11	3	0.21	4	0.16	0	0.11	2	0.11	1	0.11	5	3.68	1.4E-03	-2.86
PR2	0.17	8	0.11	3	0.22	9	0.17	0	0.11	2	0.11	1	0.11	6	4.67	4.0E-03	-2.40
MIN															0.00	2.7E-05	-4.57
Calibration Actions																	
Fermi OE1	0.22	6	0.12	4	0.22	4	0.12	4	0.12	4	0.12	5	0.08	4	4.56	2.6E-03	-2.59
STP HEOR05	0.22	7	0.12	7	0.22	8	0.12	5	0.12	8	0.12	8	0.08	6	7.14	1.0E-01	-1.00
EST_MAX															10.00	9.0E-01	-0.05

Revised quantification with poorly matched calibration action (DC Cook ZHEOB1) removed. The curve fit is slightly better and the median HER's decline by about 35%. As the original quantification uses the higher values, the original quantification will be used until a major revision to the model is made.

Regression Output:

Constant	-4.56
Std Err of Y Est	0.310
R Squared	0.970
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.4643
Std Err of Coef.	0.0807

Table B-13 (Page 6 of 10). Quantification of Operator Group 1 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 1
Action Grouping Logic: E - Complexity Important, Procedures Not Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	1.0E+00	0.01
AE1	0.14	3	0.14	0	0.14	1	0.00	0	0.29	1	0.14	1	0.14	4	1.57	2.9E-04	-3.54
OS5	0.16	8	0.16	8	0.16	10	0.04	10	0.16	8	0.16	9	0.16	8	8.56	2.5E-01	-0.60
OF1	0.12	5	0.12	7	0.18	5	0.06	7	0.24	9	0.18	7	0.12	5	6.65	3.9E-02	-1.40
RT1	0.06	4	0.13	2	0.19	7	0.00	0	0.25	2	0.25	0	0.13	0	2.31	5.9E-04	-3.23
OF2	0.12	7	0.12	7	0.18	6	0.06	2	0.24	9	0.18	7	0.12	5	6.76	4.4E-02	-1.35
MIN															0.00	6.2E-05	-4.21
Calibration Actions																	
Plant B MSOB*	0.00	0	0.29	0	0.14	0	0.00	0	0.14	1	0.29	1	0.14	1	0.57	0.0001	-4.11
DC Cook ZHEOS1	0.11	2	0.11	2	0.22	3	0.11	5	0.23	1	0.11	5	0.11	4	2.87	0.0015	-2.82
STP HEOR07	0.11	5	0.11	7	0.22	6	0.11	4	0.23	5	0.11	5	0.11	6	5.44	0.0130	-1.89
EST_MAX															10.00	9.0E-01	-0.05

* Plant B MSOB included in calibration tasks as best reflection of both low procedures and high training weights.

Regression Output:

Constant	-4.20
Std Err of Y Est	0.163
R Squared	0.993
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4215
Std Err of Coef.	0.0233

Table B-13 (Page 7 of 10). Quantification of Operator Group 1 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 1
Action Grouping Logic: F - Time, Training, and Procedures Equally Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	9.1E-01	-0.04
OS2	0.10	8	0.10	8	0.19	6	0.19	5	0.10	8	0.19	7	0.14	8	6.86	5.3E-02	-1.27
OS1	0.10	8	0.10	8	0.19	6	0.19	5	0.10	8	0.19	7	0.14	8	6.86	5.3E-02	-1.27
SL1	0.13	2	0.13	1	0.19	5	0.13	1	0.13	5	0.19	1	0.13	4	2.75	1.3E-03	-2.88
MIN															0.00	1.1E-04	-3.96
Calibration Actions																	
DC Cook ZHEOS1	0.11	2	0.11	2	0.22	3	0.11	5	0.23	1	0.11	5	0.11	4	2.87	1.5E-03	-2.82
Oyster Crk ZHEMU1	0.17	7	0.13	5	0.15	2	0.18	5	0.12	5	0.15	4	0.10	6	4.84	4.0E-03	-2.40
Browns Ferry BF9*	0.11	5	0.20	5	0.11	5	0.16	5	0.11	5	0.22	5	0.09	5	5.00	2.1E-02	-1.68
EST_MAX															10.00	9.0E-01	-0.05

* Browns Ferry BF9 included as best reflection of both high procedures and training weights.

Regression Output:

Constant	-3.96
Std Err of Y Est	0.328
R Squared	0.951
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.3922
Std Err of Coef.	0.0624

Table B-13 (Page 8 of 10). Quantification of Operator Group 1 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 1
Action Grouping Logic: G - Preceding and Concurrent Actions Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.75	1.0E+00	0.00
RR1	0.25	3	0.13	2	0.13	5	0.13	0	0.13	2	0.13	1	0.13	4	2.50	7.2E-04	-3.14
MU1	0.20	8	0.13	8	0.13	1	0.13	4	0.13	6	0.13	6	0.13	2	5.20	1.1E-02	-1.97
OT1	0.21	5	0.14	2	0.07	1	0.14	0	0.14	2	0.14	1	0.14	4	2.43	6.7E-04	-3.17
DS7	0.20	5	0.13	2	0.13	5	0.13	1	0.13	6	0.13	2	0.13	5	3.80	2.6E-03	-2.58
AC1	0.25	6	0.13	2	0.13	7	0.13	1	0.13	2	0.13	1	0.13	3	3.50	2.0E-03	-2.71
DS3	0.20	5	0.13	6	0.13	2	0.13	2	0.13	6	0.13	6	0.13	4	4.47	5.1E-03	-2.29
CS1	0.25	5	0.13	2	0.13	4	0.13	1	0.13	2	0.13	5	0.13	5	3.63	2.2E-03	-2.65
AC2	0.20	3	0.13	4	0.13	3	0.13	3	0.13	4	0.13	9	0.13	4	4.20	3.9E-03	-2.41
OB1	0.24	5	0.12	3	0.12	5	0.12	1	0.12	5	0.12	5	0.18	8	4.82	7.3E-03	-2.13
MIN															0.00	5.9E-05	-4.23
Calibration Actions																	
Fermi OE1	0.22	6	0.12	4	0.22	4	0.12	4	0.12	4	0.12	5	0.08	4	4.56	0.0026	-2.59
DC Cook ZHEOB1	0.24	5	0.12	7	0.12	6	0.12	7	0.14	4	0.12	6	0.14	8	6.00	0.0550	-1.26
STP HEOR05	0.22	7	0.12	7	0.22	8	0.12	5	0.12	8	0.12	8	0.08	6	7.14	0.1000	-1.00
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-4.22
Std Err of Y Est	0.379
R Squared	0.912
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4340
Std Err of Coef.	0.0948

Table B-13 (Page 9 of 10). Quantification of Operator Group 1 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 1
Action Grouping Logic: H - Preceding and Concurrent Actions and Complexity Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.55	1.0E+00	0.00
RE1	0.24	8	0.12	8	0.12	5	0.06	8	0.18	8	0.12	7	0.18	6	7.18	5.8E-02	-1.24
AE2	0.19	8	0.13	7	0.13	6	0.13	6	0.19	7	0.13	6	0.13	7	6.81	3.7E-02	-1.43
CI1	0.22	8	0.11	5	0.11	1	0.11	10	0.22	8	0.11	9	0.11	6	7.00	4.7E-02	-1.33
RD1	0.18	5	0.12	6	0.12	1	0.12	4	0.24	7	0.12	8	0.12	5	5.35	6.5E-03	-2.19
MIN															0.00	1.0E-05	-4.98
Calibration Actions																	
ANO 1 IREP A2	0.24	2	0.12	2	0.24	3	0.00	0	0.16	2	0.12	2	0.12	2	2.24	1.0E-04	-4.00
Calvert Clf CC7	0.24	4	0.12	5	0.24	5	0.00	0	0.16	5	0.12	4	0.12	4	4.52	1.0E-03	-3.00
STP HEOR07	0.11	5	0.11	7	0.22	6	0.11	4	0.23	5	0.11	5	0.11	6	5.44	1.3E-02	-1.89
DC Cook ZHEOB1	0.24	5	0.12	7	0.12	6	0.12	7	0.14	4	0.12	6	0.14	8	6.00	5.5E-02	-1.26
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-4.97
Std Err of Y Est	0.473
R Squared	0.928
No. of Observations	5
Degrees of Freedom	3
X Coefficient(s)	0.5214
Std Err of Coef.	0.0836

Table B-13 (Page 10 of 10). Quantification of Operator Group 1 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 1
Action Grouping Logic: I - Time and Complexity Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	9.6E-01	-0.02
RE2	0.10	8	0.10	7	0.20	10	0.10	10	0.20	10	0.10	10	0.20	10	9.50	5.6E-01	-0.25
DS4	0.20	5	0.10	8	0.20	9	0.10	1	0.20	9	0.10	2	0.10	10	6.70	2.7E-02	-1.56
DS5	0.20	7	0.10	8	0.20	10	0.10	1	0.20	10	0.10	2	0.10	10	7.50	6.5E-02	-1.19
EB1	0.11	0	0.11	8	0.21	7	0.11	0	0.21	9	0.16	2	0.11	5	5.05	4.6E-03	-2.33
SE2	0.20	6	0.10	9	0.20	6 *	0.10	5	0.20	8	0.10	8	0.10	6	6.80	3.1E-02	-1.51
MIN															0.00	2.0E-05	-4.70
Calibration Actions																	
STP HEOR07	0.11	5	0.11	7	0.22	6	0.11	4	0.23	5	0.11	5	0.11	6	5.44	1.3E-02	-1.89
Calvert Clf CC7	0.24	4	0.12	5	0.24	5	0.00	0	0.16	5	0.12	4	0.12	4	4.52	1.0E-03	-3.00
DC Cook ZHEOS1	0.11	2	0.11	2	0.22	3	0.11	5	0.23	1	0.11	5	0.11	4	2.87	1.5E-03	-2.82
ANO 1 IREP A2	0.24	2	0.12	2	0.24	3	0.00	0	0.16	2	0.12	2	0.12	2	2.24	1.0E-04	-4.00
EST_MAX															10.00	9.0E-01	-0.05

* The original time scaling of 10 is changed to 6 to reflect the fact that at least 10 minutes are available to stop the RCP's rather than the 2 minutes stated on the original evaluation form for this action.

Regression Output:

Constant	-4.69
Std Err of Y Est	0.465
R Squared	0.926
No. of Observations	5
Degrees of Freedom	3
X Coefficient(s)	0.4683
Std Err of Coef.	0.0759

Table B-14 (Page 1 of 10). Quantification of Operator Group 2 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 2
Action Grouping Logic: A - All Performance Shaping Factors Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.73	1.0E+00	0.01
MU3	0.15	9	0.08	2	0.15	F	0.15	8	0.15	9	0.15	10	0.15	10	FAIL	1.0E+00	0.00
RH1	0.14	5	0.14	2	0.14	3	0.14	0	0.14	2	0.14	7	0.14	5	3.43	9.6E-05	-4.02
RR2	0.14	10	0.14	8	0.14	10	0.14	0	0.14	8	0.14	7	0.14	8	7.29	2.8E-02	-1.55
CH1	0.14	5	0.14	2	0.14	3	0.14	0	0.14	2	0.14	4	0.14	2	2.57	2.7E-05	-4.57
MU1	0.18	9	0.09	8	0.09	0	0.18	1	0.18	8	0.18	9	0.09	5	6.09	4.8E-03	-2.32
OF2	0.17	8	0.17	2	0.08	7	0.08	6	0.17	9	0.17	9	0.17	8	7.08	2.1E-02	-1.68
RE1	0.14	9	0.14	10	0.14	10	0.14	8	0.14	7	0.14	9	0.14	10	9.00	3.5E-01	-0.46
OS5	0.17	10	0.17	9	0.08	5	0.17	0	0.08	4	0.17	7	0.17	10	6.75	1.3E-02	-1.90
RE2	0.14	10	0.14	9	0.14	F	0.14	0	0.14	9	0.14	8	0.14	10	FAIL	1.0E+00	0.00
DS6	0.15	8	0.15	8	0.15	10	0.08	2	0.15	9	0.15	7	0.15	10	8.15	1.0E-01	-1.00
AE2	0.14	10	0.14	9	0.14	10	0.14	10	0.14	10	0.14	10	0.14	10	9.86	1.0E+00	0.00
AC2	0.15	8	0.15	0	0.15	7	0.08	8	0.15	7	0.15	9	0.15	8	6.62	1.0E-02	-1.98
CT1	0.17	8	0.17	2	0.08	2	0.17	0	0.08	0	0.17	2	0.17	5	3.00	5.1E-05	-4.29
OS4	0.15	9	0.15	2	0.15	7	0.15	0	0.08	0	0.15	5	0.15	8	4.77	6.9E-04	-3.16
OS1	0.17	10	0.17	2	0.17	7	0.08	0	0.17	7	0.08	9	0.17	8	6.42	7.8E-03	-2.11
OS2	0.17	10	0.17	2	0.17	5	0.08	0	0.17	7	0.08	9	0.17	6	5.75	2.9E-03	-2.54
MU2	0.17	9	0.08	2	0.17	F	0.17	0	0.17	8	0.08	6	0.17	10	FAIL	1.0E+00	0.00
OB1	0.17	9	0.17	8	0.17	8	0.08	5	0.08	2	0.17	8	0.17	8	7.42	3.4E-02	-1.47
WC1	0.17	5	0.17	2	0.17	7	0.17	9	0.08	5	0.08	7	0.17	8	6.17	5.4E-03	-2.27
MIN															0.00	6.2E-07	-6.21
Calibration Actions																	
Seabrook ON	0.14	0	0.14	0	0.14	2	0.16	0	0.17	1	0.17	0	0.08	0	0.45	1.0E-06	-6.00
Plant B OR(1A)	0.14	5	0.14	5	0.14	4	0.16	5	0.17	5	0.17	5	0.08	5	4.86	1.0E-04	-4.00
Oyster Crk ZHEMU1	0.17	7	0.13	5	0.15	2	0.18	5	0.12	5	0.15	4	0.10	6	4.84	4.0E-03	-2.40
STP HE0D03	0.14	6	0.14	6	0.15	8	0.14	5	0.15	6	0.14	6	0.14	9	6.58	3.0E-02	-1.52
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-6.20
Std Err of Y Est	0.732
R Squared	0.923
No. of Observations	5
Degrees of Freedom	3
X Coefficient(s)	0.6389
Std Err of Coef.	0.1061

Table B-14 (Page 2 of 10). Quantification of Operator Group 2 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 2
Action Grouping Logic: C - Time and Interfaces Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	6.3E-01	-0.20
PR1	0.13	8	0.25	0	0.25	3	0.13	0	0.06	0	0.06	5	0.13	8	3.06	1.6E-04	-3.81
PR2	0.11	8	0.22	5	0.22	7	0.11	0	0.06	0	0.06	5	0.22	8	5.61	3.3E-03	-2.48
MIN															0.00	4.0E-06	-5.40
Calibration Actions																	
Fermi HERS1	0.13	7	0.13	2	0.25	4	0.10	3	0.13	2	0.13	2	0.13	6	3.77	5.3E-04	-3.28
Oyster Crk ZHEME2	0.14	4	0.21	9	0.20	5	0.08	3	0.11	2	0.16	4	0.10	4	4.95	1.3E-03	-2.89
Diablo Cyn ZHESV2	0.19	6	0.16	5	0.22	8	0.07	10	0.16	7	0.11	10	0.09	7	7.25	1.3E-02	-1.89
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-5.39
Std Err of Y Est	0.244
R Squared	0.980
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.5197
Std Err of Coef.	0.0514

Table B-14 (Page 3 of 10). Quantification of Operator Group 2 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 2
Action Grouping Logic: E - Complexity Important, Procedures Not Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	1.0E+00	0.01
DS7	0.17	9	0.17	2	0.09	3	0.04	10	0.17	7	0.17	9	0.17	8	6.78	4.5E-02	-1.35
DS5	0.10	8	0.19	2	0.10	7	0.05	10	0.19	7	0.19	9	0.19	8	6.86	4.8E-02	-1.32
DS3	0.10	3	0.19	1	0.10	5	0.05	10	0.19	7	0.19	9	0.19	8	6.00	2.1E-02	-1.68
OF1	0.10	8	0.20	2	0.10	5	0.10	7	0.20	8	0.20	4	0.10	6	5.40	1.2E-02	-1.93
MIN															0.00	6.2E-C5	-4.21
Calibration Actions																	
Plant B MSOB*	0.00	0	0.29	0	0.14	0	0.00	0	0.14	1	0.29	1	0.14	1	0.57	7.8E-05	-4.11
DC Cook ZHEOS1	0.11	2	0.11	2	0.22	3	0.11	5	0.23	1	0.11	5	0.11	4	2.87	1.5E-03	-2.82
STP HEOR07	0.11	5	0.11	7	0.22	6	0.11	4	0.23	5	0.11	5	0.11	6	5.44	1.3E-02	-1.89
EST_MAX															10.00	9.0E-01	-0.05

* Plant B MSOB included in calibration tasks as best reflection of both low procedures and high training weights.

Regression Output:

Constant	-4.20
Std Err of Y Est	0.163
R Squared	0.993
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4215
Std Err of Coef.	0.0233

Table B-14 (Page 4 of 10). Quantification of Operator Group 2 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 2
Action Grouping Logic: F - Time, Training, and Procedures Equally Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	9.1E-01	-0.04
RR1	0.09	5	0.18	2	0.18	7	0.18	0	0.09	0	0.18	4	0.09	5	3.27	2.1E-03	-2.68
SE2	0.10	3	0.19	8	0.19	5	0.19	2	0.05	7	0.19	3	0.10	6	4.62	7.1E-03	-2.15
AF1	0.10	10	0.10	8	0.20	10	0.10	6	0.10	9	0.20	7	0.20	10	8.70	2.8E-01	-0.55
MIN															0.00	1.1E-04	-3.96
Calibration Actions																	
DC Cook ZHEOS1	0.11	2	0.11	2	0.22	3	0.11	5	0.23	1	0.11	5	0.11	4	2.87	1.5E-03	-2.82
Oyster Crk ZHEMU1	0.17	7	0.13	5	0.15	2	0.18	5	0.12	5	0.15	4	0.10	6	4.84	4.0E-03	-2.40
Browns Ferry BF9*	0.11	5	0.20	5	0.11	5	0.16	5	0.11	5	0.22	5	0.09	5	5.00	2.1E-02	-1.68
EST_MAX															10.00	9.0E-01	-0.05

* Browns Ferry BF9 included as best reflection of both high procedures and training weights.

Regression Output:

Constant	-3.96
Std Err of Y Est	0.328
R Squared	0.951
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.3922
Std Err of Coef.	0.0624

Table B-14 (Page 5 of 10). Quantification of Operator Group 2 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 2
Action Grouping Logic: G - Preceding and Concurrent Actions Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.75	1.0E+00	0.00
AE1	0.25	8	0.13	0	0.13	3	0.13	0	0.13	0	0.13	5	0.13	4	3.50	2.0E-03	-2.71
OS3	0.25	8	0.13	2	0.13	3	0.13	0	0.13	0	0.13	7	0.13	5	4.13	3.6E-03	-2.44
CH2	0.22	9	0.11	2	0.11	3	0.11	0	0.11	0	0.11	4	0.22	8	4.78	7.0E-03	-2.15
HH1	0.25	5	0.13	5	0.13	3	0.13	0	0.13	0	0.13	5	0.13	5	3.50	2.0E-03	-2.71
AC1	0.20	7	0.20	0	0.10	4	0.10	0	0.10	0	0.10	5	0.20	8	3.90	2.9E-03	-2.54
MIN															0.00	5.9E-05	-4.23
Calibration Actions																	
Fermi OE1	0.22	6	0.12	4	0.22	4	0.12	4	0.12	4	0.12	5	0.08	4	4.56	2.6E-03	-2.59
DC Cook ZHEOB1	0.24	5	0.12	7	0.12	6	0.12	7	0.14	4	0.12	6	0.14	8	6.00	5.5E-02	-1.26
STP HEOR05	0.22	7	0.12	7	0.22	8	0.12	5	0.12	8	0.12	8	0.08	6	7.14	1.0E-01	-1.00
EST_MAX															10.00	9.0E-01	-0.05

No calibration actions had a weight profile incuding both high preceding and concurrent actions and high stress. Consequently, AC1 and CH2 are included in this group.

Regression Output:

Constant	-4.22
Std Err of Y Est	0.379
R Squared	0.912
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4340
Std Err of Coef.	0.0948

Table B-14 (Page 6 of 10). Quantification of Operator Group 2 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 2
Action Grouping Logic: K - Time Important, Procedures and Complexity Not Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.49	1.0E+00	0.00
SE1	0.17	7	0.17	5	0.33	7	0.00	7	0.00	2	0.17	5	0.17	8	6.50	2.7E-02	-1.56
MIN															0.00	1.1E-05	-4.97
Calibration Actions																	
ANO 1 IREP A2	0.24	2	0.12	2	0.24	3	0.00	0	0.16	2	0.12	2	0.12	2	2.24	1.0E-04	-4.00
Fermi HERS1	0.13	7	0.13	2	0.25	4	0.10	3	0.13	2	0.13	2	0.13	6	3.77	5.3E-04	-3.28
STP HEOR07	0.11	5	0.11	7	0.22	6	0.11	4	0.23	5	0.11	5	0.11	6	5.44	1.3E-02	-1.89
DC Cook ZHEOB1	0.24	5	0.12	7	0.12	6	0.12	7	0.14	4	0.12	6	0.14	8	6.00	5.5E-02	-1.26
EST_MAX															10.00	9.0E-01	-0.05

There are currently no calibration actions in the database having zero weight for complexity. Consequently, this group is evaluated with the best match that could be found.

Regression Output:

Constant	-4.97
Std Err of Y Est	0.445
R Squared	0.940
No. of Observations	5
Degrees of Freedom	3
X Coefficient(s)	0.5239
Std Err of Coef.	0.0762

Table B-14 (Page 7 of 10). Quantification of Operator Group 2 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 2
Action Grouping Logic: L - Stress Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.79	1.0E+00	0.00
RS1	0.13	5	0.13	2	0.13	3	0.13	0	0.13	2	0.13	7	0.25	8	4.38	8.2E-03	-2.09
MIN															0.00	1.7E-04	-3.77
Calibration Actions																	
Indian Pt IP12	0.17	3	0.12	4	0.13	3	0.17	4	0.12	4	0.12	4	0.17	4	3.70	5.0E-03	-2.30
Oconee, OPRA-8	0.15	5	0.15	5	0.12	4	0.16	1	0.12	5	0.12	6	0.19	7	4.74	1.0E-02	-2.00
Limerick L4B	0.17	10	0.12	9	0.13	10	0.17	10	0.12	9	0.12	9	0.17	10	9.64	9.0E-01	-0.05

Regression Output:

Constant	-3.77
Std Err of Y Est	0.072
R Squared	0.998
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.3857
Std Err of Coef.	0.0161

Table B-14 (Page 8 of 10). Quantification of Operator Group 2 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 2
Action Grouping Logic: M - Training and Interfaces Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.84	1.0E+00	0.00
MR1	0.06	8	0.12	8	0.12	5	0.12	7	0.12	0	0.24	7	0.24	8	6.35	1.4E-02	-1.85
CS1	0.11	8	0.22	2	0.11	3	0.11	0	0.11	0	0.22	5	0.11	5	3.33	3.5E-04	-3.45
EB1	0.05	8	0.21	2	0.11	5	0.11	7	0.11	8	0.21	4	0.21	8	5.47	4.8E-03	-2.32
RD1	0.11	4	0.22	2	0.11	3	0.11	0	0.11	0	0.22	2	0.11	5	2.22	9.1E-05	-4.04
CI1	0.00	9	0.17	8	0.17	7	0.17	5	0.17	9	0.17	9	0.17	10	8.00	1.1E-01	-0.97
MIN															0.00	6.0E-06	-5.22
Calibration Actions																	
Fermi OF1	0.00	5	0.29	3	0.14	5	0.00	7	0.14	8	0.29	4	0.14	6	4.69	8.8E-04	-3.06
Big Rock BR5	0.11	5	0.22	6	0.07	5	0.11	5	0.16	6	0.22	6	0.11	6	5.71	1.4E-02	-1.85
Seabrook RT	0.00	0	0.29	9	0.14	8	0.14	7	0.00	0	0.29	7	0.14	7	7.72	1.0E-01	-1.00
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-5.22
Std Err of Y Est	0.354
R Squared	0.948
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.5311
Std Err of Coef.	0.0871

Table B-14 (Page 9 of 10). Quantification of Operator Group 2 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 2
Action Grouping Logic: N - Interfaces, Procedures, and Training Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	7.4E-01	-0.13
OT1	0.07	3	0.13	2	0.13	1	0.27	0	0.13	2	0.13	5	0.13	5	2.20	4.3E-04	-3.37
DS4	0.09	5	0.18	2	0.09	5	0.18	5	0.09	8	0.18	7	0.18	8	5.64	1.1E-02	-1.94
DS2	0.11	3	0.21	2	0.05	0	0.21	2	0.11	7	0.21	7	0.11	4	3.79	2.0E-03	-2.71
SL1	0.10	3	0.20	2	0.10	3	0.20	6	0.10	2	0.20	1	0.10	4	3.00	9.2E-04	-3.04
DS1	0.11	3	0.21	2	0.05	0	0.21	3	0.11	8	0.21	7	0.11	4	4.11	2.6E-03	-2.58
MIN															0.00	5.2E-05	-4.28
Calibration Actions																	
Big Rock L2C	0.11	4	0.22	4	0.07	5	0.11	4	0.16	4	0.22	4	0.11	4	4.07	1.0E-03	-3.00
Browns Ferry BF9	0.11	5	0.20	5	0.11	5	0.16	5	0.11	5	0.22	5	0.09	5	5.00	2.1E-02	-1.68
Crystal River	0.11	9	0.22	9	0.07	9	0.16	9	0.11	8	0.22	9	0.11	9	8.89	1.6E-01	-0.80
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-4.28
Std Err of Y Est	0.497
R Squared	0.897
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4153
Std Err of Coef.	0.0991

Table B-14 (Page 10 of 10). Quantification of Operator Group 2 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 2
Action Grouping Logic: 0 - Interfaces, Training, and Stress Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	9.3E-01	-0.03
RT1	0.06	3	0.24	0	0.12	5	0.12	7	0.00	5	0.24	2	0.24	5	3.24	1.1E-03	-2.95
MIN															0.00	4.5E-05	-4.35
Calibration Actions																	
Plant B MSOB	0.00	0	0.29	0	0.14	0	0.00	0	0.14	1	0.29	1	0.14	1	0.57	7.8E-05	-4.11
Seabrook RT	0.00	0	0.29	9	0.14	8	0.14	7	0.00	0	0.29	7	0.14	7	7.72	1.0E-01	-1.00
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-4.34
Std Err of Y Est	0.021
R Squared	0.999
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.4317
Std Err of Coef.	0.0031

Table B-15 (Page 1 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: A - All Performance Shaping Factors Equally Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.72	1.0E+00	0.00
DS3	0.14	5	0.14	7	0.14	5	0.14	3	0.14	8	0.14	3	0.14	5	5.14	1.2E-03	-2.92
CH1	0.17	3	0.17	2	0.08	3	0.17	2	0.08	2	0.17	1	0.17	4	2.42	2.2E-05	-4.66
DS5	0.14	5	0.14	8	0.14	5	0.14	3	0.14	8	0.14	3	0.14	6	5.43	1.8E-03	-2.74
CS1	0.18	7	0.18	5	0.18	5	0.09	2	0.09	4	0.09	3	0.18	5	4.82	7.4E-04	-3.13
RR1	0.14	5	0.14	2	0.14	5	0.14	2	0.14	2	0.14	3	0.14	3	3.14	6.3E-05	-4.20
RR2	0.14	7	0.14	5	0.14	5	0.14	3	0.14	3	0.14	3	0.14	4	4.29	3.4E-04	-3.47
DS2	0.15	5	0.15	7	0.08	4	0.15	3	0.15	8	0.15	3	0.15	4	4.92	8.6E-04	-3.06
DS4	0.14	5	0.14	8	0.14	5	0.14	3	0.14	8	0.14	3	0.14	6	5.43	1.8E-03	-2.74
RS1	0.15	3	0.15	3	0.15	4	0.15	0	0.15	3	0.08	8	0.15	5	3.38	9.0E-05	-4.05
AE1	0.18	8	0.18	2	0.18	3	0.09	0	0.09	1	0.09	4	0.18	5	3.73	1.5E-04	-3.83
WC1	0.15	5	0.15	2	0.15	4	0.15	1	0.08	5	0.15	3	0.15	5	3.46	1.0E-04	-4.00
OS3	0.14	8	0.14	5	0.14	3	0.14	1	0.14	2	0.14	3	0.14	2	3.43	9.6E-05	-4.02
CH2	0.15	3	0.15	2	0.15	5	0.15	4	0.08	2	0.15	1	0.15	4	3.08	5.7E-05	-4.24
MIN															0.00	6.2E-07	-6.21
Calibration Actions																	
Seabrook ON	0.14	0	0.14	0	0.14	2	0.16	0	0.17	1	0.17	0	0.08	0	0.45	1.0E-06	-6.00
Plant B OR(1A)	0.14	5	0.14	5	0.14	4	0.16	5	0.17	5	0.17	5	0.08	5	4.86	1.0E-04	-4.00
Oyster Crk ZHEMU1	0.17	7	0.13	5	0.15	2	0.18	5	0.12	5	0.15	4	0.10	6	4.84	4.0E-03	-2.40
STP HEOD03	0.14	6	0.14	6	0.15	8	0.14	5	0.15	6	0.14	6	0.14	9	6.58	3.0E-02	-1.52
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-6.20
Std Err of Y Est	0.732
R Squared	0.923
No. of Observations	5
Degrees of Freedom	3
X Coefficient(s)	0.6389
Std Err of Coef.	0.1061

Table B-15 (Page 2 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: B - Time Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.76	1.0E+00	0.00
MU2	0.10	8	0.10	8	0.20	8	0.10	5	0.20	9	0.10	5	0.20	8	7.60	8.8E-02	-1.05
OF2	0.07	5	0.13	8	0.27	7	0.13	5	0.13	9	0.13	4	0.13	6	6.47	2.5E-02	-1.61
OS5	0.13	8	0.13	8	0.25	7	0.13	6	0.13	8	0.13	3	0.13	6	6.63	3.0E-02	-1.53
OF1	0.07	5	0.13	8	0.27	7	0.13	5	0.13	8	0.13	4	0.13	6	6.33	2.1E-02	-1.67
MU3	0.11	8	0.11	9	0.21	7	0.05	5	0.21	9	0.11	6	0.21	8	7.74	1.0E-01	-0.99
OS4	0.13	8	0.13	5	0.25	8	0.13	5	0.13	2	0.13	3	0.13	6	5.63	9.6E-03	-2.02
EB1	0.10	5	0.20	8	0.20	8	0.10	7	0.20	9	0.10	4	0.10	6	7.20	5.6E-02	-1.25
MIN															0.00	1.7E-05	-4.77
Calibration Actions																	
Fermi HERS1	0.13	7	0.13	2	0.25	4	0.10	3	0.13	2	0.13	2	0.13	6	3.77	5.3E-04	-3.28
DC Cook ZHEOX1	0.13	1	0.13	2	0.25	7	0.10	2	0.13	5	0.13	3	0.13	6	4.16	3.2E-03	-2.49
STP HEOR05	0.22	7	0.12	7	0.22	8	0.12	5	0.12	8	0.12	8	0.08	6	7.14	1.0E-01	-1.00
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-4.76
Std Err of Y Est	0.377
R Squared	0.955
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4885
Std Err of Coef.	0.0749

Table B-15 (Page 3 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: C - Time and Interface Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	6.3E-01	-0.20
RT1	0.10	3	0.20	2	0.40	5	0.00	0	0.00	2	0.20	4	0.10	4	3.90	4.3E-04	-3.37
PR2	0.08	3	0.17	0	0.33	5	0.17	0	0.00	2	0.08	4	0.17	6	3.25	2.0E-04	-3.71
SE2	0.13	8	0.27	8	0.27	7	0.07	5	0.07	2	0.07	2	0.13	4	6.20	6.7E-03	-2.18
MR1	0.18	5	0.18	2	0.36	5	0.00	0	0.09	2	0.00	4	0.18	5	4.18	6.0E-04	-3.22
PR1*	0.00	0	0.22	2	0.22	5	0.22	0	0.00	2	0.11	1	0.22	2	2.11	5.0E-05	-4.30
MIN															0.00	4.0E-06	-5.40
Calibration Actions																	
Fermi HERS1	0.13	7	0.13	2	0.25	4	0.10	3	0.13	2	0.13	2	0.13	6	3.77	5.3E-04	-3.28
Oyster Crk ZHEME2	0.14	4	0.21	9	0.20	5	0.08	3	0.11	2	0.16	4	0.10	4	4.95	1.3E-03	-2.89
Diablo Cyn ZHESV2	0.19	6	0.16	5	0.22	8	0.07	10	0.16	7	0.11	10	0.09	7	7.25	1.3E-02	-1.89
EST_MAX															10.00	9.0E-01	-0.05

* Action PR1 was included in this group because its unique weight profile is best met by these calibration tasks. The low FLI makes the choice less critical.

No suitable calibration tasks were available that combined a high weight for time with a low weight for complexity. Therefore, the selection process concentrated on the PSFs with high weight.

Regression Output:

Constant	-5.39
Std Err of Y Est	0.244
R Squared	0.980
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.5197
Std Err of Coef.	0.0514

Table B-15 (Page 4 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: D - Time and Preceding and Concurrent Actions Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.75	1.0E+00	0.00
OS1	0.22	8	0.11	5	0.22	7	0.11	1	0.11	2	0.11	3	0.11	2	4.78	7.0E-03	-2.15
SE1	0.27	7	0.13	6	0.27	7	0.00	0	0.13	4	0.07	4	0.13	5	6.00	2.4E-02	-1.62
MIN															0.00	5.9E-05	-4.23
Calibration Actions																	
DC Cook ZHEOB1*	0.24	5	0.12	7	0.12	6	0.12	7	0.14	4	0.12	6	0.14	8	6.00	5.5E-02	-1.26
Fermi OE1	0.22	6	0.12	4	0.22	4	0.12	4	0.12	4	0.12	5	0.08	4	4.56	2.6E-03	-2.59
STP HEOR05	0.22	7	0.12	7	0.22	8	0.12	5	0.12	8	0.12	8	0.08	6	7.14	1.0E-01	-1.00
EST_MAX															10.00	9.0E-01	-0.05

* Poorly matched calibration action has a conservative impact on the quantification. See next sheet.

Regression Output:

Constant	-4.22
Std Err of Y Est	0.379
R Squared	0.912
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4340
Std Err of Coef.	0.0948

Table B-15 (Page 5 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: D - Time and Preceding and Concurrent Actions Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.85	1.0E+00	0.00
OS1	0.22	8	0.11	5	0.22	7	0.11	1	0.11	2	0.11	3	0.11	2	4.78	4.5E-03	-2.35
SE1	0.27	7	0.13	6	0.27	7	0.00	0	0.13	4	0.07	4	0.13	5	6.00	1.6E-02	-1.78
MIN															0.00	2.7E-05	-4.57
Calibration Actions																	
Fermi OE1	0.22	6	0.12	4	0.22	4	0.12	4	0.12	4	0.12	5	0.08	4	4.56	2.6E-03	-2.59
STP HEOR05	0.22	7	0.12	7	0.22	8	0.12	5	0.12	8	0.12	8	0.08	6	7.14	1.0E-01	-1.00
EST_MAX															10.00	9.0E-01	-0.05

* Revised quantification with poorly matched calibration action (DC Cook ZHEOB1) removed. The curve fit is slightly better and the median HER's decline by about 35%. As the original quantification uses the higher values, the original quantification will be used until a major revision to the model is made.

Regression Output:

Constant	-4.56
Std Err of Y Est	0.310
R Squared	0.970
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.4643
Std Err of Coef.	0.0807

Table B-15 (Page 6 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: G - Preceding and Concurrent Actions Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.75	1.0E+00	0.00
OS2	0.25	8	0.13	5	0.13	4	0.13	1	0.13	2	0.13	3	0.13	2	4.13	3.6E-03	-2.44
AC1	0.29	7	0.29	8	0.14	6	0.07	7	0.00	1	0.07	1	0.14	6	6.57	4.2E-02	-1.38
MIN															0.00	5.9E-05	-4.23
Calibration Actions																	
Fermi OE1	0.22	6	0.12	4	0.22	4	0.12	4	0.12	4	0.12	5	0.08	4	4.56	2.6E-03	-2.59
DC Cook ZHEOB1	0.24	5	0.12	7	0.12	6	0.12	7	0.14	4	0.12	6	0.14	8	6.00	5.5E-02	-1.26
STP HEOR05	0.22	7	0.12	7	0.22	8	0.12	5	0.12	8	0.12	8	0.08	6	7.14	1.0E-01	-1.00
EST_MAX															10.00	9.0E-01	-0.05

* No calibration actions had a weight profile incuding both high preceding and concurrent actions and high plant interfaces. Consequently, AC1 is included in this group as a best fit estimate.

Regression Output:

Constant	-4.22
Std Err of Y Est	0.379
R Squared	0.912
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4340
Std Err of Coef.	0.0948

Table B-15 (Page 7 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: J - Training Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.32	1.0E+00	0.00
RE1	0.14	6	0.07	8	0.14	7	0.07	5	0.14	8	0.29	5	0.14	5	6.07	9.8E-03	-2.01
MIN															0.00	1.7E-06	-5.76
Calibration Actions																	
Seabrook, ON	0.16	0	0.14	0	0.14	2	0.17	1	0.14	0	0.17	0	0.08	0	0.45	1.0E-06	-6.00
Browns Ferry BF9	0.11	5	0.20	5	0.11	5	0.16	5	0.11	5	0.22	5	0.09	5	5.00	2.1E-02	-1.68
Seabrook RT	0.00	0	0.29	9	0.14	8	0.14	7	0.00	0	0.29	7	0.14	7	7.72	1.0E-01	-1.00
EST_MAX															10.00	9.0E-01	-0.05

Available calibration actions that weight training heavily have also weighted plant interfaces heavily. They were used here as a best fit estimate.

Regression Output:

Constant	-5.76
Std Err of Y Est	0.857
R Squared	0.929
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.6180
Std Err of Coef.	0.1205

Table B-15 (Page 8 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: L - Time, Training, and Stress Important, Other Actions, Interfaces, and Complexity Not Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	8.2E-01	-0.08
CT1	0.00	1	0.00	2	0.29	5	0.14	5	0.00	1	0.29	4	0.29	5	4.71	6.6E-03	-2.18
MIN															0.00	8.8E-05	-4.05
Calibration Actions																	
EST_MIN															0.00	1.0E-04	-4.00
DC Cook ZHEOX1	0.13	1	0.13	2	0.25	7	0.10	2	0.13	5	0.13	3	0.13	6	4.16	3.2E-03	-2.49
EST_MAX															10.00	9.0E-01	-0.05

Action CT1 had a unique weight profile that necessitated the use of one "best estimate" calibration task and two bounding estimates to establish calibration.

Regression Output:

Constant	-4.05
Std Err of Y Est	0.113
R Squared	0.998
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.3969
Std Err of Coef.	0.0159

Table B-15 (Page 9 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: M - Procedures Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	9.1E-01	-0.04
CI1	0.13	9	0.06	8	0.13	5	0.25	3	0.06	9	0.13	7	0.25	9	6.69	5.8E-02	-1.24
RH1	0.17	4	0.00	2	0.00	5	0.33	0	0.17	2	0.17	8	0.17	5	3.17	3.1E-03	-2.51
OB1	0.07	5	0.13	2	0.13	5	0.27	2	0.13	5	0.13	2	0.13	7	3.67	4.7E-03	-2.33
MIN															0.00	2.2E-04	-3.65
Calibration Actions																	
Grand Gulf GG3*	0.11	2	0.22	2	0.11	2	0.22	3	0.11	2	0.11	3	0.12	2	2.33	1.5E-03	-2.82
Indian Pt IP12	0.17	3	0.12	4	0.13	3	0.17	4	0.12	4	0.12	4	0.17	4	3.70	5.0E-03	-2.30
EST_MAX															10.00	9.0E-01	-0.05

* Grand Gulf GG3 was used because of its high weight for procedures.

Regression Output:

Constant	-3.65
Std Err of Y Est	0.020
R Squared	0.999
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.3609
Std Err of Coef.	0.0035

Table B-15 (Page 10 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: N - Interfaces and Complexity Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.45	1.0E+00	0.00
MU1	0.13	7	0.13	8	0.07	3	0.13	5	0.27	9	0.13	8	0.13	5	7.00	3.0E-02	-1.52
RD1	0.12	5	0.12	8	0.06	5	0.24	3	0.24	8	0.12	7	0.12	4	5.71	4.8E-03	-2.32
DS1	0.17	5	0.17	7	0.00	1	0.17	3	0.17	8	0.17	4	0.17	4	5.17	2.2E-03	-2.66
AE2	0.20	10	0.20	8	0.10	7	0.10	3	0.20	9	0.10	10	0.10	8	8.20	1.7E-01	-0.78
SL1	0.13	3	0.25	4	0.13	4	0.13	3	0.13	5	0.13	1	0.13	5	3.63	2.4E-04	-3.61
DS7	0.11	8	0.22	8	0.11	7	0.11	3	0.22	8	0.11	3	0.11	6	6.56	1.6E-02	-1.80
DS6	0.11	8	0.21	8	0.05	3	0.11	3	0.21	9	0.11	3	0.21	9	7.11	3.5E-02	-1.46
MIN															0.00	1.4E-06	-5.86
Calibration Actions																	
Seabrook ON	0.14	0	0.14	0	0.14	2	0.16	0	0.17	1	0.17	0	0.08	0	0.45	1.0E-06	-6.00
Big Rock L2C	0.11	4	0.22	4	0.07	5	0.11	4	0.16	4	0.22	4	0.11	4	4.07	1.0E-03	-3.00
Big Rock BR5	0.11	5	0.22	6	0.07	5	0.11	5	0.16	6	0.22	6	0.11	6	5.71	1.4E-02	-1.85
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-5.86
Std Err of Y Est	0.572
R Squared	0.965
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.6199
Std Err of Coef.	0.0834

Table B-15 (Page 11 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: 0 - Preceding and Concurrent Actions and Procedures Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.84	1.0E+00	0.00
OT1	0.22	3	0.11	2	0.11	4	0.22	1	0.11	2	0.11	4	0.11	2	2.44	7.5E-04	-3.13
HH1	0.20	7	0.20	5	0.10	2	0.20	0	0.00	2	0.10	4	0.20	4	3.80	2.8E-03	-2.55
MIN															0.00	6.9E-05	-4.16
Calibration Actions																	
Oyster Crk ZHEMU1	0.17	7	0.13	5	0.15	2	0.18	5	0.12	5	0.15	4	0.10	6	4.84	4.0E-03	-2.40
DC Cook ZHEOB1	0.24	5	0.12	7	0.12	6	0.12	7	0.14	4	0.12	6	0.14	8	6.00	5.5E-02	-1.26
Limerick L4B	0.17	10	0.12	9	0.13	10	0.17	10	0.12	9	0.12	9	0.17	10	9.64	9.0E-01	-0.05
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-4.16
Std Err of Y Est	0.337
R Squared	0.940
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4232
Std Err of Coef.	0.0752

Table B-15 (Page 12 of 12). Quantification of Operator Group 3 Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: 3
Action Grouping Logic: P - Complexity Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.83	1.0E+00	0.00
AC2	0.13	6	0.13	8	0.13	5	0.13	3	0.25	8	0.13	5	0.13	5	6.00	1.2E-02	-1.92
RE2	0.22	8	0.11	8	0.11	6	0.06	5	0.22	8	0.06	6	0.22	9	7.72	8.7E-02	-1.06
AF1	0.12	8	0.12	8	0.06	3	0.12	5	0.24	9	0.12	3	0.24	9	7.24	5.0E-02	-1.30
MIN															0.00	1.2E-05	-4.94
Calibration Actions*																	
ANO 1 IREP A2	0.24	2	0.12	2	0.24	3	0.00	0	0.16	2	0.12	2	0.12	2	2.24	1.0E-04	-4.00
STP HEOR07	0.11	5	0.11	7	0.22	6	0.11	4	0.23	5	0.11	5	0.11	6	5.44	1.3E-02	-1.89
EST_MAX															10.00	9.0E-01	-0.05

* No suitable calibration actions were available that combined both a high weight for complexity and a low weight for time. The calibration actions above are considered to be a best estimate.

Regression Output:

Constant	-4.93
Std Err of Y Est	0.392
R Squared	0.980
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.5023
Std Err of Coef.	0.0711

Table B-16 (Page 1 of 2). Composite Human Error Rates Used for Quantification of the Watts Bar PRA

Action Code	WBN1 Median HER	WBN2 Median HER	WBN3 Median HER	Composite Human Error Rate				
				Mean	5th Percentile	50th Percentile	95th Percentile	Range Factor
HAAC1	2.0-03	2.9-03	4.2-02	2.51-02	5.34-04	3.87-03	8.90-02	14
HAAC2	3.9-03	1.0-02	1.2-02	1.41-02	1.00-03	6.31-03	3.96-02	6
HAAE1	2.9-04	2.0-03	1.5-04	1.50-03	2.33-05	3.76-04	4.82-03	16
HAAE2	3.7-02	1.0+00	1.7-01	4.39-01	1.12-02	1.45-01	1.00+00	9
HAAF1	2.3-02	2.8-01	5.0-02	1.56-01	6.31-03	5.39-02	5.41-01	10
HACH1	1.2-05	2.7-05	2.2-05	5.54-05	1.81-06	1.58-05	1.61-04	10
HACH2	5.6-03	7.0-03	5.7-05	6.93-03	1.12-05	2.53-03	2.15-02	45
HACI1	4.7-02	1.1-01	5.8-02	1.13-01	1.00-02	6.31-02	3.03-01	6
HACS1	2.2-03	3.5-04	7.4-04	2.16-03	5.49-05	7.57-04	6.34-03	11
HACT1	4.1-05	5.1-05	6.6-03	3.63-03	5.46-06	8.64-05	1.40-02	55
HADS1	6.3-05	2.6-03	2.2-03	2.68-03	1.26-05	1.00-03	8.12-03	26
HADS2	3.4-05	2.0-03	8.6-04	1.90-03	6.60-06	4.84-04	6.01-03	31
HADS3	5.1-03	2.1-02	1.2-03	1.50-02	3.98-04	4.14-03	4.76-02	12
HADS4	2.7-02	1.1-02	1.8-03	2.15-02	6.10-04	7.45-03	6.45-02	11
HADS5	6.5-02	4.8-02	1.8-03	6.15-02	6.13-04	2.25-02	1.88-01	19
HADS6	5.6-02	1.0-01	3.5-02	1.01-01	9.89-03	5.27-02	2.68-01	6
HADS7	2.6-03	4.5-02	1.6-02	3.47-02	8.60-04	1.13-02	1.06-01	12
HAEB1	4.6-03	4.8-03	5.6-02	3.48-02	1.00-03	7.07-03	1.20-01	12
HAHH1	1.2-04	2.0-03	2.8-03	2.72-03	2.38-05	1.05-03	8.13-03	19
HAMR1	1.2-03	1.4-02	6.0-04	8.93-03	1.08-04	1.55-03	3.09-02	18
HAMU1	1.1-02	4.8-03	3.0-02	2.46-02	1.48-03	1.00-02	7.09-02	8
HAMU2	1.1-01	1.0+00	8.8-02	4.41-01	2.29-02	1.58-01	1.00+00	7
HAMU3	4.0-02	1.0+00	1.0-01	7.21-01	3.27-02	1.00+00	1.00+00	6
HAOB1	7.3-03	3.4-02	4.7-03	2.52-02	1.25-03	8.82-03	7.68-02	9
HAOF1	3.9-02	1.2-02	2.1-02	3.88-02	3.26-03	1.80-02	1.02-01	6
HAOF2	4.4-02	2.1-02	2.5-02	4.85-02	4.53-03	2.51-02	1.28-01	6
HAOS1	5.3-02	7.8-03	7.0-03	3.62-02	1.58-03	1.02-02	1.16-01	9
HAOS2	5.3-02	2.9-03	3.6-03	3.17-02	6.31-04	5.07-03	1.14-01	14

Note: Exponential notation is indicated in abbreviated form; e.g., 2.0-03 = 2.0×10^{-03}.

TABLEB16.WBN.07/13/92

Table B-16 (Page 2 of 2). Composite Human Error Rates Used for Quantification of the Watts Bar PRA

Action Code	WBN1 Median HER	WBN2 Median HER	WBN3 Median HER	Composite Human Error Rate				
				Mean	5th Percentile	50th Percentile	95th Percentile	Range Factor
HAOS3	1.4-05	3.6-03	9.6-05	2.09-03	2.95-06	8.49-05	7.89-03	55
HAOS4	1.2-02	6.9-04	9.6-03	1.22-02	1.35-04	4.95-03	3.72-02	17
HAOS5	2.5-01	1.3-02	3.0-02	1.28-01	3.98-03	3.15-02	4.74-01	12
HAOT1	6.7-04	4.3-04	7.5-04	1.65-03	5.08-05	5.14-04	4.78-03	11
HAPR1	2.3-03	1.6-04	5.0-05	1.43-03	8.88-06	1.86-04	5.04-03	26
HAPR2	6.3-03	3.3-03	2.0-04	5.39-03	3.91-05	1.99-03	1.60-02	21
HARD1	6.5-03	9.1-05	4.8-03	6.15-03	1.71-05	2.20-03	1.87-02	34
HARE1	5.8-02	3.5-01	9.8-03	1.69-01	3.15-03	4.71-02	6.31-01	15
HARE2	5.6-01	1.0+00	8.7-02	7.15-01	2.53-02	1.00+00	1.00+00	6
HARH1	3.4-05	9.6-05	3.1-03	1.78-03	5.96-06	1.19-04	6.73-03	36
HARR1	7.2-04	2.1-03	6.3-05	1.86-03	1.25-05	4.85-04	5.90-03	23
HARR2	3.5-03	2.8-02	3.4-04	1.86-03	1.25-05	4.85-04	5.90-03	23
HARS1	6.3-05	8.2-03	9.0-05	4.67-03	8.85-06	1.46-04	1.80-02	49
HART1	5.9-04	1.1-03	4.3-04	1.51-03	5.88-05	6.29-04	4.19-03	9
HASE1	5.3-03	2.7-02	2.4-02	3.06-02	1.58-03	1.43-02	8.77-02	8
HASE2	3.1-02	7.1-03	6.7-03	2.41-02	1.58-03	9.99-03	7.02-02	7
HASL1	1.3-03	9.2-04	2.4-04	1.75-03	3.99-05	6.31-04	4.96-03	12
HAWC1	1.2-03	5.4-03	1.0-04	3.72-03	2.00-05	9.01-04	1.22-02	26

Note: Exponential notation is indicated in abbreviated form; e.g., 2.0-03 = 2.0×10^{-03}.

Table B-17 (Page 1 of 7). Results of Sorts of a Composite of Operators' Evaluations To Display the Most Difficult 20 Actions with Respect to Each Performance-Shaping Factor Category

Sorted on: Preceding and Concurrent Actions

Operator	Action	Other Actions			Interfaces			Time Adequancy			Procedures			Complexity			Training			Stress			Total
Group	Code	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	FLI
WBN3	AE2	0.20	10	2.00	0.20	8	1.60	0.10	7	0.70	0.10	3	0.30	0.20	9	1.80	0.10	10	1.00	0.10	8	0.80	8.20
WBN2	CH2	0.22	9	2.00	0.11	2	0.22	0.11	3	0.33	0.11	0	0.00	0.11	0	0.00	0.11	4	0.44	0.22	8	1.78	4.78
WBN2	AE1	0.25	8	2.00	0.13	0	0.00	0.13	3	0.38	0.13	0	0.00	0.13	0	0.00	0.13	5	0.63	0.13	4	0.50	3.50
WBN3	AC1	0.29	7	2.00	0.29	8	2.29	0.14	6	0.86	0.07	7	0.50	0.00	1	0.00	0.07	1	0.07	0.14	6	0.86	6.57
WBN3	OS2	0.25	8	2.00	0.13	5	0.63	0.13	4	0.50	0.13	1	0.13	0.13	2	0.25	0.13	3	0.38	0.13	2	0.25	4.13
WBN2	OS3	0.25	8	2.00	0.13	2	0.25	0.13	3	0.38	0.13	0	0.00	0.13	0	0.00	0.13	7	0.88	0.13	5	0.63	4.13
WBN1	RE1	0.24	8	1.88	0.12	8	0.94	0.12	5	0.59	0.06	8	0.47	0.18	8	1.41	0.12	7	0.82	0.18	6	1.06	7.18
WBN3	SE1	0.27	7	1.87	0.13	6	0.80	0.27	7	1.87	0.00	0	0.00	0.13	4	0.53	0.07	4	0.27	0.13	5	0.67	6.00
WBN3	RE2	0.22	8	1.78	0.11	8	0.89	0.11	6	0.67	0.06	5	0.28	0.22	8	1.78	0.06	6	0.33	0.22	9	2.00	7.72
WBN3	OS1	0.22	8	1.78	0.11	5	0.56	0.22	7	1.56	0.11	1	0.11	0.11	2	0.22	0.11	3	0.33	0.11	2	0.22	4.78
WBN1	CI1	0.22	8	1.78	0.11	5	0.56	0.11	1	0.11	0.11	10	1.11	0.22	8	1.78	0.11	9	1.00	0.11	6	0.67	7.00
WBN1	PR1	0.21	8	1.68	0.11	3	0.32	0.21	4	0.84	0.16	0	0.00	0.11	2	0.21	0.11	1	0.11	0.11	5	0.53	3.68
WBN2	OS2	0.17	10	1.67	0.17	2	0.33	0.17	5	0.83	0.08	0	0.00	0.17	7	1.17	0.08	9	0.75	0.17	6	1.00	5.75
WBN2	OS5	0.17	10	1.67	0.17	9	1.50	0.08	5	0.42	0.17	0	0.00	0.08	4	0.33	0.17	7	1.17	0.17	10	1.67	6.75
WBN2	OS1	0.17	10	1.67	0.17	2	0.33	0.17	7	1.17	0.08	0	0.00	0.17	7	1.17	0.08	9	0.75	0.17	8	1.33	6.42
WBN2	MU1	0.18	9	1.64	0.09	8	0.73	0.09	0	0.00	0.18	1	0.18	0.18	8	1.45	0.18	9	1.64	0.09	5	0.45	6.09
WBN1	MU1	0.20	8	1.60	0.13	8	1.07	0.13	1	0.13	0.13	4	0.53	0.13	6	0.80	0.13	6	0.80	0.13	2	0.27	5.20
WBN2	DS7	0.17	9	1.57	0.17	2	0.35	0.09	3	0.26	0.04	10	0.43	0.17	7	1.22	0.17	9	1.57	0.17	8	1.39	6.78
WBN1	OS4	0.22	7	1.56	0.11	3	0.33	0.22	9	2.00	0.11	3	0.33	0.11	2	0.22	0.11	3	0.33	0.11	5	0.56	5.33
WBN1	CH2	0.22	7	1.56	0.11	5	0.56	0.22	7	1.56	0.11	1	0.11	0.11	2	0.22	0.11	1	0.11	0.11	4	0.44	4.56

Table B-17 (Page 2 of 7). Results of Sorts of a Composite of Operators' Evaluations To Display the Most Difficult 20 Actions with Respect to Each Performance-Shaping Factor Category

Sorted on: Stress

Operator Group	Action Code	Other Actions W	Other Actions S	Other Actions FLI	Interfaces W	Interfaces S	Interfaces FLI	Time Adequacy W	Time Adequacy S	Time Adequacy FLI	Procedures W	Procedures S	Procedures FLI	Complexity W	Complexity S	Complexity FLI	Training W	Training S	Training FLI	Stress W	Stress S	Stress FLI	Total FLI
WBN3	CI1	0.13	9	1.13	0.06	8	0.50	0.13	5	0.63	0.25	3	0.75	0.06	9	0.56	0.13	7	0.88	0.25	9	2.25	6.69
WBN1	MU3	0.11	7	0.78	0.11	8	0.89	0.22	0	0.00	0.06	9	0.50	0.06	9	0.50	0.22	9	2.00	0.22	10	2.22	6.89
WBN3	AF1	0.12	8	0.94	0.12	8	0.94	0.06	3	0.18	0.12	5	0.59	0.24	9	2.12	0.12	3	0.35	0.24	9	2.12	7.24
WBN2	RS1	0.13	5	0.63	0.13	2	0.25	0.13	3	0.38	0.13	0	0.00	0.13	2	0.25	0.13	7	0.88	0.25	8	2.00	4.38
WBN2	AF1	0.10	10	1.00	0.10	8	0.80	0.20	10	2.00	0.10	6	0.60	0.10	9	0.90	0.20	7	1.40	0.20	10	2.00	8.70
WBN1	RE2	0.10	8	0.80	0.10	7	0.70	0.20	10	2.00	0.10	10	1.00	0.20	10	2.00	0.10	10	1.00	0.20	10	2.00	9.50
WBN3	RE2	0.22	8	1.78	0.11	8	0.89	0.11	6	0.67	0.06	5	0.28	0.22	8	1.78	0.06	6	0.33	0.22	9	2.00	7.72
WBN3	DS6	0.11	8	0.84	0.21	8	1.68	0.05	3	0.16	0.11	3	0.32	0.21	9	1.89	0.11	3	0.32	0.21	9	1.89	7.11
WBN2	MR1	0.06	8	0.47	0.12	8	0.94	0.12	5	0.59	0.12	7	0.82	0.12	0	0.00	0.24	7	1.65	0.24	8	1.88	6.35
WBN2	CH2	0.22	9	2.00	0.11	2	0.22	0.11	3	0.33	0.11	0	0.00	0.11	0	0.00	0.11	4	0.44	0.22	8	1.78	4.78
WBN2	PR2	0.11	8	0.89	0.22	5	1.11	0.22	7	1.56	0.11	0	0.00	0.06	0	0.00	0.06	5	0.28	0.22	8	1.78	5.61
WBN1	AF1	0.19	7	1.33	0.10	9	0.86	0.14	6	0.86	0.10	1	0.10	0.19	10	1.90	0.10	4	0.38	0.19	9	1.71	7.14
WBN2	EB1	0.05	8	0.42	0.21	2	0.42	0.11	5	0.53	0.11	7	0.74	0.11	8	0.84	0.21	4	0.84	0.21	8	1.68	5.47
WBN3	MU3	0.11	8	0.84	0.11	9	0.95	0.21	7	1.47	0.05	5	0.26	0.21	9	1.89	0.11	6	0.63	0.21	8	1.68	7.74
WBN2	MU2	0.17	9	1.50	0.08	2	0.17	0.17	F	0.00	0.17	0	0.00	0.17	8	1.33	0.08	6	0.50	0.17	10	1.67	FAIL
WBN2	OS5	0.17	10	1.67	0.17	9	1.50	0.08	5	0.42	0.17	0	0.00	0.08	4	0.33	0.17	7	1.17	0.17	10	1.67	6.75
WBN2	CI1	0.00	9	0.00	0.17	8	1.33	0.17	7	1.17	0.17	5	0.83	0.17	9	1.50	0.17	9	1.50	0.17	10	1.67	8.00
WBN3	MU2	0.10	8	0.80	0.10	8	0.80	0.20	8	1.60	0.10	5	0.50	0.20	9	1.80	0.10	5	0.50	0.20	8	1.60	7.60
WBN2	AC1	0.20	7	1.40	0.20	0	0.00	0.10	4	0.40	0.10	0	0.00	0.10	0	0.00	0.10	5	0.50	0.20	8	1.60	3.90
WBN2	DS6	0.15	8	1.23	0.15	8	1.23	0.15	10	1.54	0.08	2	0.15	0.15	9	1.38	0.15	7	1.08	0.15	10	1.54	8.15
WBN2	MU3	0.15	9	1.38	0.08	2	0.15	0.15	F	0.00	0.15	8	1.23	0.15	9	1.38	0.15	10	1.54	0.15	10	1.54	FAIL

Table B-17 (Page 3 of 7). Results of Sorts of a Composite of Operators' Evaluations To Display the Most Difficult 20 Actions with Respect to Each Performance-Shaping Factor Category

Sorted on: Time Adequacy

Operator Group	Action Code	Other Actions W	Other Actions S	Other Actions FLI	Interfaces W	Interfaces S	Interfaces FLI	Time Adequancy W	Time Adequancy S	Time Adequancy FLI	Procedures W	Procedures S	Procedures FLI	Complexity W	Complexity S	Complexity FLI	Training W	Training S	Training FLI	Stress W	Stress S	Stress FLI	Total FLI
WBN1	MR1	0.13	0	0.00	0.13	2	0.25	0.25	10	2.50	0.13	1	0.13	0.13	2	0.25	0.13	1	0.13	0.13	4	0.50	3.75
WBN1	MU2	0.12	4	0.47	0.12	8	0.94	0.24	10	2.35	0.06	8	0.47	0.12	9	1.06	0.24	6	1.41	0.12	9	1.06	7.76
WBN2	SE1	0.17	7	1.17	0.17	5	0.83	0.33	7	2.33	0.00	7	0.00	0.00	2	0.00	0.17	5	0.83	0.17	8	1.33	6.50
WBN1	DS5	0.20	7	1.40	0.10	8	0.80	0.20	10	2.00	0.10	1	0.10	0.20	10	2.00	0.10	2	0.20	0.10	10	1.00	7.50
WBN1	RE2	0.10	8	0.80	0.10	7	0.70	0.20	10	2.00	0.10	10	1.00	0.20	10	2.00	0.10	10	1.00	0.20	10	2.00	9.50
WBN2	AF1	0.10	10	1.00	0.10	8	0.80	0.20	10	2.00	0.10	6	0.60	0.10	9	0.90	0.20	7	1.40	0.20	10	2.00	8.70
WBN3	OS4	0.13	8	1.00	0.13	5	0.63	0.25	8	2.00	0.13	5	0.63	0.13	2	0.25	0.13	3	0.38	0.13	6	0.75	5.63
WBN1	PR2	0.17	8	1.33	0.11	3	0.33	0.22	9	2.00	0.17	0	0.00	0.11	2	0.22	0.11	1	0.11	0.11	6	0.67	4.67
WBN1	OS4	0.22	7	1.56	0.11	3	0.33	0.22	9	2.00	0.11	3	0.33	0.11	2	0.22	0.11	3	0.33	0.11	5	0.56	5.33
WBN3	RT1	0.10	3	0.30	0.20	2	0.40	0.40	5	2.00	0.00	0	0.00	0.00	2	0.00	0.20	4	0.80	0.10	4	0.40	3.90
WBN3	SE2	0.13	8	1.07	0.27	8	2.13	0.27	7	1.87	0.07	5	0.33	0.07	2	0.13	0.07	2	0.13	0.13	4	0.53	6.20
WBN3	OF1	0.07	5	0.33	0.13	8	1.07	0.27	7	1.87	0.13	5	0.67	0.13	8	1.07	0.13	4	0.53	0.13	6	0.80	6.33
WBN3	OF2	0.07	5	0.33	0.13	8	1.07	0.27	7	1.87	0.13	5	0.67	0.13	9	1.20	0.13	4	0.53	0.13	6	0.80	6.47
WBN3	SE1	0.27	7	1.87	0.13	6	0.80	0.27	7	1.87	0.00	0	0.00	0.13	4	0.53	0.07	4	0.27	0.13	5	0.67	6.00
WBN3	MR1	0.18	5	0.91	0.18	2	0.36	0.36	5	1.82	0.00	0	0.00	0.09	2	0.18	0.00	4	0.00	0.18	5	0.91	4.18
WBN1	DS4	0.20	5	1.00	0.10	8	0.80	0.20	9	1.80	0.10	1	0.10	0.20	9	1.80	0.10	2	0.20	0.10	10	1.00	6.70
WBN3	OS5	0.13	8	1.00	0.13	8	1.00	0.25	7	1.75	0.13	6	0.75	0.13	8	1.00	0.13	3	0.38	0.13	6	0.75	6.63
WBN3	PR2	0.08	3	0.25	0.17	0	0.00	0.33	5	1.67	0.17	0	0.00	0.00	2	0.00	0.08	4	0.33	0.17	6	1.00	3.25
WBN3	MU2	0.10	8	0.80	0.10	8	0.80	0.20	8	1.60	0.10	5	0.50	0.20	9	1.80	0.10	5	0.50	0.20	8	1.60	7.60
WBN3	EB1	0.10	5	0.50	0.20	8	1.60	0.20	8	1.60	0.10	7	0.70	0.20	9	1.80	0.10	4	0.40	0.10	6	0.60	7.20
WBN1	OS5	0.16	8	1.28	0.16	8	1.28	0.16	10	1.60	0.04	10	0.40	0.16	8	1.28	0.16	9	1.44	0.16	8	1.28	8.56

Table B-17 (Page 4 of 7). Results of Sorts of a Composite of Operators' Evaluations To Display the Most Difficult 20 Actions with Respect to Each Performance-Shaping Factor Category

Sorted on: Complexity

Operator Group	Action Code	Other Actions W	Other Actions S	Other Actions FLI	Interfaces W	Interfaces S	Interfaces FLI	Time Adequancy W	Time Adequancy S	Time Adequancy FLI	Procedures W	Procedures S	Procedures FLI	Complexity W	Complexity S	Complexity FLI	Training W	Training S	Training FLI	Stress W	Stress S	Stress FLI	Total FLI
WBN3	MU1	0.13	7	0.93	0.13	8	1.07	0.07	3	0.20	0.13	5	0.67	0.27	9	2.40	0.13	8	1.07	0.13	5	0.67	7.00
WBN1	OF2	0.12	7	0.82	0.12	7	0.82	0.18	6	1.06	0.06	2	0.12	0.24	9	2.12	0.18	7	1.24	0.12	5	0.59	6.76
WBN1	OF1	0.12	5	0.59	0.12	7	0.82	0.18	5	0.88	0.06	7	0.41	0.24	9	2.12	0.18	7	1.24	0.12	5	0.59	6.65
WBN3	AF1	0.12	8	0.94	0.12	8	0.94	0.06	3	0.18	0.12	5	0.59	0.24	9	2.12	0.12	3	0.35	0.24	9	2.12	7.24
WBN3	AC2	0.13	6	0.75	0.13	8	1.00	0.13	5	0.63	0.13	3	0.38	0.25	8	2.00	0.13	5	0.63	0.13	5	0.63	6.00
WBN1	DS5	0.20	7	1.40	0.10	8	0.80	0.20	10	2.00	0.10	1	0.10	0.20	10	2.00	0.10	2	0.20	0.10	10	1.00	7.50
WBN1	RE2	0.10	8	0.80	0.10	7	0.70	0.20	10	2.00	0.10	10	1.00	0.20	10	2.00	0.10	10	1.00	0.20	10	2.00	9.50
WBN1	DS6	0.19	7	1.33	0.14	9	1.29	0.14	10	1.43	0.10	2	0.19	0.19	10	1.90	0.10	2	0.19	0.14	10	1.43	7.76
WBN1	AF1	0.19	7	1.33	0.10	9	0.86	0.14	6	0.86	0.10	1	0.10	0.19	10	1.90	0.10	4	0.38	0.19	9	1.71	7.14
WBN3	DS6	0.11	8	0.84	0.21	8	1.68	0.05	3	0.16	0.11	3	0.32	0.21	9	1.89	0.11	3	0.32	0.21	9	1.89	7.11
WBN3	MU3	0.11	8	0.84	0.11	9	0.95	0.21	7	1.47	0.05	5	0.26	0.21	9	1.89	0.11	6	0.63	0.21	8	1.68	7.74
WBN1	EB1	0.11	0	0.00	0.11	8	0.84	0.21	7	1.47	0.11	0	0.00	0.21	9	1.89	0.16	2	0.32	0.11	5	0.53	5.05
WBN3	RD1	0.12	5	0.59	0.12	8	0.94	0.06	5	0.29	0.24	3	0.71	0.24	8	1.88	0.12	7	0.82	0.12	4	0.47	5.71
WBN1	DS4	0.20	5	1.00	0.10	8	0.80	0.20	9	1.80	0.10	1	0.10	0.20	9	1.80	0.10	2	0.20	0.10	10	1.00	6.70
WBN3	EB1	0.10	5	0.50	0.20	8	1.60	0.20	8	1.60	0.10	7	0.70	0.20	9	1.80	0.10	4	0.40	0.10	6	0.60	7.20
WBN3	AE2	0.20	10	2.00	0.20	8	1.60	0.10	7	0.70	0.10	3	0.30	0.20	9	1.80	0.10	10	1.00	0.10	8	0.80	8.20
WBN3	MU2	0.10	8	0.80	0.10	8	0.80	0.20	8	1.60	0.10	5	0.50	0.20	9	1.80	0.10	5	0.50	0.20	8	1.60	7.60
WBN3	RE2	0.22	8	1.78	0.11	8	0.89	0.11	6	0.67	0.06	5	0.28	0.22	8	1.78	0.06	6	0.33	0.22	9	2.00	7.72
WBN1	CI1	0.22	8	1.78	0.11	5	0.56	0.11	1	0.11	0.11	10	1.11	0.22	8	1.78	0.11	9	1.00	0.11	6	0.67	7.00
WBN3	DS7	0.11	8	0.89	0.22	8	1.78	0.11	7	0.78	0.11	3	0.33	0.22	8	1.78	0.11	3	0.33	0.11	6	0.67	6.56

Table B-17 (Page 5 of 7). Results of Sorts of a Composite of Operators' Evaluations To Display the Most Difficult 20 Actions with Respect to Each Performance-Shaping Factor Category

Sorted on: Training

Operator	Action	Other Actions			Interfaces			Time Adequancy			Procedures			Complexity			Training			Stress			Total
Group	Code	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	FLI
WBN1	MU3	0.11	7	0.78	0.11	8	0.89	0.22	0	0.00	0.06	9	0.50	0.06	9	0.50	0.22	9	2.00	0.22	10	2.22	6.89
WBN2	DS5	0.10	8	0.76	0.19	2	0.38	0.10	7	0.67	0.05	10	0.48	0.19	7	1.33	0.19	9	1.71	0.19	8	1.52	6.86
WBN2	DS3	0.10	3	0.29	0.19	1	0.19	0.10	5	0.48	0.05	10	0.48	0.19	7	1.33	0.19	9	1.71	0.19	8	1.52	6.00
WBN2	MR1	0.06	8	0.47	0.12	8	0.94	0.12	5	0.59	0.12	7	0.82	0.12	0	0.00	0.24	7	1.65	0.24	8	1.88	6.35
WBN2	MU1	0.18	9	1.64	0.09	8	0.73	0.09	0	0.00	0.18	1	0.18	0.18	8	1.45	0.18	9	1.64	0.09	5	0.45	6.09
WBN2	DS7	0.17	9	1.57	0.17	2	0.35	0.09	3	0.26	0.04	10	0.43	0.17	7	1.22	0.17	9	1.57	0.17	8	1.39	6.78
WBN2	MU3	0.15	9	1.38	0.08	2	0.15	0.15	F	0.00	0.15	8	1.23	0.15	9	1.38	0.15	10	1.54	0.15	10	1.54	FAIL
WBN2	CI1	0.00	9	0.00	0.17	8	1.33	0.17	7	1.17	0.17	5	0.83	0.17	9	1.50	0.17	9	1.50	0.17	10	1.67	8.00
WBN2	OF2	0.17	8	1.33	0.17	2	0.33	0.08	7	0.58	0.08	6	0.50	0.17	9	1.50	0.17	9	1.50	0.17	8	1.33	7.08
WBN2	DS1	0.11	3	0.32	0.21	2	0.42	0.05	0	0.00	0.21	3	0.63	0.11	8	0.84	0.21	7	1.47	0.11	4	0.42	4.11
WBN2	DS2	0.11	3	0.32	0.21	2	0.42	0.05	0	0.00	0.21	2	0.42	0.11	7	0.74	0.21	7	1.47	0.11	4	0.42	3.79
WBN1	OS5	0.16	8	1.28	0.16	8	1.28	0.16	10	1.60	0.04	10	0.40	0.16	8	1.28	0.16	9	1.44	0.16	8	1.28	8.56
WBN2	AE2	0.14	10	1.43	0.14	9	1.29	0.14	10	1.43	0.14	10	1.43	0.14	10	1.43	0.14	10	1.43	0.14	10	1.43	9.86
WBN3	RE1	0.14	6	0.86	0.07	8	0.57	0.14	7	1.00	0.07	5	0.36	0.14	8	1.14	0.29	5	1.43	0.14	5	0.71	6.07
WBN1	MU2	0.12	4	0.47	0.12	8	0.94	0.24	10	2.35	0.06	8	0.47	0.12	9	1.06	0.24	6	1.41	0.12	9	1.06	7.76
WBN2	AF1	0.10	10	1.00	0.10	8	0.80	0.20	10	2.00	0.10	6	0.60	0.10	9	0.90	0.20	7	1.40	0.20	10	2.00	8.70
WBN2	AC2	0.15	8	1.23	0.15	0	0.00	0.15	7	1.08	0.08	8	0.62	0.15	7	1.08	0.15	9	1.38	0.15	8	1.23	6.62
WBN1	OS2	0.10	8	0.76	0.10	8	0.76	0.19	6	1.14	0.19	5	0.95	0.10	8	0.76	0.19	7	1.33	0.14	8	1.14	6.86
WBN2	OB1	0.17	9	1.50	0.17	8	1.33	0.17	8	1.33	0.08	5	0.42	0.08	2	0.17	0.17	8	1.33	0.17	8	1.33	7.42
WBN3	RH1	0.17	4	0.67	0.00	2	0.00	0.00	5	0.00	0.33	0	0.00	0.17	2	0.33	0.17	8	1.33	0.17	5	0.83	3.17
WBN1	OS1	0.10	8	0.76	0.10	8	0.76	0.19	6	1.14	0.19	5	0.95	0.10	8	0.76	0.19	7	1.33	0.14	8	1.14	6.86

Table B-17 (Page 6 of 7). Results of Sorts of a Composite of Operators' Evaluations To Display the Most Difficult 20 Actions with Respect to Each Performance-Shaping Factor Category

Sorted on: Plant Interfaces

Operator	Action	Other Actions			Interfaces			Time Adequacy			Procedures			Complexity			Training			Stress			Total
Group	Code	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	FLI
WBN3	AC1	0.29	7	2.00	0.29	8	2.29	0.14	6	0.86	0.07	7	0.50	0.00	1	0.00	0.07	1	0.07	0.14	6	0.86	6.57
WBN3	SE2	0.13	8	1.07	0.27	8	2.13	0.27	7	1.87	0.07	5	0.33	0.07	2	0.13	0.07	2	0.13	0.13	4	0.53	6.20
WBN3	DS7	0.11	8	0.89	0.22	8	1.78	0.11	7	0.78	0.11	3	0.33	0.22	8	1.78	0.11	3	0.33	0.11	6	0.67	6.56
WBN3	DS6	0.11	8	0.84	0.21	8	1.68	0.05	3	0.16	0.11	3	0.32	0.21	9	1.89	0.11	3	0.32	0.21	9	1.89	7.11
WBN3	EB1	0.10	5	0.50	0.20	8	1.60	0.20	8	1.60	0.10	7	0.70	0.20	9	1.80	0.10	4	0.40	0.10	6	0.60	7.20
WBN3	AE2	0.20	10	2.00	0.20	8	1.60	0.10	7	0.70	0.10	3	0.30	0.20	9	1.80	0.10	10	1.00	0.10	8	0.80	8.20
WBN2	SE2	0.10	3	0.29	0.19	8	1.52	0.19	5	0.95	0.19	2	0.38	0.05	7	0.33	0.19	3	0.57	0.10	6	0.57	4.62
WBN2	OS5	0.17	10	1.67	0.17	9	1.50	0.08	5	0.42	0.17	0	0.00	0.08	4	0.33	0.17	7	1.17	0.17	10	1.67	6.75
WBN2	RE1	0.14	9	1.29	0.14	10	1.43	0.14	10	1.43	0.14	8	1.14	0.14	7	1.00	0.14	9	1.29	0.14	10	1.43	9.00
WBN2	OB1	0.17	9	1.50	0.17	8	1.33	0.17	8	1.33	0.08	5	0.42	0.08	2	0.17	0.17	8	1.33	0.17	8	1.33	7.42
WBN2	CI1	0.00	9	0.00	0.17	8	1.33	0.17	7	1.17	0.17	5	0.83	0.17	9	1.50	0.17	9	1.50	0.17	10	1.67	8.00
WBN2	RE2	0.14	10	1.43	0.14	9	1.29	0.14	F	0.00	0.14	0	0.00	0.14	9	1.29	0.14	8	1.14	0.14	10	1.43	FAIL
WBN2	AE2	0.14	10	1.43	0.14	9	1.29	0.14	10	1.43	0.14	10	1.43	0.14	10	1.43	0.14	10	1.43	0.14	10	1.43	9.86
WBN1	DS6	0.19	7	1.33	0.14	9	1.29	0.14	10	1.43	0.10	2	0.19	0.19	10	1.90	0.10	2	0.19	0.14	10	1.43	7.76
WBN1	OS5	0.16	8	1.28	0.16	8	1.28	0.16	10	1.60	0.04	10	0.40	0.16	8	1.28	0.16	9	1.44	0.16	8	1.28	8.56
WBN2	DS6	0.15	8	1.23	0.15	8	1.23	0.15	10	1.54	0.08	2	0.15	0.15	9	1.38	0.15	7	1.08	0.15	10	1.54	8.15
WBN3	DS1	0.17	5	0.83	0.17	7	1.17	0.00	1	0.00	0.17	3	0.50	0.17	8	1.33	0.17	4	0.67	0.17	4	0.67	5.17
WBN3	DS5	0.14	5	0.71	0.14	8	1.14	0.14	5	0.71	0.14	3	0.43	0.14	8	1.14	0.14	3	0.43	0.14	6	0.86	5.43
WBN3	DS4	0.14	5	0.71	0.14	8	1.14	0.14	5	0.71	0.14	3	0.43	0.14	8	1.14	0.14	3	0.43	0.14	6	0.86	5.43
WBN2	RR2	0.14	10	1.43	0.14	8	1.14	0.14	10	1.43	0.14	0	0.00	0.14	8	1.14	0.14	7	1.00	0.14	8	1.14	7.29

Table B-17 (Page 7 of 7). Results of Sorts of a Composite of Operators' Evaluations To Display the Most Difficult 20 Actions with Respect to Each Performance-Shaping Factor Category

Sorted on: Procedures

Operator	Action	Other Actions			Interfaces			Time Adequancy			Procedures			Complexity			Training			Stress			Total
Group	Code	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	W	S	FLI	FLI
WBN2	WC1	0.17	5	0.83	0.17	2	0.33	0.17	7	1.17	0.17	9	1.50	0.08	5	0.42	0.08	7	0.58	0.17	8	1.33	6.17
WBN2	AE2	0.14	10	1.43	0.14	9	1.29	0.14	10	1.43	0.14	10	1.43	0.14	10	1.43	0.14	10	1.43	0.14	10	1.43	9.86
WBN2	MU3	0.15	9	1.38	0.08	2	0.15	0.15	F	0.00	0.15	8	1.23	0.15	9	1.38	0.15	10	1.54	0.15	10	1.54	FAIL
WBN2	SL1	0.10	3	0.30	0.20	2	0.40	0.10	3	0.30	0.20	6	1.20	0.10	2	0.20	0.20	1	0.20	0.10	4	0.40	3.00
WBN2	RE1	0.14	9	1.29	0.14	10	1.43	0.14	10	1.43	0.14	8	1.14	0.14	7	1.00	0.14	9	1.29	0.14	10	1.43	9.00
WBN1	CI1	0.22	8	1.78	0.11	5	0.56	0.11	1	0.11	0.11	10	1.11	0.22	8	1.78	0.11	9	1.00	0.11	6	0.67	7.00
WBN1	RE2	0.10	8	0.80	0.10	7	0.70	0.20	10	2.00	0.10	10	1.00	0.20	10	2.00	0.10	10	1.00	0.20	10	2.00	9.50
WBN1	OS2	0.10	8	0.76	0.10	8	0.76	0.19	6	1.14	0.19	5	0.95	0.10	8	0.76	0.19	7	1.33	0.14	8	1.14	6.86
WBN1	OS1	0.10	8	0.76	0.10	8	0.76	0.19	6	1.14	0.19	5	0.95	0.10	8	0.76	0.19	7	1.33	0.14	8	1.14	6.86
WBN2	DS4	0.09	5	0.45	0.18	2	0.36	0.09	5	0.45	0.18	5	0.91	0.09	8	0.73	0.18	7	1.27	0.18	8	1.45	5.64
WBN2	CI1	0.00	9	0.00	0.17	8	1.33	0.17	7	1.17	0.17	5	0.83	0.17	9	1.50	0.17	9	1.50	0.17	10	1.67	8.00
WBN2	MR1	0.06	8	0.47	0.12	8	0.94	0.12	5	0.59	0.12	7	0.82	0.12	0	0.00	0.24	7	1.65	0.24	8	1.88	6.35
WBN2	RT1	0.06	3	0.18	0.24	0	0.00	0.12	5	0.59	0.12	7	0.82	0.00	5	0.00	0.24	2	0.47	0.24	5	1.18	3.24
WBN3	CI1	0.13	9	1.13	0.06	8	0.50	0.13	5	0.63	0.25	3	0.75	0.06	9	0.56	0.13	7	0.88	0.25	9	2.25	6.69
WBN3	OS5	0.13	8	1.00	0.13	8	1.00	0.25	7	1.75	0.13	6	0.75	0.13	8	1.00	0.13	3	0.38	0.13	6	0.75	6.63
WBN1	AE2	0.19	8	1.50	0.13	7	0.88	0.13	6	0.75	0.13	6	0.75	0.19	7	1.31	0.13	6	0.75	0.13	7	0.88	6.81
WBN2	EB1	0.05	8	0.42	0.21	2	0.42	0.11	5	0.53	0.11	7	0.74	0.11	8	0.84	0.21	4	0.84	0.21	8	1.68	5.47
WBN3	CT1	0.00	1	0.00	0.00	2	0.00	0.29	5	1.43	0.14	5	0.71	0.00	1	0.00	0.29	4	1.14	0.29	5	1.43	4.71
WBN3	RD1	0.12	5	0.59	0.12	8	0.94	0.06	5	0.29	0.24	3	0.71	0.24	8	1.88	0.12	7	0.82	0.12	4	0.47	5.71
WBN2	OF1	0.10	8	0.80	0.20	2	0.40	0.10	5	0.50	0.10	7	0.70	0.20	8	1.60	0.20	4	0.80	0.10	6	0.60	5.40
WBN3	EB1	0.10	5	0.50	0.20	8	1.60	0.20	8	1.60	0.10	7	0.70	0.20	9	1.80	0.10	4	0.40	0.10	6	0.60	7.20

Table B-18 (Page 1 of 2). Summary of Watts Bar Recovery Actions Incorporated into the Plant Model

Top Event	Database Variable	Definition of Action	Time Constraints	Mean HER /Demand
IE	FLAB1R	Identify and Isolate ERCW Header Flood in Auxiliary Building	Hypothesized break large enough to flood RHR and CS pumps within 30 minutes.	0.001010
IE	FLAB3C	Identify and Isolate a Break in the Condensate Storage Tank Discharge Piping, Given Break Can be Isolated	Hypothesized break large enough to release 200,000 gallons within 20 minutes.	0.008860
IE	FLPH1R	Identify and Isolate a Line Break in Intake Piping A1A-A (or one of other three systems) in the Strainer Room	Assume up to 45 minutes to isolate leak before component cooling problems result in the loss of cooled equipment.	0.001550
IE	FLPH2R	Identify and Isolate an ERCW Intake Line Break in the Pump Room of ERCW Intake	Assume up to 45 minutes to isolate leak before component cooling problems require reactor trip.	0.001550
AF	HAFR1	Restore Auxiliary Feedwater Flow, Given Loss of Control Air.	Approximately 50 minutes available after air accumulators lost to steam generator dryout.	0.005030
RL	HARL1	Recover from an Automatic Sump Swapover Failure	Approximately 5 minutes before RWST reaches a point at which pumps lose suction.	0.004030
CCSR	HCCSR1	Align the C-S Pump to the A CCS Heat Exchanger	Estimate 5 to 10 minutes available before charging pump failure.	0.194000
CCPR	HCCSR2	Align and Initiate Alternate Component Cooling to the Charging Pump	Estimate 5 to 10 minutes available before charging pump failure.	0.016100
CCSR	HCCSR3	Align ERCW Header 2A to CCS Heat Exchanger A, Given Loss of B Train ERCW.	Assume 45 minutes available before vital equipment begins to fail due to overheating.	0.001550
	HCRL1	Inadvertently Reset SI Signal, Failure of Automatic Sump Swapover	Not applicable - error of commission, Swain and Guttman estimate	0.003750
DA DB DC DD	HDAR1	Switch to Spare Battery Charger, Given Operating Charger Fails.	At least 2 hours (without recharging under normal bus loads) before batteries are depleted.	0.017800
DS	HDSR1	Cooldown and Depressurize by Cycling S/G PORV's Full Open/Full Closed.	Continuous control requirement until RCS below secondary system pressure. Respond to anomalies within 5 minutes.	0.001250

Table B-18 (Page 2 of 2). Summary of Watts Bar Recovery Actions Incorporated into the Plant Model

Top Event	Database Variable	Definition of Action	Time Constraints	Mean HER /Demand
DSLR	HERCW1	Recover ERCW Cooling To Operating Diesel Generator, Given Loss of ERCW to the Diesel Generator	Trip the diesel generators within 5 minutes to avoid overheating failure. Complete alignment and restart within 30 minutes.	0.035500
No Credit Taken	HERCW2	Cool Down with Auxiliary Feedwater and Steam Generator PORV's, Given Total Loss of ERCW, RSW Available To Cool Air Compressor	Initiate cool down within 10 minutes (as soon as possible) to avoid seal damage at 1 hour. Control over 2 hours.	0.012500
DSLR	HERCW3	Cooldown with Auxiliary Feedwater and S/G PORV's, Given Total Loss of ERCW, RSW Not Available To Cool Air Compressors	Initiate cooldown within 10 minutes to avoid seal damage at 1 hour. Control over 2 hours.	0.050000
TPR	HSLR1	Locally Transfer Steam Supply to TDAFP, Given Station Blackout and Loss of Steam Generator #1	Approximately 1 hour to steam generator dryout, given RCPs not running.	0.017800
TPR	HTPR1	Start Turbine Driven Pump, Given it Failed To Start due To Control or Signal Failures	Steam Generator dryout at approximately 50 minutes if RCPs running.	0.008250
V1R V2R	HV1R1	Restore Ventilation to 6.9-k V Switchgear Room	At least 12 hours to accomplish before temperature approaches design limits.	0.000373
VNV1R VNV2R	HVNVR1	Restore Ventilation to the 480V Board Room 1BB (2BB), Given Loss of Room Supply Fan	Six hours to heat up past allowable limits.	0.002080
VT1AR VT1BR VT2AR VT2BR	HVT1AR	Establish Portable Ventilation to the Shutdown Board Transformer Room	Five hours to heat up past allowable limits, given four fully loaded tranformers.	0.002080

Table B-19 (Page 1 of 20). Operator Response Forms Used To Assess Recovery Actions

HAFR1: Restore Auxiliary Feedwater Flow, Given Loss of Control Air and Plant Trip

PRECEDING EVENTS

- Loss of control air subsystem (CAS).
- Subsequent failure of ACAS compressors A & B.
- Reactor trip due to main feedwater regulating valves failing closed.
- Auxiliary air has isolated from the control air.
- Motor driven auxiliary feedwater has failed and the TDAFP level control valves have failed closed.

INDICATIONS OF PLANT CONDITION

- Decreasing NR levels in the S/G's.
- Various equipment not functioning because of air failures.
- Main control room HVAC failed.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- AOI-10 loss of control air.
- Take local manual control of S/G level control valves using SOI-3.2.
- Take local manual control of the Terry turbine level control valves.
- Open the motor driven turbine pressure control valves and set the discharge pressure at 1,200 psi.
- Control any one of three auxiliary feedwater pumps.

CONCURRENT ACTIONS/COMPETING FACTORS

- In EOI's.
- Responding to a variety of failures.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT

- NR level restored in at least 2 S/G's.

FAILURE IMPACT

- Feed and bleed required.

TIME CONSTRAINTS

- Approximately 40 minutes available after air accumulators lost to S/G dryout.

Table B-19 (Page 2 of 20). Operator Response Forms Used To Assess Recovery Actions

HARL1: Recover from an automatic sump swapover failure

PRECEDING EVENTS
- Large break LOCA.
- SI signal reset.

INDICATIONS OF PLANT CONDITION
- RHR safety injection into core.
- Containment press = 3 psig and dropping.
- Two trains CS operating at @4,800 gpm.
- RWST level < 27% and dropping.
- Sump level > 11.25% and rising.
- White lights for FCV-63-73 & 63-72 SI signal not lit.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Level transmitters are functioning properly. **(NOTE: Recovery from a swapover failure due to erroneous level indications. The operators stated that they will believe their readings if the readings are not obviously wrong, eg. stationary when they can see flow from the RWST tank.)**
- Recognize failure to swapover.
- Swap ECCS pump suction to sump prior to 8% level in RWST.
- Perform manual alignment to sump for RHR pumps suction.

CONCURRENT ACTIONS/COMPETING FACTORS
- Site emergency called and TSC being activated.
- Monitoring core response to blowdown and refill.
- Sump swapover takes precedence over all other procedures.
- Numerous other alarms and responses associated with a LOCA competing for operators attention.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT
- Indications of RHR and CS pump suction alignment to containment sump.
- RWST level stops declining.
- Sump level stabilizes.

FAILURE IMPACT
- Loss of suction to ECCS pumps.
- Core uncovery and melt.
- Potential for pump burnout that would hinder containment functions.

TIME CONSTRAINTS
- Approx 5 minutes before RWST reaches 8% and pumps lose suction.

NOTES:
- This action will be used to recover from all failures except level transmitter failure modes. It was evaluated for recovery from an inadvertent reset of the SI signal, which is considered to bound the operators' error rate for accomplishing the swapover manually.

Table B-19 (Page 3 of 20). Operator Response Forms Used To Assess Recovery Actions

HCCSR1: Align the C-S Pump to the A CCS Heat Exchanger

PRECEDING EVENTS
- Unit at 100% power under normal operations.
- Loss of 1A CCS pump.

AND
- Loss of 1B shutdown board.

INDICATIONS OF PLANT CONDITION
- Low flows on CCS A train heat exchanger.
- High temp on components serviced by A train CCS.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

Note: No procedures available for this action.
- Realign CCS flow B Train of Unit 1 to A train of Unit 1.
- Close valve 0-70-510 to the C heat exchanger.
- Open 1-FCV-70-13 and 1_FCV-70-23 to the A train heat exchanger.
- Verify CCS return path.

CONCURRENT ACTIONS/COMPETING FACTORS
- Possible removal of RCP's from service.
- Reactor trip and associated shutdown actions.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT
- 1A CCP restored to service & RCP seal injection established.
- Charging & letdown restored and inventory maintained.
- RCP oil cooler and thermal barrier in service.

FAILURE IMPACT
- Seal LOCA.

TIME CONSTRAINTS
- Estimate 5-10 minutes to charging pump failure.
- Procedure gives operators 2 minutes to trip RCP's when oil cooler heat exchangers lost.

Table B-19 (Page 4 of 20). Operator Response Forms Used To Assess Recovery Actions

HCCSR2: Align and Initiate Alternate Component Cooling to the Charging Pump

PRECEDING EVENTS

- Loss of B train CCS or B Train CCS out-of-service.

AND

- Loss of CCS to 1A CCP (A Train ESF header).

INDICATIONS OF PLANT CONDITION

- Low flows on CCS A & B train or low A Train flow w/B CCP OOS.
- High temp on components serviced by CCS.
- Reactor building header flow low.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- Turn off charging pumps (Guidelines in AOI-15 on loss of ESF header).
- Realign ERCW to the A train (AOI-15, note on checklist 2).

CONCURRENT ACTIONS/COMPETING FACTORS

- Possible removal of RCP's from service.
- Reactor trip and associated shutdown actions.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT

- 1A CCP restored to service & RCP seal injection established.
- Charging & letdown restored and inventory maintained.

FAILURE IMPACT

- Seal LOCA.

TIME CONSTRAINTS

- Estimate 5-10 minutes to charging pump failure.

Table B-19 (Page 5 of 20). Operator Response Forms Used To Assess Recovery Actions

HCCSR3: Align ERCW Header 2A to Heat Exchanger A, Given Loss of B Train ERCW

PRECEDING EVENTS
- Unit at 100% power.
- Loss of ERCW Train B.

INDICATIONS OF PLANT CONDITION
- Alarm: ERCW header pressure abnormal.
- White lights on Header 1B pumps.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Alarm response.
- Recognize reduction of ERCW flow.
- Identify source of alarm.
- Close valve 1-FCV-67-458.
- Open valves 1-FCV-67-233 and 2-FCV-67-233.

NOTE: There is no specific procedure for realignment.

CONCURRENT ACTIONS/COMPETING FACTORS
- Evaluating necessity to trip reactor and RCPs.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT
- ERCW flow established to CCS HX A.
- Continued availability of equipment cooled by CCS Train A.
- No requirement to trip RCPs.

FAILURE IMPACT
- Loss of equipment cooled by CCS Train A HX.
- Requirement to trip RCP.

TIME CONSTRAINTS
- Assume the water in CCS Train A takes 20 minutes to heat up to unacceptable temperature for cooling.

NOTES
- Not directly quantified with operators. Use the HER quantified for the action FLPH2R, which is considered to be a conservative estimate for application to this action for the reasons stated below.
- This action is very similar to FLPH2R regarding the valve manipulation and end effect. This action has less available time and less cues than the flooding response action (ie no high water level alarms), but there is less to do, and it can be done from the Control Room. Given that there is no requirement to dispatch personnel to investigate a leak, the 20 minutes allocated for success in the above action is judged to be equivalent to the 45 minutes available for success for FLPH2R.

Table B-19 (Page 6 of 20). Operator Response Forms Used To Assess Recovery Actions

HCCSRE: Align C-S Pump to alternate source of power, given failure of 2B-1B Shutdown Board.

PRECEDING EVENTS
- Scenario not defined; action hypothesized for a sequence that is not longer dominant.
- Train A CCP tagged out for maintanence (or other reason to lose Train A).
- Loss of 2B-1B Shutdown Board.

NOTE: If this action is requied during a transient requiring SI or CS, we need to know why the A train equipment is not working while the A train powe is available.

INDICATIONS OF PLANT CONDITION
- Alarm for loss of 2B-1B Shutdown Board.
- Overheating of cooled equipment.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

NOTE: There are no specific procedures for this action. There are precautions regrading this action in SOI-70.01, CCS.
- Recognize loss of 2B-1B Shutdown Board.
- Recognize overheating of cooled equipment.
- Dispatch AUO to transfer power to 1A-2A Shutdown Board [**covered in ARI?**].
- AUO manipulates transfer switches on local panel.
- Select alternate power source on control panel.
- Reinitiate C-S pump.

CONCURRENT ACTIONS/COMPETING FACTORS
- Loss of other equipment powered bv.

INDICATION OF SUCCESSFUL COMPLETION/SUCCESS IMPACT

FAILURE IMPACT

TIME CONSTRAINTS

NOTES
- This action was quantified from a composite of previous operator evaluations as follows:

  The action is considered to have two sources of error, recognition and error during local manipulation of controls. The recognition problem is similar to HERCW1 (Recover ERCW cooling to opposite train diesel generator, given total loss of ERCW). The local action has the same type of focus as HSLR1 (Locally transfer steam supply to TDAFP, given station blackout and loss of steam generator #1), in that it manipulations for alignment of source of motive force.

  The HER for CCSRE is estimated by summing the median HER for both of the above actions (thus taking the total HER of each to model a portion of the action). This produces the following lognormal distribution parameters.

  Median = 2.2E-02 + 1.1E-02 = 3.3E-02, Range factor = 5

Table B-19 (Page 7 of 20). Operator Response Forms Used To Assess Recovery Actions

HDAR1: Switch to spare battery charger, given operating charger fails

PRECEDING EVENTS
- Unit at 100% power during normal operations.

INDICATIONS OF PLANT CONDITION
- Alarm: low vital DC bus voltage.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

CONCURRENT ACTIONS/COMPETING FACTORS
- Primary focus of attention.

INDICATION OF SUCCESSFUL COMPLETION

FAILURE IMPACT
- Further loss of battery charge and bus voltage, resulting in a plant trip with loss of one vital DC bus.

TIME CONSTRAINTS
- Not time sensitive. Tens of minutes available before battery loses significant addition charge and voltage.

NOTES:
- As this action was identified as being important during the final quantification, the following reasoning is used to establish an HER for it.
- The evaluation of other recovery actions indicates that action HSLR1 (Locally transfer steam supply to TDAFP, given station blackout and loss of Steam Generator #1) requires actions similar to this action. Both involve actions to align and alternate support system locally. Since HSLR1 is done under much more severe conditions, and it would be an upper bound to the HER for HDAR1 and, therefore, suitable for screening purposes.

Table B-19 (Page 8 of 20). Operator Response Forms Used To Assess Recovery Actions

HDSR1: Cooldown and Depressurize by Cycling Steam Generator PORVs Full Open/Full Closed

PRECEDING EVENTS
- SGTR initiating event.
- Successful reactor scram.
- Ruptured S/G successfully isolated.
- Condenser not available.
- AFW successfully established, but only to 2 S/G's.
- Vital AC for modulating S/G PORV's fails.

INDICATIONS OF PLANT CONDITION
- Plant air available.
- CST level > 55%.
- RCS temperature and pressure dropping slowly.
- CCP not running.
- Both safety injection pumps running on miniflow recirculation.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- SOI 1.01, Section 8 - Operation of S/G PORV's locally.

CONCURRENT ACTIONS/COMPETING FACTORS
- Main activity.
- In REP.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT
- RCS < 350°F and 380 psig.

FAILURE IMPACT
- Makeup to RWST required (MU) to avoid depleting RCS and subsequent core uncovery.

TIME CONSTRAINTS
- Continuous control requirement until primary pressure =< secondary system pressure.
- Respond to anomalies during cooldown within 5 minutes to avoid excessive depletion of RWST.

Table B-19 (Page 9 of 20). Operator Response Forms Used To Assess Recovery Actions

HERCWR1: Manually Align ERCW to Opposite Train Diesel Generators, Given Loss of One Train of ERCW

PRECEDING EVENTS

- Loss of offsite power initiating event from full power conditions.
- Unit successfully shuts down.
- Train A(B) DGs start, but ERCW fails on that train.
- Train B(A) DGs start and have adequate ERCW.

INDICATIONS OF PLANT CONDITION

- LOSP alarms.
- ERCW low pressure and low flow alarms.
- ERCW pump indications tripped.
- No flow indicated on main header.
- DG jacket temp rising (Panel 0-M-27 outside of horseshoe).

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- Trip the diesel generators (E-0, step 12).
- Close the normal HX valve.
- Open the alternate train HX valve.
- Restart diesel generators.

CONCURRENT ACTIONS/COMPETING FACTORS

- Immediate actions upon plant trip underway.
- Degraded conditions due to LOSP.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT

- D/G jacket water temp cools.
- D/G continues to run.

FAILURE IMPACT

- D/G failure due to overheating (no recovery possible).
- Loss of shutdown power.

TIME CONSTRAINTS

- 5 minutes to recognize and accomplish the alignment to avoid overheating the diesel generators.

Table B-19 (Page 10 of 20). Operator Response Forms Used To Assess Recovery Actions

HERCWR2: Cooldown with AFW and Steam Generator PORVs, Given Total Loss of ERCW, RSW Available

PRECEDING EVENTS

- General transient or total loss of ERCW initiating events.
- Condenser not available due to loss of air on loss of ERCW.
- High pressure injection lost on loss of ERCW.
- CCS remains circulating, but temperature rises because of loss of heat sink.

INDICATIONS OF PLANT CONDITION

- CCS temperature rising to the point it which it has no cooling value.
- High temp alarms on SI pump oil coolers, RHR pumps, CS pumps.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- Dispatch AUO to locally open 2 valves to transfer RSW to cool air compressors. (AOI-13, 2.2 [7] - explicitly stated for rupture events).
- Open S/G PORV and establish a controlled cooldown rate at 100°F/hour.
- Monitor S/G levels at > 10% NR

CONCURRENT ACTIONS/COMPETING FACTORS

- Monitoring CCS temperature rise.
  - Cut down on thermal loads to CCS.
- Response to plant trip conditions.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT

- Air compressor remain operational.
- Ability to control cooldown from the control room retained.

FAILURE IMPACT

- Late seal LOCA at high pressure.

TIME CONSTRAINTS

- Initiate cooldown within 10 minutes to avoid seal damage at 1 hour.

Table B-19 (Page 11 of 20). Operator Response Forms Used To Assess Recovery Actions

HERCWR3: Cooldown with AFW and Steam Generator PORVs, Given Total Loss of ERCW, RSW Not Available

PRECEDING EVENTS

- General transient or total loss of ERCW initiating events.
- Condenser not available due to loss of air on loss of ERCW.
- High pressure injection lost on loss of ERCW.
- CCS remains circulating, but temperature rises because of loss of heat sink.
- Operators successfully stopped RCP's to avert early high pressure seal LOCA (HDASE2 = S).

INDICATIONS OF PLANT CONDITION

- CCS temperature rising to the point it which it has no cooling value.
- High temp alarms on SI pump oil coolers, RHR pumps, CS pumps.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- Control S/G pressure locally via manual cycling of S/G PORV's (SOI-1.01, Section 8.2).
  - 2 AUOs required.
  - AUO on floor communicates to CR.
  - AUO at valve receives hand signals from AUO on floor and manipulates valve when required.
- Control TDAFP via local manipulation of turbine throttle valve.

CONCURRENT ACTIONS/COMPETING FACTORS

- Initiate a feed and bleed on the CCS to maintain an acceptable temperature.
  - Cut down on thermal loads to CCS.
  - Letdown to floor until inventory can just be maintained.
  - Open valve from DI to CCS loop.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT

- Natural circulation established and maintained.
- Seal LOCA initiation averted.

FAILURE IMPACT

- Late seal LOCA at high pressure.

TIME CONSTRAINTS

- Initiate cooldown within 10 minutes to avoid seal damage at 1 hour.

Table B-19 (Page 12 of 20). Operator Response Forms Used To Assess Recovery Actions

HFLAB1R: Identify and Isolate ERCW Header Flood in Auxiliary Building

PRECEDING EVENTS
- Plant at 100% power under normal operating conditions.

INDICATIONS OF PLANT CONDITION
- Auxiliary building flood alarm.
- Later - equipment temperature alarms.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Diagnose that a break in one of the ERCW headers has occurred.(AOI-13).
- Dispatch an AUO to investigate.
- AUO identifies source of break.
- AUO isolates break by manipulating the necessary valves per AOI-13.

CONCURRENT ACTIONS/COMPETING FACTORS
- Monitoring plant parameters for trip conditions.
- Equipment being taken off line to avoid overheating.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT
- One header of ERCW isolated.
- No collateral loss of other equipment due to flooding.

FAILURE IMPACT
- RHR and containment spray pumps lost due to flooding.

TIME CONSTRAINTS
- Hypothesized break is large enough to cause flooding of RHR and containment spray pumps within 30 minutes.

Table B-19 (Page 13 of 20). Operator Response Forms Used To Assess Recovery Actions

HFLAB3CR: Identify and Isolate a Break in the Condensate Storage Tank Discharge Piping

NOTE: This action applies to only those breaks that can be isolated. That fraction is estimated by considering the relative lengths of discharge piping on either side of the discharge isolation valves.

PRECEDING EVENTS
- Unit at 100% power under normal operating conditions.

INDICATIONS OF PLANT CONDITION
- Decreasing CST level.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- SRO dispatch AUO to investigate.
- AUO diagnoses source of leak and determines course of action to isolate if leak is below isolation valves.
- Specific valve manipulation requirements depends on location of leak.

CONCURRENT ACTIONS/COMPETING FACTORS
- Initiate controlled unit shutdown per Tech Spec. (GOI-6).
- Flood conditions may prevent access to valves that require closure if Terry Turbine feed line or casing ruptured.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT
- Maintain CST inventory.
- AFW available.

FAILURE IMPACT
- CST drained and unavailable.

TIME CONSTRAINTS
- Hypothesized break large enough to release 200,000 gallons of water in 20 minutes.

Table B-19 (Page 14 of 20). Operator Response Forms Used To Assess Recovery Actions

HFLPH1R: Identify and Isolate a Line Break in Intake Piping A1A-A (or one of other 3) in the Strainer Room

PRECEDING EVENTS

- Unit at 100% power under normal operating conditions.

INDICATIONS OF PLANT CONDITION

- Reduction of ERCW header pressure.
- Flood alarm from sump pumps if in the intake strainer room.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- AOI-13.
- Trip the 4 ERCW pumps and investigate.
- Identify source of leak by closing valves one at a time and observing changes in flow and pressure instrumentation.
- Dispatch AUO to location.
- Determine location of leak.
- Locally manipulate valves to isolate leak.

CONCURRENT ACTIONS/COMPETING FACTORS

- Monitoring plant parameters for trip conditions.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT

- Loss of strainers.
- Loss of equipment limited to one train of ERCW pumps.
- Downstream headers aligned to the other pumping station header.

FAILURE IMPACT

- Loss of one train of ERCW.
- Heat up and loss of supported equipment, if not secured or an alternate source of cooling found.

TIME CONSTRAINTS

- Assume up to 45 minutes to isolate leak before component cooling problems require reactor trip.

Table B-19 (Page 15 of 20). Operator Response Forms Used To Assess Recovery Actions

FLPH2R: Identify and Isolate a Line Break in the Intake Pumping Station

PRECEDING EVENTS
- Unit at 100% power under normal operating conditions.

INDICATIONS OF PLANT CONDITION
- IPS sump level high.
- ERCW pump discharge pressure low.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Identify source of leak using AOI-13.
- If necessary, dispatch AUO to location to determine location of leak.
- Manipulate valves to isolate leak (both CR and local valves may be involved).

CONCURRENT ACTIONS/COMPETING FACTORS
- Evaluation for unit shutdown.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT
- Continue operations.

FAILURE IMPACT
- Conditions requiring plant trip.
- Loss of one train of ERCW.

TIME CONSTRAINTS
- Assume up to 45 minutes to isolate leak before component cooling problems requrie reactor trip.

Table B-19 (Page 16 of 20). Operator Response Forms Used To Assess Recovery Actions

HSLR1: Locally Transfer Steam Supply to TDAFP, Given Station Blackout and Loss of Flow from Steam Generator #1

PRECEDING EVENTS

- LOSP.
- Turbine driven feedwater pump started successfully.
- Diesel generators fail to start, or start and fail to run.
- Operators have successfully opened the level control valves.

INDICATIONS OF PLANT CONDITION

- All shutdown boards deenergized.
- Narrow range level in all steam generators dropping.
- Decrease in Terry Turbine speed.
- Low AFW flow indications.
- Low TDAFP speed.
- No specific alarms.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- Recognize need to transfer TDAFP to operable S/G (ECA-0.0, step 12).
- Instruct and dispatch AUO to locally accomplish actions.
- AUO verifies trip and throttle valve closed.
- Close valve FCV-1-15 from S/G #1 with handwheel.
- Open valve FCV-1-16 from S/G #4 with handwheel.
- Notify CR to restart TDAFP.
- UO restarts TDAFP and reestablishes flow.

CONCURRENT ACTIONS/COMPETING FACTORS

- No procedure with specific sequence of actions.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT

- Increase in TDAFP speed and flow.
- S/G levels recover.

FAILURE IMPACT

- Steam generator dryout.

TIME CONSTRAINTS

- Approximately 1 hour to steam generator dryout, given RCP's are not operating (LOSP).

Table B-19 (Page 17 of 20). Operator Response Forms Used To Assess Recovery Actions

HTPR1: Start the Turbine-Driven Pump, Given it Failed To Start due to Control or Signal Failures, LOSP

PRECEDING EVENTS
- Loss of offsite power initiating event.
- Two diesel generators fail to start or run.
- Turbine driven pump initially starts, but trips on overspeed.

INDICATIONS OF PLANT CONDITION
- Wide variety of LOSP and resulting alarms.
- TDAFP indicates no flow.
- No lights on motor driven feedwater pump indicators.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- Recognize AFW pump not in operation (ECA-0.0, step 3).
- Contact and dispatch AUO to TDAFP.
- AUO manually start TDAFP (SOI-3.2, Section 8.2 on wall).

CONCURRENT ACTIONS/COMPETING FACTORS
- Other E-0 and ECA-0.0 actions.
- AOI-35 actions to recover offsite power.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT
- Core cooling achieved, extending time to recover offsite power.

FAILURE IMPACT
- Core uncovery and damage at high pressure if offsite power not recovered.

TIME CONSTRAINTS
- Approximately 30 minutes to avoid steam generator dryout at 45 minutes if RCPs running.

Table B-19 (Page 18 of 20). Operator Response Forms Used To Assess Recovery Actions

HV1R1: Restore Ventilation to 6.9-kV Shutdown Board Room

PRECEDING EVENTS

- Ventilation working during normal operation.
- General transient initiating event.
- Reactor successfully trips and plant responds per plant model (failures of other systems at normal rates).

INDICATIONS OF PLANT CONDITION

- Annunciator response - 6.9 kv HVAC system abnormal.
- Other annunciators and conditions typical of a response to plant trip.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS

- SOI-30.7.
- Place standby chiller and AHU's in service.
- Open doors if temp > 104°F (not in a procedure).
- Place portable fans as necessary to maintain temperature below design temperature limit.
- Use control room HVAC to supply shutdown board room.

CONCURRENT ACTIONS/COMPETING FACTORS

- Cannot start a chiller if idle > 48 hours.
- Inlet temp to AHU > 85°F prevents running a chiller & trips a running chiller.
- Other actions to respond to plant trip condition.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT

- Room temperature remains within acceptable limits.

FAILURE IMPACT

- Loss of shutdown boards.

TIME CONSTRAINTS

- At least 12 hours to accomplish before temperature approaches design limit.

Table B-19 (Page 19 of 20). Operator Response Forms Used To Assess Recovery Actions

HVNVR1: Restore Ventilation to the 480V Board Room 1BB (2BB), Given Loss of Room Supply Fan

PRECEDING EVENTS
- Ventilation working during normal operation.
- General transient initiating event.
- Reactor successfully trips and plant responds per plant model (failures of other systems at normal rates).

INDICATIONS OF PLANT CONDITION
- 480 volt Board Room temperature alarm in control room.
- Other annunciators and conditions typical of a response to plant trip.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- No procedure for this action, considered part of normal operational response to a condition.
- Open door and put in a fan.
- Fail damper open for natural circulation.

CONCURRENT ACTIONS/COMPETING FACTORS
- Other actions to respond to plant trip condition.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT
- Room temperature remains within acceptable limits.

FAILURE IMPACT
- Loss of 480 volt boards.

TIME CONSTRAINTS
- Heat up of 6 hours, TIECS-95 based on 4 fully loaded transformers in the room (bounds the time available).

Table B-19 (Page 20 of 20). Operator Response Forms Used To Assess Recovery Actions

HVT1AR1: Establish Portable Ventilation to the Shutdown Board Transformer Room

NOTE: This action applies to heatup in the shutdown board of either train.

PRECEDING EVENTS
- Ventilation working during normal operation.
- General transient initiating event.
- Reactor successfully trips and plant responds per plant model (failures of other systems at normal rates).

INDICATIONS OF PLANT CONDITION
- Recognize need to accomplish the action.
- Transformer temperature alarm in control room at 104°F.
- Other annunciators and conditions typical of a response to plant trip.

PROCEDURAL GUIDANCE/REQUIRED ACTIONS
- No procedure for this action, considered part of normal operational response to a condition.
- Open door and put in a fan.
- Fail damper open for natural circulation.

CONCURRENT ACTIONS/COMPETING FACTORS
- Other actions to respond to plant trip condition.

INDICATION OF SUCCESSFUL COMPLETION AND SUCCESS IMPACT
- Room temperature remains within acceptable limits.

FAILURE IMPACT
- Loss of shutdown boards.

TIME CONSTRAINTS
- Heat up of 5 hours, TIECS-95 based on 4 fully loaded transformers in the room (bounds the time available based on VT1BR).

Table B-20. Raw and Normalized Weights and Scores of Actions Evaluated by the Team of Licensed Operators Evaluating Recovery Actions

WBN Recovery Action Evaluations - Raw Weights

ID	Actions		Interface		Time		Procedure		Complex		Training		Stress		Tot
Code	W	S	W	S	W	S	W	S	W	S	W	S	W	S	Wgt
AFR1	1	3	2	1	2	6	1	0	4	7	4	1	2	4	16
CCSR1	2	9	2	7	4	8	0	10	2	7	2	10	1	6	13
CCSR2	2	7	2	7	4	6	1	3	2	1	2	9	1	5	14
DHARL1	2	2	4	2	3	7	4	1	1	5	2	1	2	2	18
DSR1	1	1	2	4	2	4	1	1	4	1	4	1	2	1	16
ERCWR1	2	8	2	7	4	10	0	0	2	3	2	1	1	6	13
ERCWR2	1	8	2	2	2	7	1	1	4	5	4	4	2	5	16
ERCWR3	1	8	2	8	2	7	1	1	4	9	4	4	2	5	16
FLAB1R	2	1	2	4	3	2	2	0	2	3	4	4	1	5	16
FLAB3C	2	8	2	6	3	4	2	8	2	0	4	4	1	6	16
FLAB3R	GUARRANTEED FAILED - CAN NOT ISOLATE THE LONGEST PIPE														
FLPH1R	2	1	2	4	3	4	2	0	2	3	4	4	1	5	16
FLPH2R	2	1	2	4	3	4	2	0	2	3	4	4	1	5	16
SLR1	2	8	2	9	4	6	0	8	2	1	2	4	1	8	13
TPR1	4	0	1	0	2	3	2	0	2	8	2	1	3	6	16
V1R	2	8	0	4	1	0	1	2	4	1	1	2	1	1	10
VNVR1	2	8	0	4	1	0	1	10	4	1	1	4	1	5	10
VT1AR1	2	8	0	4	1	0	1	10	4	1	1	4	1	5	10

WBN Recovery Action Evaluations - Normalized Weights

ID	Actions		Interface		Time		Procedure		Complex		Training		Stress		FLI
Code	W	S	W	S	W	S	W	S	W	S	W	S	W	S	
AFR1	0.06	3	0.13	1	0.13	6	0.06	0	0.25	7	0.25	1	0.13	4	3.56
CCSR1	0.15	9	0.15	7	0.31	8	0.00	10	0.15	7	0.15	10	0.08	6	8.00
CCSR2	0.14	7	0.14	7	0.29	6	0.07	3	0.14	1	0.14	9	0.07	5	5.71
DHARL1	0.11	2	0.22	2	0.17	7	0.22	1	0.06	5	0.11	1	0.11	2	2.67
DSR1	0.06	1	0.13	4	0.13	4	0.06	1	0.25	1	0.25	1	0.13	1	1.75
ERCWR1	0.15	8	0.15	7	0.31	10	0.00	0	0.15	3	0.15	1	0.08	6	6.46
ERCWR2	0.06	8	0.13	2	0.13	7	0.06	1	0.25	5	0.25	4	0.13	5	4.56
ERCWR3	0.06	8	0.13	8	0.13	7	0.06	1	0.25	9	0.25	4	0.13	5	6.31
FLAB1R	0.13	1	0.13	4	0.19	2	0.13	0	0.13	3	0.25	4	0.06	5	2.69
FLAB3CR	0.13	8	0.13	6	0.19	4	0.13	8	0.13	0	0.25	4	0.06	6	4.88
FLAB3RR	GUARRANTEED FAILED - CAN NOT ISOLATE THE LONGEST PIPE														FAIL
FLPH1R	0.13	1	0.13	4	0.19	4	0.13	0	0.13	3	0.25	4	0.06	5	3.06
FLPH2R	0.13	1	0.13	4	0.19	4	0.13	0	0.13	3	0.25	4	0.06	5	3.06
SLR1	0.15	8	0.15	9	0.31	6	0.00	8	0.15	1	0.15	4	0.08	8	5.85
TPR1	0.25	0	0.06	0	0.13	3	0.13	0	0.13	8	0.13	1	0.19	6	2.63
V1R	0.20	8	0.00	4	0.10	0	0.10	2	0.40	1	0.10	2	0.10	1	2.50
VNVR1	0.20	8	0.00	4	0.10	0	0.10	10	0.40	1	0.10	4	0.10	5	3.90
VT1AR1	0.20	8	0.00	4	0.10	0	0.10	10	0.40	1	0.10	4	0.10	5	3.90

Table B-21 (Page 1 of 6). Quantification of Recovery Action Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: Recovery
Action Grouping Logic: Previous and Concurrent Actions Important, Plant Interface not Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	9.6E-01	-0.02
TPR1	0.25	0	0.06	0	0.13	3	0.13	0	0.13	8	0.13	1	0.19	6	2.63	4.1E-03	-2.39
MIN															0.00	5.8E-04	-3.23
Calibration Actions																	
DC Cook ZHEOB1	0.24	5	0.12	7	0.12	6	0.12	7	0.14	4	0.12	6	0.14	8	6.00	5.5E-02	-1.26
STP HEOR05	0.22	7	0.12	7	0.22	8	0.12	5	0.12	8	0.12	8	0.08	6	7.14	1.0E-01	-1.00
EST_MAX															10.00	1.0E+00	0.00

Regression Output:

Constant	-3.23
Std Err of Y Est	0.078
R Squared	0.992
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.3216
Std Err of Coef.	0.0270

Table B-21 (Page 2 of 6). Quantification of Recovery Action Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: Recovery
Action Grouping Logic: Time Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.95	1.0E+00	0.00
CCSR2	0.14	7	0.14	7	0.29	6	0.07	3	0.14	1	0.14	9	0.07	5	5.71	9.9E-03	-2.00
SLR1	0.15	8	0.15	9	0.31	6	0.00	8	0.15	1	0.15	4	0.08	8	5.85	1.1E-02	-1.94
ERCWR1	0.15	8	0.15	7	0.31	10	0.00	0	0.15	3	0.15	1	0.08	6	6.46	2.2E-02	-1.65
CCSR1	0.15	9	0.15	7	0.31	8	0.00	10	0.15	7	0.15	10	0.08	6	8.00	1.2E-01	-0.92
MIN															0.00	2.0E-05	-4.71
Calibration Actions																	
Fermi HERS1	0.13	7	0.13	2	0.25	4	0.10	3	0.13	2	0.13	2	0.13	6	3.77	5.3E-04	-3.28
Beaver Valley ZHE	0.13	1	0.13	2	0.25	7	0.11	2	0.13	5	0.13	3	0.13	6	4.15	2.5E-03	-2.61
DC Cook ZHEOX1	0.13	1	0.13	2	0.25	7	0.10	2	0.13	5	0.13	3	0.13	6	4.16	3.2E-03	-2.49
EST_MAX															10.00	1.0E+00	0.00

Regression Output:

Constant	-4.70
Std Err of Y Est	0.317
R Squared	0.967
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4729
Std Err of Coef.	0.0612

Table B-21 (Page 3 of 6). Quantification of Recovery Action Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: Recovery
Action Grouping Logic: Complexity and Training Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	9.1E-01	-0.04
AFR1	0.06	3	0.13	1	0.13	6	0.06	0	0.25	7	0.25	1	0.13	4	3.56	2.5E-03	-2.61
DSR1	0.06	1	0.13	4	0.13	4	0.06	1	0.25	1	0.25	1	0.13	1	1.75	4.7E-04	-3.33
ERCWR3	0.06	8	0.13	8	0.13	7	0.06	1	0.25	9	0.25	4	0.13	5	6.31	3.1E-02	-1.51
ERCWR2	0.06	8	0.13	2	0.13	7	0.06	1	0.25	5	0.25	4	0.13	5	4.56	6.2E-03	-2.21
MIN															0.00	9.3E-05	-4.03
Calibration Actions																	
DC Cook ZHEOS1	0.11	2	0.11	2	0.22	3	0.11	5	0.23	1	0.11	5	0.11	4	2.87	1.5E-03	-2.82
Big Rock BR5	0.11	5	0.22	6	0.07	5	0.11	5	0.16	6	0.22	6	0.11	6	5.71	1.4E-02	-1.85
EST_MAX															10.00	1.0E+00	0.00

Regression Output:

Constant	-4.03
Std Err of Y Est	0.125
R Squared	0.996
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.3989
Std Err of Coef.	0.0247

Table B-21 (Page 4 of 6). Quantification of Recovery Action Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: Recovery
Action Grouping Logic: Complexity and Preceding and Concurrent Actions Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.64	1.0E+00	0.00
VNVR1	0.20	8	0.00	4	0.10	0	0.10	10	0.40	1	0.10	4	0.10	5	3.90	7.8E-04	-3.11
VT1AR1	0.20	8	0.00	4	0.10	0	0.10	10	0.40	1	0.10	4	0.10	5	3.90	7.8E-04	-3.11
V1R	0.20	8	0.00	4	0.10	0	0.10	2	0.40	1	0.10	2	0.10	1	2.50	1.4E-04	-3.87
MIN															0.00	6.0E-06	-5.22
Calibration Actions																	
ANO 1 IREP A2	0.24	2	0.12	2	0.24	3	0.00	0	0.16	2	0.12	2	0.12	2	2.24	1.0E-04	-4.00
Calvert Clf CC7	0.24	4	0.12	5	0.24	5	0.00	0	0.16	5	0.12	4	0.12	4	4.52	1.0E-03	-3.00
Beaver Valley ZHE	0.1666	9	0	2	0.1666	4	0.1666	5	0.1666	8	0.1666	8	0.1666	9	7.17	1.2E-01	-0.92
EST_MAX															10.00	1.0E+00	0.00

Regression Output:

Constant	-5.22
Std Err of Y Est	0.363
R Squared	0.973
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.5420
Std Err of Coef.	0.0627

Table B-21 (Page 5 of 6). Quantification of Recovery Action Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: Recovery
Action Grouping Logic: Training Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															9.73	1.0E+00	0.00
FLPH3R	0.13	1	0.13	4	0.19	4	0.13	0	0.13	3	0.25	4	0.06	5	3.06	5.8E-04	-3.24
FLAB3R															FAIL	1.0E+00	-4.72
FLAB3C	0.13	8	0.13	6	0.19	4	0.13	8	0.13	0	0.25	4	0.06	6	4.88	4.4E-03	-2.36
FLAB1R	0.13	1	0.13	4	0.19	2	0.13	0	0.13	3	0.25	4	0.06	5	2.69	3.8E-04	-3.42
FLPH1R	0.13	1	0.13	4	0.19	4	0.13	0	0.13	3	0.25	4	0.06	5	3.06	5.8E-04	-3.24
MIN															0.00	1.9E-05	-4.72
Calibration Actions																	
Diablo Cyn ZHERT1	0.00	0	0.29	3	0.14	4	0.00	0	0.14	4	0.29	3	0.14	4	3.42	3.0E-04	-3.52
Browns Ferry BF9	0.11	5	0.20	5	0.11	5	0.16	5	0.11	5	0.22	5	0.09	5	5.00	2.1E-02	-1.68
Seabrook RT	0.00	0	0.29	9	0.14	8	0.14	7	0.00	0	0.29	7	0.14	7	7.72	1.0E-01	-1.00
EST_MAX															10.00	1.0E+00	0.00

Regression Output:

Constant	-4.72
Std Err of Y Est	0.552
R Squared	0.907
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	0.4854
Std Err of Coef.	0.1095

Table B-21 (Page 6 of 6). Quantification of Recovery Action Evaluations into Human Error Rates

Dynamic Human Action Evaluation for: Watts Bar Nuclear Plant, Unit 1
Evaluation Team: Recovery
Action Grouping Logic: Plant Interfaces and Procedures Important

Action Code	Preceding & Conc. Actions Weight	Score	Plant Interfaces Weight	Score	Time Adequacy Weight	Score	Procedures Weight	Score	Complexity Weight	Score	Training & Experience Weight	Score	Stress Weight	Score	FLI	P(fail)	LOG(P(fail))
Rated Actions																	
MAX															10.00	9.1E-01	-0.04
DHARL1	0.11	2	0.22	2	0.17	7	0.22	1	0.06	5	0.11	1	0.11	2	2.67	2.0E-03	-2.69
MIN															0.00	2.2E-04	-3.65
Calibration Actions																	
Grand Gulf GG3	0.11	2	0.22	2	0.11	2	0.22	3	0.11	2	0.11	3	0.12	2	2.33	1.5E-03	-2.82
Indian Pt IP12	0.17	3	0.12	4	0.13	3	0.17	4	0.12	4	0.12	4	0.17	4	3.70	5.0E-03	-2.30
EST_MAX															10.00	9.0E-01	-0.05

Regression Output:

Constant	-3.65
Std Err of Y Est	0.020
R Squared	0.999
No. of Observations	3
Degrees of Freedom	1
X Coefficient(s)	0.3609
Std Err of Coef.	0.0035

Table B-22 (Page 1 of 2). Recovery Human Error Rate Distributions Used for Quantification of the Watts Bar PRA

Database Variable	Brief Description	Top Event	Mean HER/ Demand	5th	Median HER/ Demand	95th
FLAB1R	Identify and Isolate ERCW Header Flood in Auxiliary Building	IE	0.001010	0.000036	0.000369	0.003680
FLAB3C	Identify and Isolate a Break in the Condensate Storage Tank Discharge Piping, Given Break Can be Isolated	IE	0.008860	0.000592	0.004290	0.029900
FLPH1R	Identify and Isolate a Line Break in Intake Piping A1A-A (or one of other three systems) in the Strainer Room	IE	0.001550	0.000054	0.000562	0.005620
FLPH2R	Identify and Isolate an ERCW Intake Line Break in the Pump Room of ERCW Intake	IE	0.001550	0.000054	0.000562	0.005620
HAFR1	Restore Auxiliary Feedwater Flow, Given Loss of Control Air.	AF	0.005030	0.000337	0.002440	0.017000
HARL1	Recover from an Automatic Sump Swapover Failure	RL	0.004030	0.000269	0.001950	0.013600
HCCSR1	Align the C-S Pump to the A CCS Heat Exchanger	CCSR	0.194000	0.022800	0.117000	0.584000
HCCSR2	Align and Initiate Alternate Component Cooling to the Charging Pump	CCPR	0.016100	0.001900	0.009780	0.048700
HCCSR3	Align ERCW Header 2A to CCS Heat Exchanger A, Given Loss of B Train ERCW.	CCSR	0.001550	0.000054	0.000562	0.005620
HCRL1	Inadvertently Reset SI Signal, Failure of Automatic Sump Swapover	RL	0.003750	0.000966	0.002960	0.008820
HDAR1	Switch to Spare Battery Charger, Given Operating Charger Fails.	DA DB DC DD	0.017800	0.002090	0.010800	0.053500
HDSR1	Cooldown and Depressurize by Cycling S/G PORV's Full Open/Full Closed.	DS	0.001250	0.000044	0.000456	0.004550
HERCW1	Recover ERCW Cooling To Operating Diesel Generator, Given Loss of ERCW to the Diesel Generator	DSLR	0.035500	0.004190	0.021500	0.107000
HERCW2	Cool Down with Auxiliary Feedwater and Steam Generator PORV's, Given Total Loss of ERCW, RSW Available To Cool Air Compressor	No Credit Taken	0.012500	0.008350	0.006040	0.042100
HERCW3	Cooldown with Auxiliary Feedwater and S/G PORV's, Given Total Loss of ERCW, RSW Not Available To Cool Air Compressors	DSLR	0.050000	0.005900	0.030300	0.151000
HSLR1	Locally Transfer Steam Supply to TDAFP, Given Station Blackout and Loss of Steam Generator #1	TPR	0.017800	0.002090	0.010800	0.053500
HTPR1	Start Turbine Driven Pump, Given it Failed To Start due To Control or Signal Failures	TPR	0.008250	0.000552	0.003990	0.027900

Table B-22 (Page 2 of 2). Recovery Human Error Rate Distributions Used for Quantification of the Watts Bar PRA

Database Variable	Brief Description	Top Event	Mean HER/ Demand	5th	Median HER/ Demand	95th
HV1R1	Restore Ventilation to 6.9-k V Switchgear Room	V1R V2R	0.000373	0.000013	0.000136	0.001360
HVNVR1	Restore Ventilation to the 480V Board Room 1BB (2BB), Given Loss of Room Supply Fan	VNV1R VNV2R	0.002080	0.000073	0.000756	0.007550
HVT1AR	Establish Portable Ventilation to the Shutdown Board Transformer Room	VT1AR VT1BR VT2AR VT2BR	0.002080	0.000073	0.000756	0.007550

Volume 4

WATTS BAR NUCLEAR PLANT UNIT 1 PROBABILISTIC RISK ASSESSMENT INDIVIDUAL PLANT EXAMINATION

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Volume 4

WATTS BAR NUCLEAR PLANT UNIT 1 PROBABILISTIC RISK ASSESSMENT INDIVIDUAL PLANT EXAMINATION

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C. THERMAL-HYDRAULIC CALCULATIONS AND TIMING JUSTIFICATIONS FOR DYNAMIC AND RECOVERY OPERATOR ACTIONS

This appendix presents the reasoning and simplified thermal-hydraulic analyses to support the selection of time windows for the human actions that appear in the event sequence models. The individual action definitions are listed in the alphabetical order by type (dynamic or recovery) as they appear in Section 3.3.3 and Appendix B with the time constraints that apply to the risk model. In Appendix B, actions evaluated in the accident sequences have been classified into two categories: dynamic and recovery. These actions differ primarily by when they were identified and incorporated into the plant model. Dynamic actions were identified during the initial construction of the model and were evaluated by three operator teams. Recovery actions were identified during the review of the preliminary quantifications and address actions that reduce the frequency of important accident sequences in those preliminary quantifications. The recovery actions were evaluated by one group of operators. The dynamic actions are listed in Section C.1, while the recovery actions are listed in Section C.2.

The time constraints presented on the Operator Response Forms are not an explicit variable used to obtain the human error rate (HER) directly from a correlation. Rather, they provide information for only one of the performance-shaping factors considered by the operators during their evaluation. During the elicitation process, the operators are asked to use the time constraints as a guide for the evaluation of the degree of difficulty of the action. It forms one basis by which they formulate the context of the action for the evaluation process. Because of the nature of the elicitation process, the preciseness of the time constraints is not as important as it would be if an explicit time-dependent correlation were used to quantify the error rates.

To expedite the preparation of Operator Response Forms and the interview of operator teams, best estimates of the time available for the hypothesized actions were made by the plant modelers, licensed operators, and the human action analyst preparing the forms. As Appendix C was developed to verify the time constraints, some discrepancies between the best estimate times and those determined by thermal-hydraulic calculations were found after the operators completed their evaluations based on the initial estimates. Each of these discrepancies is identified below with a footnote number. The footnotes assess the impact of the discrepancy on the evaluated failure rate. As discussed above, time constraint is only one input that the operators use to assess the degree of difficulty of the action. Therefore, the discrepancies generally have an insignificant impact on the evaluation results.

C.1 DYNAMIC HUMAN ACTIONS

HAAC1: Start Standby Component Cooling System (CCS) Pump, Given Running Pump Fails during Non-Safety Injection Events

Timing: Operator evaluated action assuming 2 minutes available.

It is assumed that the operators have 2 minutes in which to recover CCS before they are required to shut down the reactor coolant pumps. This period is based on a "caution" in procedure AOI-15, which requires that the reactor coolant pumps be shut down within 2 minutes if CCS is failed.

HAAC2: Isolate CCS Train A from Spent Fuel Pool Heat Exchanger

Timing: Not time sensitive; assume 45 minutes[1] for heatup of cooled equipment.

The action is required when one of two train A CCS pumps has failed. Under these conditions coolant flow is being maintained, but the operators isolate nonessential loads in response to low flow alarms to ensure that essential heat loads are serviced. Based on the judgment of the operating crew, a period of 45 minutes was selected to convey a reasonable time frame to the operators in which gradual heatup will lead to equipment failure with only partial cooling.

HAAE1: Start Standby Essential Raw Cooling Water (ERCW) Pump, Given Running Pump Fails during Non-Safety Injection Events

Timing: Not time sensitive; assume 45 minutes[1] for heatup of cooled equipment at lower ERCW flow.

The action is required when only one ERCW pump has failed. Under these conditions, coolant flow is being maintained, but the operators respond to low flow alarms to ensure that heat loads can be serviced. When safety injection has not been actuated, the heat load on the ERCW remains only a small percentage of its design heat removal capability. After discussion with licensed operators from the plant, 45 minutes was selected to convey a reasonable time frame to the operators in which gradual heatup will lead to equipment failure with only partial cooling.

HAAEIE: Start Standby ERCW Pump To Avert Plant Trip, Given Running Pump Fails during Normal Operations

Timing: Not time sensitive; assume 45 minutes[1] for heatup of cooled equipment at lower ERCW flow.

This is the same as action HAAE1; however, it occurs during normal operations. The same time constraint arguments apply.

---

[1]The term "tens of minutes" was used in the Operator Response Forms that the operators evaluated. The 45-minute time constraint used here conveys the order of magnitude of the time constraint more specifically and should be used for any reevaluation. The change has no impact on the actual evaluations.

HAAF1: Locally Operate Turbine-Driven Auxiliary Feedwater Pump (TDAFW) Valve, Given Loss of All AC Power

Timing: Approximately 1 hour to steam generator dryout.

Each of the four steam generators has a design secondary-side heat content of 7.0×10^7 Btu, based on the liquid and vapor properties in Table 10.1-1 of Reference C-1, as calculated below.

The total energy removal capacity of the steam generator coolant inventory is estimated to be

$$E_{SG} = W_{STEAM}\,\Delta h_{STEAM} + W_{LIQUID}\,(\Delta h_{LIQUID} + X\,h_{fg})$$

Using initial conditions of full-power operation and assuming that feedwater mixes quickly so that the inventory of liquid and steam in the steam generator is at saturation conditions for 970 ≅ 970 psia,

$$h_{f1} = 37.8 \qquad h_{g1} = 1{,}193.5$$

If the steam is boiled off at the relief valve pressure of 1,085 (1,025), the following enthalpies apply:

$$h_{f2} = 555.2 \text{ Btu/lbm} \qquad h_{g2} = 1{,}188.9 \text{ Btu/lbm} \qquad h_{fg} = 633.8 \text{ Btu/lbm}$$

The available inventory is obtained from Table 10.1-1 of Reference C-1,

$$W_{LIQUID} = 2{,}322 \text{ ft}^3/0.02109 \text{ ft}^3/\text{lbm} = 110{,}100 \text{ lbm}$$

$$W_{STEAM} = 3{,}546 \text{ ft}^3/0.5264 = 6{,}740 \text{ lbm}$$

$$E_{SG} = 3{,}546\,(1{,}188.9 - 1{,}193.5) + 110{,}100\,[(555.2 - 37.8) + 633.8\,X]$$

where X is the fraction of the liquid inventory that boils off.

$$E_{SG} = 1.90 \times 10^6 + 6.98 \times 10^7\,X$$

$$= 6.8 \times 10^7 \text{ Btu if 95\% of the liquid can boil off}$$

The number of full-power seconds available in the secondary-side inventory, given loss of feed to all of the steam generators, is then:

$$E_{SG} = \frac{4\text{ SG }(6.8 \times 10^7 \text{ Btu/SG})(3{,}600 \text{ sec/hr})}{(3{,}411 \text{ MWt})(3.413 \times 10^6 \text{ Btu/MW-hr})}$$

$$= 84.1 \text{ full-power seconds (from 100\% to 5\% liquid capacity).}$$

If the steam generators are 85% full and the reactor has been operating for an extended period at full power (~ 18 months), American Nuclear Society Guide 5.1 can be used to calculate decay heat that can be transferred before the steam generators boil to 5% liquid:

Decay Heat equivalent to $65.75 \times t^{0.7037}$ = 70.8 full-power seconds (from 85% to 5% liquid capacity)

which yields

t = 1.11 hours or ~ 67 minutes, given that reactor coolant pumps (RCP) are not operating.

The steam generators transfer (3,411/4 =) 853 MWt from the primary to secondary coolant system at full power. This is very similar to the rating of 884 MWt for the Beaver Valley plant, which is also a Westinghouse unit. The thermal-hydraulic analysis of the steam generator supporting the human actions analysis for its individual plant examination (IPE) (Reference C-2) produced the same period of time to boil dry the steam generators, given that the RCPs are not operating.

HACH1: Transfer Spray from Refueling Water Storage Tank (RWST) to Sump, Given Residual Heat Removal (RHR) Swapover was Successful

Timing: Four minutes[2] from 8% RWST level until loss of suction to containment spray pumps.

At 8% level, the RWST contains 30,000 gallons of water. The containment spray pumps are rated at approximately 4,000 gpm. If two pumps are operating, 3.75 minutes are available before the RWST is dry. This is rounded up to 4 minutes to account for the inventory in the discharge piping.

HACH2: Transfer Spray from RWST to Sump, Given RHR Swapover Failed

Timing: Four minutes[2] from 8% RWST level until loss of suction to containment spray pumps.

Timing is the same as for action HACH1. The containment spray pumps are the only pumps taking suction from the RWST (RHR pumps tripped during transfer).

---

[2]The initial Operator Response Form estimated that 5 minutes would be required to lose suction from the 8% level. The operators evaluated this action, given that the RWST level has been dropping from 29% and the sump level has been increasing. Since the first action is to pull-to-lock the containment spray pumps, the discrepancy is judged to have no impact on their evaluations.

HACI1: Backup Containment Isolation

Timing: Not time sensitive; assume approximately 3 hours to avoid containment conditions that could result in release of radioactive materials into the environment.

This time constraint was given to the operators to indicate that the majority of the more frequent accident sequences that challenge the containment function result from slowly evolving scenarios. Given this most likely result, the operators were asked to consider the action, given a large amount of flexibility to act with respect to time.

The actual timing for this action is scenario dependent. This evaluation is performed as part of the Level 2 analysis. The time constraint given to the operators was selected after discussion with Level 2 analysts having experience on other probabilistic risk assessments (PRA) as being a reasonable representation of the situation the operators would be expected to encounter.

HACS1: Backup Core Spray Pump Initiation, Given Containment Pressure > 2.81 psig

Timing: Approximately 20 minutes after signal to avoid containment conditions that could result in release of radioactive materials into the environment.

The time constraint for this action was selected judgmentally to represent the expected lower bound of time available to the operators to respond to an increase in containment pressure. This action can be required under any scenario, including a large loss of coolant accident (LOCA).

The actual timing for this action is scenario dependent. This evaluation is performed as part of the Level 2 analysis. The time constraint given to the operators was selected after discussion with Level 2 analysts having experience on other PRAs as being a reasonable conservative representation of the situation the operators would be expected to encounter.

HACT1: Refill Condensate Storage Tank (CST) during Non-LOCA Events

Timing: Condensate storage tank can provide up to 16 hours[3] of makeup if initially at 190,000 gallons.

Assume that the CST is empty for practical purposes when its inventory drops to 5%, or 20,000 gallons. This leaves 170,000 gallons available to provide makeup to the steam generators.

---

[3]The operators evaluated this action with an initial estimate of 6 hours availability. Because of the long time frames, the difference has no impact on their evaluations.

The enthalpy rise of the water is calculated, assuming that the water boils at atmospheric pressure and the CST water is initially at 100°F.

h_g = 1,150 Btu/lbm at atmospheric pressure.
h_f = 68 Btu/lbm at 100°F.
Δh = 1,080 Btu/lbm
Inventory = 170,000 gallons × 8.3 lbm/gallon = $1.41 \times 10^{+6}$ lbm.

$$E_{CST} = \frac{(1.41 \times 10^6 \text{ lbm})(1{,}080 \text{ Btu/lbm})(3{,}600 \text{ sec/hr})}{(3{,}411 \text{ MWt})(3.413 \times 10^6 \text{ Btu/MW-hr})} = 471 \text{ full-power seconds}$$

Using ANS Guide 5.1 for the time dependence of decay heat,

$65.75 \times t^{0.7037}$ = 471 full-power seconds.
t = 16.4 hours of inventory available.

HADS1: Cool Down and Depressurize Reactor Coolant System (RCS), Normal Cooldown

Timing: Approximately 16 hours[3] before makeup to CST required.

Justification is the same as for action HACT1.

HADS2: Cooldown and Depressurize RCS, Given an Steam Generator Tube Rupture (SGTR) with Successful Isolation

Timing: Approximately 16 hours[3] before makeup to CST required.

Justification is the same as for action HACT1.

HADS3: Cooldown and Depressurize RCS, Given SGTR with Successful Isolation, but High Head Safety Injection Failed

Timing: Approximately 16 hours[3] before makeup to CST required.

Justification is the same as for action HACT1.

HADS4: Cooldown and Depressurize RCS, Given SGTR when Unable To Isolate Ruptured Steam Generator

Timing: Approximately 16 hours[3] before makeup to CST required.

Justification is the same as for action HACT1.

---

[3]The operators evaluated this action with an initial estimate of 6 hours availability. Because of the long time frames, the difference has no impact on their evaluations.

HADS5: Cooldown and Depressurize RCS, Given SGTR when Unable To Isolate Ruptured Steam Generator and High Head Safety Injection Failed

Timing: Gain control of leakage within 30 minutes to avoid core uncovery, 16 hours[3] of inventory in CST.

The 30 minutes specified here are based on a small 2-inch-diameter LOCA, which makes the time constraint very conservative. The estimate for the time to core uncovery was taken from action OS2 of Reference C-2 (paragraph C.1-5), which calculated the time to core uncovery due to small LOCAs with the pressure history represented as follows:

2,250 psia for 0 < 1 minute

987 psia for t > 1 minute

Using the engineering calculation code SEALOC, the time to core uncovery was determined to be approximately 0.67 hours (40 minutes) for a 2-inch-diameter LOCA. Therefore, the time constraint of 30 minutes is judged to provide a conservative lower bound to the time constraint for this action.

Justification for 16 hours is the same as for action HACT1.

HADS6: Cooldown and Depressurize RCS, Given Loss of All AC Power

Timing: Initiate as soon as possible to avoid seal LOCA. Seal damage in approximately 1 hour if RCS temperature not lowered by then.

NUREG-1150 (Reference C-3) indicates that the pumps seals have a first failure approximately 1 hour after seal cooling failure. The operators were given the goal for completing the cooldown and used their judgment regarding the timing of "as soon as possible" to initiate the cooldown to meet that goal.

HADS7: Cooldown and Depressurize RCS, Given Small LOCA with Loss of High Head Safety Injection

Timing: Initiate within 30 minutes.[4] Reach RHR setpoints within 2 hours, for a total of 3 hours to avoid sump swapover.

The justification for time to initiate cooldown is the same as action HADS5. (However, in this case, the RCS may depressurize to P_{SAT} due to the leakage out of the break.)

The time to cooldown is limited by the inventory in the RWST and the pumping rate of the safety injection system. The inventory available in the RWST before sump swapover is

---

[4]The operators were given a time constraint of 1 hour to initiate cooldown and 2 hours to reach RHR setpoints. The delay in initiating cooldown will result in higher flow rates through the break due to higher differential pressure that could potentially produce core uncovery. However, it is judged that the higher flow rates will result in depressurization to the SIS injection pressure, which will provide the cooling necessary to prevent core uncovery.

370,000 - 109,000 ≅ 260,000 gallons. Given a 2-inch-diameter LOCA with no centrifugal charging pump (CCP) injection, the reactor pressure is expected to readily depressurize to the no-load saturation temperature, T_{SAT} = 557°F, P = 1,100 psia. At this point, the coolant loss is governed by critical flow, which, from the Moody chart (Reference C-4, p. 416), produces the following leak rate for a 2-inch-diameter (3.14 in^2) break:

Given a small LOCA of 2-inch diameter, the RCS is expected to steadily depressurize to T_{SAT} at

$$\dot{m} = \frac{(8{,}300\ \text{lbm/sec-ft}^2)(3.14\text{in}^2)(60\ \text{sec/min})}{144\ \text{in}^2/\text{ft}^2}$$

$$= 10{,}860\ \text{lbm/min}$$

The required makeup from the RWST is then

$$\dot{m} = (10{,}860\ \text{lbm/min})(0.0161\text{ft}^3\text{lbm})(7.84\ \text{gal/ft}^3)$$

$$= 1{,}370\ \text{gal/min} \cong 1{,}400\ \text{gal/min}$$

If the containment sprays are not required, the RWST will be drained to sump swapover by

$$\text{Time} = \frac{370{,}000-109{,}000}{1{,}400} = 186\ \text{minutes}$$

$$\cong 3\ \text{hours}$$

The 2-hour time constraint provides approximately 10 to 15 minutes of containment spray time, should it be required.

No credit for this action is taken in the current quantification (July 1992). If future use of the action is anticipated, the ratings appear to be reasonable even with the lower time constraint. Recall that the time constraints listed on the Operator Response Form are intended for the operators to use as guides. The actual evaluations for Watts Bar appear to recognize the situation, as the scores of 3, 5, and 7 span the neutral range of degree of difficulty for time adequacy, which is representative of the allowed time.

If this action is used in the future, a MAAP run should be made to determine the time constraints based on both safety injection system (SIS) injection and anticipated containment spray usage.

HAEB1: Trip Control Rod Drive (CRD) Motor Generator Power and Initiate Boration, Given Anticipated Transient without Scram (ATWS)

Timing: Approximately 10 minutes.

This time is assumed. Allowing 10 minutes to complete this action is consistent with the Westinghouse Owners Group assumption, as documented in WCAP-11993, dated December 1988 (taken from Reference C-2, paragraph C.1-40).

HAHH1: Place Hydrogen Ignitors in Service

Timing: Not time sensitive.

The operators are directed in FR-Z.1 to place the hydrogen ignitors in service as a response to high containment pressure. The operators were given the above time constraint regarding placing hydrogen ignitors in service to relay the fact that there is generally no definitive time between high containment pressure, the onset of hydrogen generation in the containment, and combustion. It is a highly scenario-dependent phenomenon that could occur over a wide range of time. Consequently, the operators were asked to consider their training when considering the potential for their failing to accomplish the action or to verify that the ignitors were previously placed into service prior to combustion.

HAMR1: Manually Insert Control Rods, Given ATWS

Timing: One minute or less.

The 1-minute time limit provides approximately 1 additional minute for the rod banks to insert negative reactivity into the core prior to the RCS pressure peak. Peak RCS pressure is expected at just under 2 minutes, assuming a total loss of feedwater (Reference C-5 taken from paragraph C.38 of Reference C-2).

HAMU1: Make Up RWST Inventory Following a SGTR Event

Timing: Approximately 8 hours[5] of inventory available when RWST = 70%.

With an inside diameter of 0.775 inch, the flow area of a double guillotine break of the single steam generator tube is 0.94 in^2.

From the Moody chart for critical flow (Reference C-4), the critical flow rate is approximately 200,000 lbm/in^2-hr when the primary side is at 1,000 psia (approximate saturation pressure of primary at T_{avg}). At this pressure, the specific volume is 0.02159 ft^3/lbm.

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[5]The operators evaluated this action for an initial best time estimate of 5 hours, which is more conservative. The difference in time constraint is judged to have no significant impact on their evaluations.

The total flow, assuming critical flow at 1,000 psia, is then

$$\text{Total Flow} = (200{,}000\ \text{lbm/in}^2\text{-hr})\ 0.943\ \text{in}^2)\ (0.02159\ \text{ft}^3/\text{lbm})\ (7.49\ \text{gal/ft}^3)$$
$$= 30{,}500\ \text{gal/hr.}$$

If the RWST is at 70% capacity and can provide makeup until it reaches 5%, the available inventory is 0.65 × 375,000 = 244,000 gallons. Consequently, the time available before the RWST is depleted is approximately 8 hours.

HAMU2: Make Up RWST Inventory, Given LOCA with Loss of Recirculation

Timing: Approximately 10 minutes to empty RWST. Approximately 20 minutes to core uncovery.

The CCP, safety injection, RHR, and containment spray pumps draw from the RWST. If both trains are running and is RHR injecting into the core, the RWST will be emptied at the following rate:

ECCS Pumps	Maximum Flow	Number	Total Flow (gpm)
CCP	550	2	1,100
Safety Injection	650	2	1,300
Containment Spray	4,000	2	8,000
RHR Pumps	3,000	2	Not Running
		Total	**10,400**

The signal for swapover to the sump occurs at 29% RWST capacity (approximately 109,000 gallons). If the RHR pumps fail during the transition to recirculation, (109,000/10,400≅) 10 minutes are available before the RWST empties.

Once the RWST is empty, the time to core uncovery was estimated based on a 6-inch-diameter break with no makeup. Based on leakage at an estimated depressurized pressure of 330 psia, paragraph C.1-4 of Reference C-2 estimated that approximately 15 minutes are available before core uncovery.

Adding the above two times, 25 minutes would be available before core uncovery. This time was conservatively reduced to 20 minutes for the purpose of providing a guideline to the operators.

HAMU3: Make Up RWST, Given LOCA with Loss of Recirculation and Containment Spray

Timing: Approximately 10 minutes to empty RWST. Approximately 20 minutes to core uncovery.

Justification was conservatively assumed to be the same as action HAMU2 even though the containment spray pumps are not running.

HAOB1: Establish RCS Feed and Bleed, Given Insufficient Secondary Heat Sink

Timing: Approximately 50 minutes[6] to steam generator dryout and RCS pressure increase to above power-operated relief valve (PORV) setpoint, given RCPs continue to run.

Action HAAF1 justification indicated that the steam generators contain inventory to remove approximately 84.1 full-power seconds of heat from the primary. When the RCPs are running, the pump power is lost to friction, resulting in a second heat load.

The pump heat load for all four loops is approximately 14 MWt, which is generated at a constant rate, or

$$\text{Pump Heat} = \frac{14 \text{ MWt } (3{,}600 \text{ sec/hr})t \text{ hr}}{3{,}411 \text{ MWt at full power}} = 14.8t \text{ full-power seconds.}$$

where t is the hours of decay heat that can be transferred.

The calculation with RCPs running is an iterative process. The spreadsheet shown in Table C-1 implements these equations as follows:

$$\text{Decay Heat} + \text{Pump Heat} - \text{Steam Generator Heat Capacity} = 0$$

To produce an estimate that the steam generators can be expected to boil dry in,

$$t = 0.84 \text{ hours} \cong 50 \text{ minutes, given that RCPs are operating.}$$

HAOF1: Restore Main Feedwater (MFW), Given AFW Failed during General Transient Not Requiring Safety Injection

Timing: Approximately 35 minutes[7] to steam generator wide range (WR) < 25%, which requires feed and bleed.

Using the spreadsheet for decay heat plus pump heat outlined in action HAOB1, the time required to boil 60% of the steam generator heat capacity is approximately 35 minutes in accordance with Table C-2.

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[6]The operators evaluated this action with an initial time estimate of 1 hour. Because of the length of time available in both cases, the 10-minute difference has no impact on their evaluation.

[7]The operators evaluated this action with an initial estimate of 45 minutes. Because of the length of time available in both cases, the 10-minute difference has no impact on their evaluation.

HAOF2: Restore Main Feedwater, Given AFW Failed during Transient Requiring Safety Injection; SLOCA.

Timing: Approximately 30 minutes to steam generator WR < 25%, which requires feed and bleed.

Justification for steam generator dryout is the same as for HAOF1. In this case, however, it is assumed that since a safety injection signal is present, the RCS could be losing inventory. Consequently, there is a need to reduce the primary temperature so that the RCS can be depressurized to SIS injection pressure. To account for this additional requirement, the time available for the operators to react was judgmentally reduced by 15 minutes.

HAOS1: Align Emergency Core Cooling System (ECCS) for Core Cooling, Given Engineered Safety Features Actuation System (ESFAS) Fails Following a Medium LOCA or Large LOCA

Timing: Approximately 1 minute to mitigate cladding failure.

For a design basis break, the time to core uncovery will be almost instant. If ECCS is not actuated, we assume that the operators can mitigate cladding failure if they manually actuate within 1 minute.

HAOS2: Align ECCS for Core Cooling, Given ESFAS Fails, Given a Main Steam Line Break Outside Containment (MSLBOC), SGTR, or Small LOCA

Timing: Bounded by 30 minutes to cladding damage during Small LOCA.

The time for this action is taken from action OS2 in Reference C-2 (paragraph C.1.3), which calculated the time to core uncovery due to a 2-inch-diameter LOCA with the pressure history represented as follows:

2,250 psia for 0 < 1 minute

987 psia for t > 1 minute

Using the engineering calculation code SEALOC, the time to core uncovery was determined to be approximately 0.67 hours (40 minutes) for a 2-inch-diameter LOCA. Therefore, the time constraint of 30 minutes is judged to provide a conservative lower bound to the time constraint for this action.

HAOS3: Manually Start AFW, Given Reactor Trip with No Safety Injection Required

Timing: Approximately 50 minutes[8] before steam generator dryout.

Justification is the same as action HAOB1, given that RCPs are running.

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[8]The operators evaluated this action using an initial time estimate of 45 minutes. Because of the length of time available in both cases, the 5-minute difference has no impact on their evaluation.

HAOS4: Start AFW, Given ATWS with ATWS Mitigation Safeguards Actuation System (AMSAC) Failure

Timing: One minute to steam generator dryout.

As stated in the justification to action HAAF1, the energy removal capability of the steam generators at 85% capacity is 69 full-power seconds. The response time requirement represents a balance between the potential for a partial power ATWS and the lag in the impact of the AFW on the steam generator cooling capability.

HAOS5: Backup Restart Timers, Given Loss of Offsite Power (LOSP) and Diesel Generator Startup

Timing: Approximately 1 hour before steam generator dryout.

Justification is the same as action HAAF1, given that the RCPs are not running.

HAOT1: Place Containment Spray in Standby and Reset Signal

Timing: Within 5 minutes of pressure reduction to permissible limits.

When pumping at design capacity, the containment spray pumps will remove 40,000 gallons from the RWST in 5 minutes. As this is less than 11% of the total inventory in the RWST, it was considered to be a reasonable time frame for conserving inventory.

Note: As the amount of water actually remaining in the RWST when sprays are no longer required is scenario dependent, no credit was taken for this action for extending the time to sump swapover in the model in the July 1992 quantification. This operation remains open for future quantifications when the sequences are analyzed more specifically.

HAPI1: Isolate Open PORV by Closing Block Valve after Depressurizing Using the PORV

Timing: Approximately 5 minutes to PRT disk rupture.

The time to disk rupture is taken to be the same as for action HAPR1, which accounts for flow at high pressure.

HAPR1: Isolate Open PORV by Closing Block Valve after Safety Injection Actuated

Timing: Approximately 5 minutes to PRT disk rupture.

The Watts Bar simulator produces a PRT disk rupture in 6:15 minutes. The Sequoyah simulator produces a PRT disk rupture in 5 minutes, and was used as the conservative estimate.

HAPR2: Isolate Open PORV by Closing Block Valve Prior To Depressurizing to 1,870-psig Safety Injection Initiation Signal

Timing: Within 30 seconds to avoid safety injection actuation.

The Watts Bar simulator produces safety injection actuation at 55 seconds. The Sequoyah simulator produces safety injection actuation at 35 seconds, and 30 seconds was used as the conservative estimate.

HARD1: Place RHR Cooling in Service following SGTR

Timing: Approximately 2 hours available after RHR entry conditions reached until RWST makeup required.

This action is required at a time when the operators are in a controlled cooldown. A period of a few hours is available over which it can be accomplished. Consequently, considerations other than time will tend to control the action.

HARE1: Shed DC Bus Loads, Given Loss of All AC Power

Timing: At least 2 hours (without recharging under normal bus loads) before batteries are depleted.

This is a design requirement for the vital batteries in accordance with paragraph 6.2.1 of Reference C-6.

Note: This action was not used in the recovery analysis for the July 1992 quantification.

HARE2: Locally Restore RHR Sump Recirculation, When Unable To Transfer from Control Room

Timing: Core damage assumed to begin 45 minutes after switchover fails.

Justification for action HAOS2 produced a time to core uncovery of 0.67 hours for a small LOCA. Given that core cooling is maintained until the RWST level is low, the time to core damage can reasonably be extended to 0.75 hours, or 45 minutes.

Note: This action was not used in the recovery analysis for the July 1992 quantification.

HARH1: Transfer To Hot Leg Recirculation, Given LOCA > 2-Inch Diameter

Timing: Not time sensitive; action is required before the time blockage occurs.

Blockage due to boron crystallization is a long-term phenomenon. A period of a few hours is available over which a decrease of boron concentration (buildup of blockage) can be detected and transfer can be accomplished. Consequently, considerations other than time will tend to control the action.

HARR1: Align High Pressure Recirculation, Given Automatic Swapover Succeeds

Timing: Approximately 20 minutes from swapover to core uncovery if swapover not completed.

The justification for action HAOS2 is supported by a calculation for core uncovery under small LOCA conditions (2-inch-diameter hole) that produce core uncovery in 0.67 hours (40 minutes). The period of time given to the operators for this action is a conservative lower bound of that estimate.

HARR2: Align High Pressure Recirculation, Given Automatic Swapover Fails

Timing: Approximately 20 minutes from swapover to core uncovery if swapover not completed.

The time constraint considerations are the same as for action HARR1.

HARS1: Place RHR Spray In Service, Given more than 1 Hour into Event and Containment Pressure High

Timing: Tens of minutes available before pressure alters containment conditions.

This action addresses scenarios in which the ice has been depleted. The rate of increase depends on when the ice depletes, which is dependent on the size of LOCA. For example, for a small LOCA of 2-inch diameter, the containment psig is approximately 4 psig until the ice depletes at 10 hours. Over the next 10 hours, the containment pressure rises only an additional 4 psig without the containment sprays.

HART1: Manually Trip Reactor, Given Solid State Protection System (SSPS) Fails

Timing: Within 1 minute.

The time of 1 minute is based on the assumption that the limiting initiator of total loss of all main feedwater occurs. This assumed response time is the same as that used in the Westinghouse Owner's Group report WCAP-11993, December 1988.

HASE1: Stop RCPs on Phase B Isolation, Given a Non-LOCA Initiator

Timing: Operators evaluated the condition that RCPs will run for 2 minutes before initiation of seal damage; actually, at least 10 minutes available.

Westinghouse response to a NRC question regarding the RCPs indicates that the RCPs have run for 10 minutes without cooling to the oil coolers and have suffered no damage or degradation of performance (Reference C-7).

HASE2: Stop RCPs on Loss of Train A CCS or RCP Cooling Path

Timing: At least 10 minutes before RCP damage begins.

Justification is the same as action HASE1.

HASL1: Identify and Isolate Ruptured Steam Generator

Timing: Forty minutes[9] available before steam generator overfill, given offset rupture of one tube.

Assuming that the primary side remains pressurized, the pressure ratio between the primary and secondary side can be (857/2,250 = 0.38), and critical flow can be maintained. For a stagnation pressure of 2,235 psia, the mass flow for critical flow is approximately 270,000 lbm/in^2-hr. The full-load steam volume for a steam generator is 3,546 ft^3 (Reference C-1, Table 10.1-1). Using the area calculated for a steam generator tube rupture calculated for action HAMU1, and the specific volume of saturated water at 860 psia,

$$\text{Time to overfill} = \frac{(3{,}546\ \text{ft}^3)(60\ \text{min/hr})}{(270{,}000\ \text{lbm/in}^2\text{-hr})(0.0211\ \text{ft}^3/\text{lbm})(0.943\ \text{in}^2)}$$

$$= 39.6 \cong 40 \text{ minutes}$$

HAWC1: Control Safety Injection To Prevent Water Challenge of PORVs

Timing: Dependent on fill rate; assume no more than 5 minutes to recognize and react.

The amount of time available is dependent on the degree of the mismatch. After consultation with the licensed operator members of the PRA team from both Sequoyah and Watts Bar, 5 minutes was selected as a reasonable time for reaction.

C.2 RECOVERY HUMAN ACTIONS

FLAB1R: Identify and Isolate ERCW Header Flood in Auxiliary Building

Timing: Hypothesized break large enough to flood RHR and core spray pumps within 30 minutes.

The initiating event frequency is based on the analysis of large leaks of 10,000 gal/min. The passive auxiliary building sump can accumulate 200,000 gallons before the floor on which the pumps are located begin to flood. This will take 20 minutes. Although the additional time required for the water to reach the pumps was not specifically calculated, 30 minutes is used to bound the minimum amount of time available to respond to the flood.

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[9]The operators evaluated this action using an initial time estimate of 50 minutes. The difference from 40 minutes is not judged to be significant.

FLAB3C: Identify and Isolate a Break in the Condensate Storage Tank Discharge Piping, Given Break Can be Isolated

Timing: Hypothesized break large enough to release 200,000 gallons within 20 minutes.

The initiating event frequency is based on the analysis of large leaks of 10,000 gal/min. The passive auxiliary building sump can accumulate 200,000 gallons before the floor on which the pumps are located begin to flood. This will take 20 minutes.

FLPH1R: Identify and Isolate a Line Break in Intake Piping 1A-A (or one of other three systems) in the Strainer Room

Timing: Assume up to 45 minutes to isolate leak before cooling problems result in the loss of cooled equipment.

The initiating event frequency is based on actual flooding data, which are presented in Appendix E, Section E.1. A review of these data indicates that none of the listed breaks resulted in a total loss of flow. As the flood is assumed to occur during normal operations when the heat load on ERCW is only a small fraction of its design heat removal capacity, the impact of a reduction in ERCW flow is assumed to be limited to a gradual heatup of impacted equipment.

After discussions with the operators serving on the PRA team from both the Sequoyah and Watts Bar nuclear plants, the 45-minute value was selected as a reasonable time before heatup could start to become a problem.

FLPH2R: Identify and Isolate an ERCW Intake Line Break in the Pump Room of ERCW Intake

Timing: Assume up to 45 minutes to isolate leak before component cooling problems require reactor trip.

Same reasoning as for action FLPH1R.

HAFR1: Restore Auxiliary Feedwater Flow, Given Loss of Control Air

Timing: Approximately 50 minutes[10] available after air accumulators lost to steam generator dryout.

Justification for 50 minutes is the same as for action HAOB1, given that RCPs are running.

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[10]The operators evaluated this action with an initial time estimate of 40 minutes, which is conservative compared to this time. Because of the length of the time available in both cases, the 10-minute difference has no impact on their evaluations.

HARL1: Recover from an Automatic Sump Swapover Failure

Timing: Approximately 5 minutes before RWST reaches a point at which pumps lose suction.

With two ECCS pumps operating, the RWST is drained at a rate of 16,400 gpm. The inventory available at 29% capacity (sump swapover point) is 109,000 gallons. Consequently, approximately 6.5 minutes are available until the RWST empties. To provide some margin, the operators were given 5 minutes to accomplish the action.

HDAR1: Switch to Spare Battery Charger, Given Operating Charger Fails

Timing: At least 2 hours (without recharging under normal bus loads) before batteries are depleted.

This is a design requirement for the vital batteries in accordance with paragraph 6.2-1 of Reference C-1.

HDSR1: Cooldown and Depressurize by Cycling Steam Generator PORVs Full Open/Full Closed

Timing: Continuous control requirement until RCS below secondary system pressure. Respond to anomalies within 5 minutes.

The amount of time available is dependent on the magnitude of the anomaly. After consultation with the licensed operator members of the PRA team from both Watts Bar and Sequoyah, 5 minutes was selected as a reasonable time for reaction during a cooldown operation.

HERCW1: Recover ERCW Cooling To Operating Diesel Generator, Given Loss of ERCW to the Diesel Generator

Timing: Trip the diesel generators within 5 minutes to avoid overheating failure. Complete alignment and restart within 30 minutes.

Reference C-8 reports a diesel generator heatup experiment for a diesel generator at Browns Ferry that concluded that the diesel generator could operate for at least 5 minutes (the calculation projected 5.7 minutes) before reaching its design temperature limit. No data were available on how long the diesel generator would continue to operate once it exceeded that temperature. Given the similarities of large diesel generator cooling requirements, the time constraint for this action is considered to be conservative but reasonable.

During a station blackout with no LOCA and no TDAFP, the steam generators will dry out in approximately 1 hour (see action HAAF1). The time constraint of 30 minutes for recovering the diesel generator allows the operators to accomplish and/or verify the alignments and actuation necessary to ensure that steam generator level is recovered and adequate core cooling is maintained.

HERCW2: Cooldown with Auxiliary Feedwater and Steam Generator PORVs, Given Total Loss of ERCW, Raw Service Water (RSW) Available To Cool Air Compressor

Timing: Initiate cooldown within 10 minutes (as soon as possible) to avoid seal damage at 1 hour. Control over 2 hours.

NUREG-1150 (Reference C-3) indicates that the pumps seals have a first failure approximately 1 hour after seal cooling failure. The operators were given the goal and used their judgment regarding the timing of "as soon as possible" to initiate the cooldown to meet that goal. The 10-minute initiation time was provided by the operators as an estimate of the initiation time that would achieve the necessary cooldown.

Note: No credit is taken for this action in July 1992 quantification, as raw service water is not modeled in the initial IPE quantification.

HERCW3: Cooldown with Auxiliary Feedwater and Steam Generator PORVs, Given Total Loss of ERCW, RSW Not Available To Cool Air Compressors

Timing: Initiate cooldown within 10 minutes to avoid seal damage at 1 hour. Control over 2 hours.

Justification is the same as for action HERCW2.

HSLR1: Locally Transfer Steam Supply to TDAFP, Given Station Blackout and Loss of Steam Generator 1

Timing: Approximately 1 hour to steam generator dryout, given RCPs not running.

Justification is the same as for action HAAF1.

HTPR1: Start Turbine-Driven Pump, Given it Failed To Start due to Control or Signal Failures

Timing: Steam generator dryout at approximately 50 minutes if RCPs running.

Justification is the same as for action HAAF1.

HV1R1: Restore Ventilation to 6.9-kV Switchgear Room

Timing: At least 12 hours to accomplish before temperature approaches design limit.

Heatup calculations in Reference C-9 indicate that up to 24 hours is required for the 6.9-kV switchgear room to heat up past allowable limits, given a total loss of ventilation. The PRA used a conservative estimate of 12 hours for the operator action.

HVNVR1: Restore Ventilation to the 480V Board Room 1BB (2BB), Given Loss of Room Supply Fan

Timing: Six hours to heat up past allowable limits.

Heatup calculations in Reference C-9 indicate that 6 hours is the minimum time for the 480V board room to heat up past allowable limits, given a total loss of ventilation.

HVT1AR: Establish Portable Ventilation to the Shutdown Board Transformer Room

Timing: Five hours to heat up past allowable limits, given four fully loaded transformers.

Heatup calculations in Reference C-9 indicate that 5 hours is the minimum time for the shutdown board room to heat up past allowable limits, given a total loss of ventilation.

HCCSR1: Align the Core Spray Pump to the CCS Heat Exchanger A

Timing: Estimate 5 to 10 minutes available before charging pump failure.

Reference C-8 states that the CCPs at Sequoyah will meet the design requirement of operation for 1 minute without sustaining any damage that could prevent the pumps from performing the required safety function. It is assumed that the Westinghouse comments regarding Sequoyah also apply to Watts Bar. The criterion against which this action is evaluated is to align the alternate cooling before an overheating CCP sustains severe damage. Once damaged, it cannot be recovered. Experience during an event at Diablo Canyon indicated that a Westinghouse design CCP continued to function for an hour without loss of safety function (Reference C-9). Considering the above two pieces of information, a time constraint of 5 to 10 minutes to charging failure was judgmentally established as reasonable for the operators to establish alternate cooling.

HCCSR2: Align and Initiate Alternate Component Cooling to the Charging Pump

Timing: Estimate 5 to 10 minutes available before charging pump failure.

Justification is the same as for action HCCSR1.

HCCSR3: Align ERCW Header 2A to CCS Heat Exchanger A, Given Loss of Train B ERCW

Timing: Assume 45 minutes available before vital equipment begins to fail due to overheating.

This action is required during full-power operation when there is very little heat load on the CCS. Although there are no heatup calculations to support this argument, it is judged that the thermal sink provided by the water within the CCS will be sufficient to cool the RCP oil coolers and the thermal barriers adequately for the 45 minutes given to the operators to recognize and accomplish this action.

C.3 REFERENCES

C-1. Watts Bar Final Safety Analysis Report.

C-2. Pickard, Lowe and Garrick, Inc., and Stone & Webster Engineering Corporation, "Beaver Valley Unit 2 Probabilistic Risk Assessment, Summary Report," prepared for Duquesne Light Company, PLG-0730, Vols. 1-4, December 1989.

C-3. U.S. Nuclear Regulatory Commission, "Severe Accident Risk: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, December 1990.

C-4. Lewis, E. E., *Nuclear Power Reactor Safety*, John Wiley & Sons, 1977.

C-5. Westinghouse Owners Group, "Emergency Response Guidelines, High Pressure Version (Revision 1) of the Background Documents," FR-5.1, p. 27, Table 3.

C-6. TVA Design Criteria No. WB-DC-30-27, R1, dated February 25, 1992, RIMS T29 920225 899.

C-7. Watts Bar Final Safety Analysis Report, Questions and Answers, Volume 1.

C-8. Browns Ferry Nuclear Plant Calculation No. BFEP-M3, RIMS Accession Number B22 1860416108, "Diesel Generator Temperature Risk at Full Load," April 16, 1986.

C-9. TI-ECS-9 Rev. 0, "10CFR50 Appendix R Heating, Ventilation and Air Conditioning Review for Watts Bar," January 16, 1985.

Table C-1. HAOB1 Timing — Estimate of Time for Steam Generators to Boil to 5% Capacity, Given the Initial Inventory is 85% Capacity and RCPs Continue to Run

Energy removal capability of steam generator

HAOB1 time constraints

Number Steam Generators	4	
Design heat removal capacity	84.1	Full Power Sec (100% to 5% full)
Thermal rating (nuclear)	3411	MWt
RCP heat load	14	MWt
Initial S/G level (Li)	85	%
Final S/G level (Lf)	5	%

Iterative calculation to balance heat generation with SG heat removal capacity with RCPs running.

	Time t hours	Decay Heat + (NRC Guide 5.1) 65.75*t^.7037	Pump Heat - (14*3600/3411)*t	S/G Capacity 84.1*(Li-Lf)/.95	= 0 Diff
	0.700	51.16	10.34	70.82	-9.32
Crossover	0.800	56.20	11.82	70.82	-2.81
50.6	0.844	58.35	12.47	70.82	0.00
Minutes	0.900	61.05	13.30	70.82	3.53
	1.000	65.75	14.78	70.82	9.70

Time for S/G to boil to 5% WR = 50.6 minutes

Table C-2. HAOF1 Timing — Estimate of Time for Steam Generators to Boil to 25% Capacity, Given the Initial Inventory is 85% Capacity

Energy removal capability of steam generator

HAOF1 time constraints

Number Steam Generators	4	
Design heat removal capacity	84.1	Full Power Sec (100% to 5% full)
Thermal rating (nuclear)	3411	MWt
RCP heat load	14	MWt
Initial S/G level (Li)	85	%
Final S/G level (Lf)	25	%

Iterative calculation to balance heat generation with SG heat removal capacity with RCPs running.

	Time	Decay Heat + (NRC Guide 5.1)	Pump Heat -	S/G Capacity	= 0
	t hours	65.75*t^.7037	(14*3600/3411)*t	84.1*(Li-Lf)/.95	Diff
	0.400	34.50	5.91	53.12	-12.70
Crossover	0.500	40.37	7.39	53.12	-5.36
34.6	0.576	44.60	8.51	53.12	0.00
Minutes	0.600	45.90	8.87	53.12	1.65
	0.700	51.16	10.34	53.12	8.38

Time for S/G to boil to 5% WR = 34.6 minutes

D. SEQUENCE QUANTIFICATION

This appendix contains all of the sequence quantification information used in the Level 1 analysis. The following items are included in this appendix:

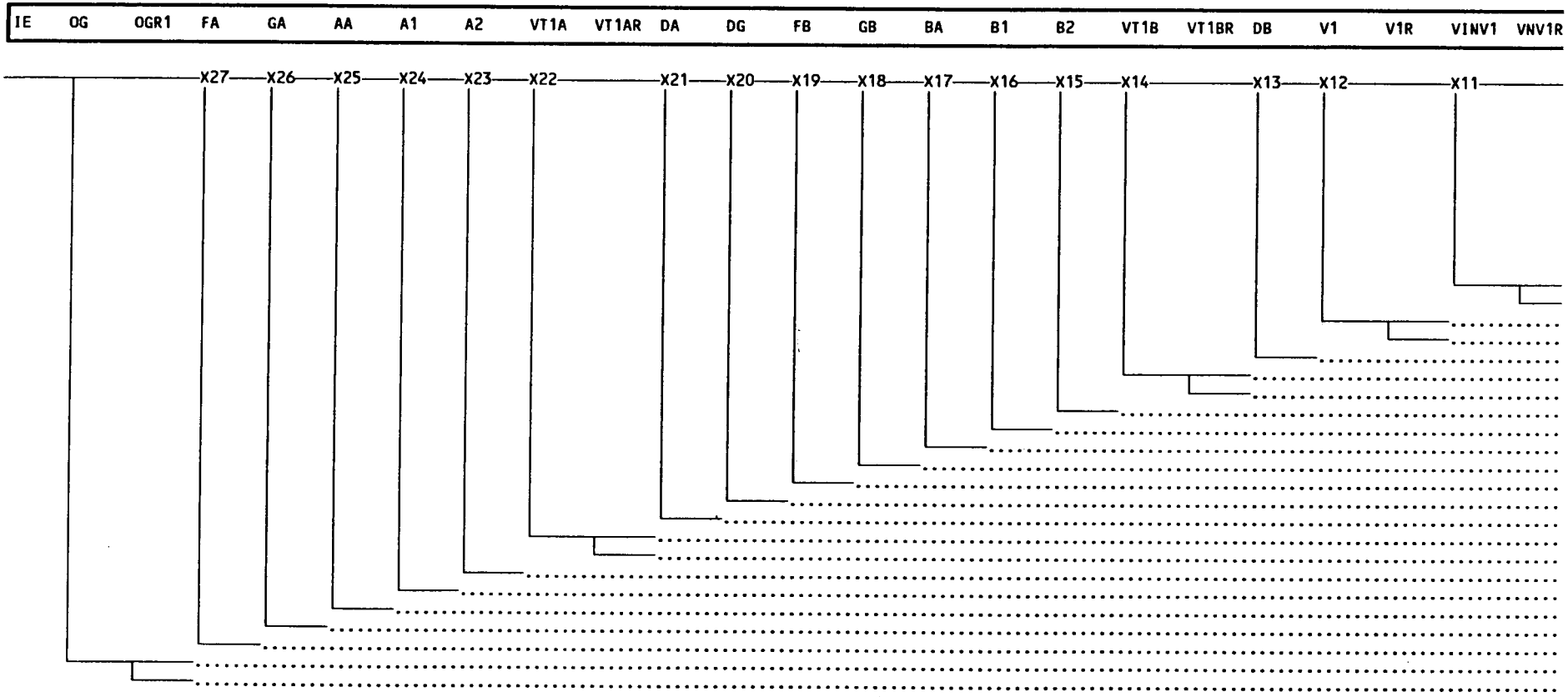
Item	Description
Quantification Input Information	
Event Trees Structure Top Event Description Split Fraction Rules Binning Rules	 Unique Shape of the Event Tree Description of Each Top Event Rules Used To Assign the Split Fraction Rules Used To Assign the Binning Rules or PDSs
Initiating Events	Listing of Precursors and Initiators of Plant Transients
Master Frequency File	Compilation of All of the Split Fractions Used in the Quantification
Quantification Results	
Top Sequences	Top 100 Sequences by Frequency
Plant Damage State Totals	Frequency Totals for All Bins or Plant Damage States
Top Event Importance	Listing of the Most Important Top Events
Split Fraction Importance	Listing of the Most Important Split Fractions
Human Action Sensitivity Analysis Results	
Top Sequences	Top 100 Sequences by Frequency
Top Event Importance	Listing of the Most Important Top Events
Split Fraction Importance	Listing of the Most Important Split Fractions

The last item in this appendix is a listing of the dominant sequences in equation form. This equation is used to determine core damage frequency uncertainty.

Page No. 1

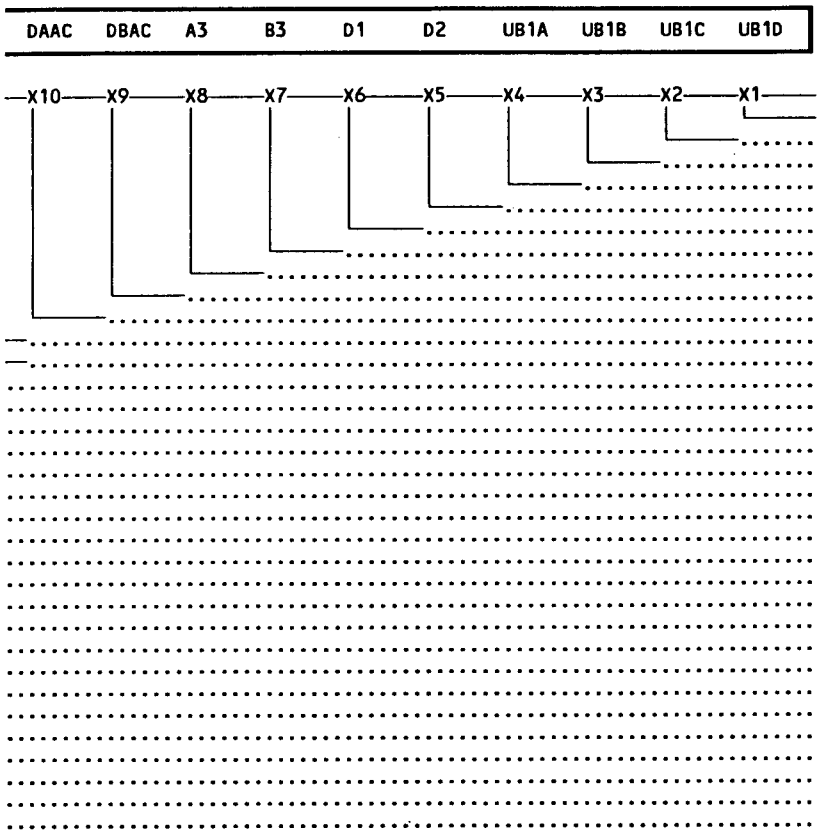
MODEL Name: WBNNEW
Event Tree: ELECT1

14:11:32 03 AUG 1992



MODEL Name: WBNNEW
Event Tree: ELECT1

14:11:35 03 AUG 1992



1		1
2		2
3	X1	3-4
4	X2	5-8
5	X3	9-16
6	X4	17-32
7	X5	33-64
8	X6	65-128
9	X7	129-256
10	X8	257-512
11	X9	513-1024
12	X10	1025-2048
13	X10	2049-3072
14	X11	3073-6144
15	X11	6145-9216
16	X12	9217-18432
17	X13	18433-36864
18	X13	36865-55296
19	X14	55297-110592
20	X15	110593-221184
21	X16	221185-442368
22	X17	442369-884736
23	X18	884737-1769472
24	X19	1769473-3538944
25	X20	3538945-7077888
26	X21	7077889-14155776
27	X21	14155777-21233664
28	X22	21233665-42467328
29	X23	42467329-84934656
30	X24	84934657-169869312
31	X25	169869313-339738624
32	X26	339738625-679477248
33	X27	679477249-1358954496
34	X27	1358954497-2038431744

MODEL Name: WBNNEW

Top Event Legend for Tree: ELECT1

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Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
OG	LOSS OF 161KV OFFSITE POWER
OGR1	FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR
FA	LOSS OF UNIT 1 TRAIN A DIESEL FUEL OIL
GA	LOSS OF UNIT 1 DIESEL GENERATOR 1A-A
AA	LOSS OF 6.9KV SD BD UNIT 1 TRAIN A
A1	LOSS OF 480V SHUTDOWN BOARD 1A1-A
A2	LOSS OF 480V SHUTDOWN BOARD 1A2-A
VT1A	LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION
VT1AR	FAILURE TO RECOVER TRANSFORMER ROOM 1A VENTILATION IN 10 HOURS
DA	LOSS OF 125V DC BATTERY BD I
DG	LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A
FB	LOSS OF UNIT 1 TRAIN B DIESEL FUEL OIL
GB	LOSS OF UNIT 1 DIESEL GENERATOR 1B-B
BA	LOSS OF 6.9KV SD BD UNIT 1 TRAIN B
B1	LOSS OF 480V SHUTDOWN BOARD 1B1-B
B2	LOSS OF 480V SHUTDOWN BOARD 1B2-B
VT1B	LOSS OF SD TRANSFORMER ROOM 1B VENTILATION
VT1BR	FAILURE TO RECOVER TRANSFORMER ROOM 1B VENTILATION IN 5 HOURS
DB	LOSS OF 125V DC BATTERY BD II
V1	LOSS OF UNIT 1 SHUTDOWN BOARD VENTILATION
V1R	FAILURE TO RECOVER UNIT 1 SHUTDOWN BD ROOM VENTILATION IN 12 HOURS
VINV1	LOSS OF 480V BOARD ROOM B VENTILATION
VNV1R	FAILURE TO RECOVER 480V BD RM B VENTILATION IN 6 HOURS
DAAC	LOSS OF 120V VITAL INST. CHANNEL 1-I
DBAC	LOSS OF 120V VITAL INST. CHANNEL 1-II

MODEL Name: WBNNEW

Top Event Legend for Tree: ELECT1

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Page 2

Top Event Designator.....	Top Event Description.....
A3	LOSS OF 480V COMMON BOARD A
B3	LOSS OF 480V COMMON BOARD B
D1	LOSS OF 250V DC BUS 1
D2	LOSS OF 250V DC BUS 2
UB1A	LOSS OF 6.9KV UNIT BOARD 1A
UB1B	LOSS OF 6.9KV UNIT BOARD 1B
UB1C	LOSS OF 6.9KV UNIT BOARD 1C
UB1D	LOSS OF 6.9KV UNIT BOARD 1D

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: ELECT1

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Page 1

```
SF........ Split Fraction Logic.............................................
OGF       INIT=LOSP
OG1       1
OGR1S     OG=S
OGR11     1
UB1AF     OG=F * OGR1=F + D1=F
UB1A1     1
UB1BF     OG=F * OGR1=F + D2=F
UB1B2     UB1A=F * D1=S * D2=S
UB1B3     UB1A=F * D1=F * D2=S
UB1B1     1
FAS       OG=S + OGR1=S
FA1       OG=F
GAS       OG=S + OGR1=S
GAF       FA=F
GA1       OG=F
AAF       OG=F * GA=F * -OGR1=S + LASD
AA1       OG=S
AA2       OG=F
A11       AA=S
A1F       AA=F
A21       AA=S
A2F       AA=F
VT1AF     A1=F
VT1A2     OG=F
VT1A1     1
VT1ARS    VT1A=S
VT1AR1    1
DAF       INIT=LVBB1
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: ELECT1

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Page 2

SF..... Split Fraction Logic.....

DA2	A1=F
DA1	A1=S
DGF	A1=F
DG1	A1=S
UB1CF	OG=F * OGR1=F + D1=F
UB1C1	UB1A=S * UB1B=S
UB1C2	UB1A=S * UB1B=F * D2=S + UB1A=F * UB1B=S
UB1C3	UB1A=F * UB1B=F * D2=S
UB1C4	UB1A=S * UB1B=F * D2=F
UB1C5	UB1A=F * UB1B=F * D2=F
UB1DF	OG=F * OGR1=F + D2=F
UB1D1	D1=S * UB1A=S * UB1B=S * UB1C=S
UB1D2	D1=S * (UB1A=S * UB1B=S * UB1C=F + UB1A=S * UB1B=F * UB1C=S + UB1A=F * UB1B=S * UB1C=S)
UB1D3	D1=S * (UB1A=S * UB1B=F * UB1C=F + UB1A=F * UB1B=F * UB1C=S + UB1A=F * UB1B=S * UB1C=F)
UB1D4	D1=S * UB1A=F * UB1B=F * UB1C=F
UB1D5	D1=F * UB1B=S
UB1D6	D1=F * UB1B=F
FBS	OG=S + OGR1=S
FB2	FA=F
FB1	FA=S
GBS	OG=S + OGR1=S
GBF	FB=F
GB3	FA=F
GB2	FA=S * GA=F
GB1	GA=S
BAF	OG=F * GB=F * -OGR1=S + LBSD

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: ELECT1

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Page 3

SF..... Split Fraction Logic.....

BA5	OG=F * GA=F
BA4	OG=F * GA=S * AA=F
BA3	OG=F * AA=S
BA2	OG=S * AA=F *-LASD
BA1	OG=S * (AA=S + LASD)
B1F	BA=F
B11	BA=S
B2F	BA=F
B21	BA=S
VT1BF	B1=F
VT1B1	1
VT1BRS	VT1B=S
VT1BR1	1
DBF	INIT=LVBB2
DB1	B2=S
DB2	B2=F
V1F	A2=F * B2=F
V11	OG=S * A2=S * B2=S
V12	OG=S * A2=F * B2=S
V13	OG=S * A2=S * B2=F
V14	OG=F * A2=S * B2=S
V15	OG=F * (A2=F + B2=F)
V1RS	V1=S
V1RF	AA=F * BA=F
V1R1	1
VINV1F	B2=F
VINV12	OG=F
VINV11	1

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: ELECT1

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Page 4

SF..... Split Fraction Logic.....

VNV1RS	VINV1=S
VNV1R1	1
DAACF	DA=F * A1=F + VINV1=F * VNV1R=F + LDAAC
DAAC3	A1=F
DAAC2	DA=F
DAAC1	1
DBACF	DB=F * B1=F + VINV1=F * VNV1R=F + LDBAC
DBAC3	B1=F
DBAC2	DB=F
DBAC1	1
A3F	OG=F * OGR1=F
A31	OG=S + OGR1=S
B3F	OG=F * OGR1=F
B31	OG=S + OGR1=S
D11	A3=S
D12	LOSP + A3=F
D21	B3=S
D22	LOSP + B3=F

Page No. 1

MODEL Name: WBNNEW
Event Tree: ELECT2

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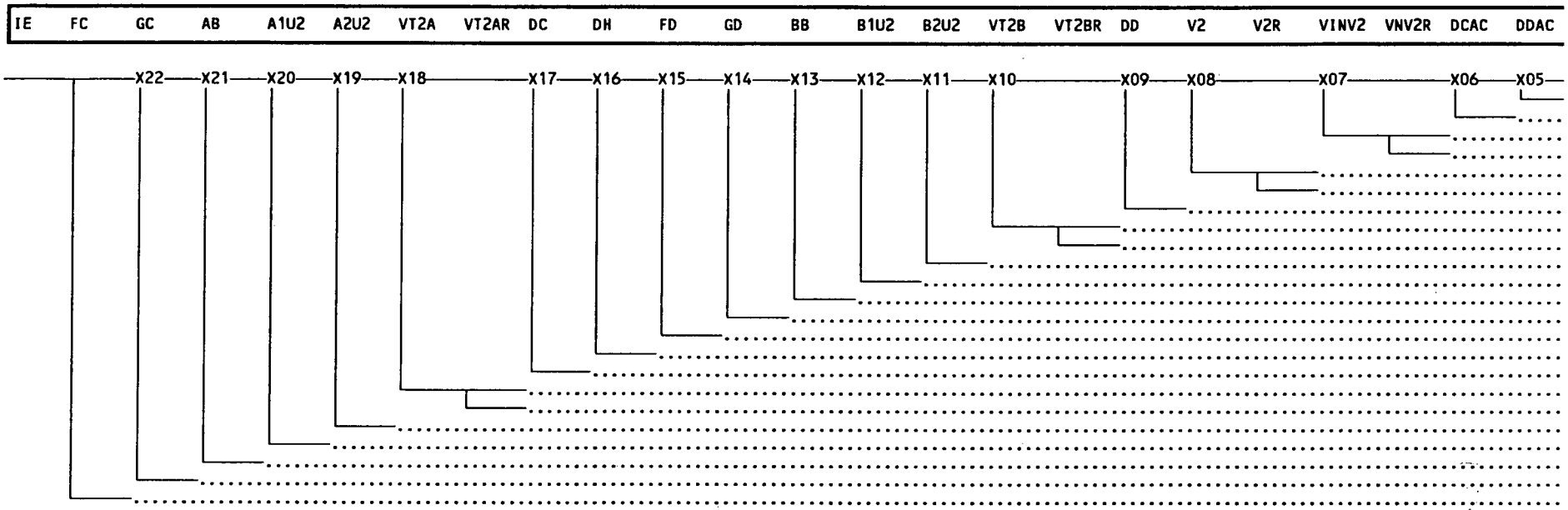

MODEL Name: WBNNEW
Event Tree: ELECT2

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]

—	1		1
—	2		2
..	3	X05	3-4
..	4	X06	5-8
..	5	X06	9-12
..	6	X07	13-24
..	7	X07	25-36
..	8	X08	37-72
..	9	X09	73-144
..	10	X09	145-216
..	11	X10	217-432
..	12	X11	433-864
..	13	X12	865-1728
..	14	X13	1729-3456
..	15	X14	3457-6912
..	16	X15	6913-13824
..	17	X16	13825-27648
..	18	X17	27649-55296
..	19	X17	55297-82944
..	20	X18	82945-165888
..	21	X19	165889-331776
..	22	X20	331777-663552
..	23	X21	663553-1327104
..	24	X22	1327105-2654208

MODEL Name: WBNNEW

Top Event Legend for Tree: ELECT2

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Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
FC	LOSS OF UNIT 2 TRAIN A DIESEL FUEL OIL
GC	LOSS OF UNIT 2 DIESEL GENERATOR 2A-A
AB	LOSS OF 6.9KV SD BD TRAIN A UNIT 2
A1U2	LOSS OF UNIT 2 480V SD BD 2A1-A
A2U2	LOSS OF UNIT 2 480V SD BD 2A2-A
VT2A	LOSS OF 480V SD TRANSFORMER ROOM 2A VENTILATION
VT2AR	FAILURE TO RECOVER 480V SD TRANSFORMER 2A VENTILATION IN 10 HOURS
DC	LOSS OF 125V DC BATTERY BD III
DH	LOSS OF UNIT 2 120V AC INSTRUMENT BOARD 2A
FD	LOSS OF UNIT 2 TRAIN B DIESEL FUEL OIL
GD	LOSS OF UNIT 2 DIESEL GENERATOR 2B-B
BB	LOSS OF 6.9KV UNIT 2 SHUTDOWN BOARD 2B-B
B1U2	LOSS OF UNIT 2 480V SD BD 2B1-B
B2U2	LOSS OF UNIT 2 480V SD BD 2B2-B
VT2B	LOSS OF 480V SD TRANSFORMER ROOM 2B VENTILATION
VT2BR	FAILURE TO RECOVER 480V TRANSFORMER ROOM VENTILATION IN 5 HOURS
DD	LOSS OF 125V DC BATTERY BD IV
V2	LOSS OF UNIT 2 SHUTDOWN BOARD VENTILATION SYSTEM
V2R	FAILURE TO RECOVER UNIT 2 SHUTDOWN BD VENTILATION IN 12 HOURS
VINV2	LOSS OF 480V SD BD RM 2B VENTILATION
VNV2R	FAILURE TO RECOVER 480V SD BD RM 2B VENTILATION IN 6 HOURS
DCAC	LOSS OF 120 V AC VITAL BD 1-III
DDAC	LOSS OF 120 V AC VITAL BD 1-IV

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: ELECT2

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Page 1

SF..... Split Fraction Logic.....

FCS	OG=S + OGR1=S
FC3	FA=F * FB=F
FC2	(FA=F + FB=F)
FC1	FA=S * FB=S
GCS	OG=S + OGR1=S
GCF	FC=F
GC5	FA=F * FB=F
GC6	(FA=S * GA=F * FB=F + FA=F * FB=S * GB=F)
GC4	(GA=S * FB=F + FA=F * GB=S)
GC3	FA=S * FB=S * GA=F * GB=F
GC2	FA=S * FB=S * (GA=F + GB=F)
GC1	GA=S * GB=S
ABF	OG=F * GC=F * -OGR1=S
AB9	OG=F * GA=F * GB=F
AB8	OG=F * (GA=S * AA=F * GB=F + GA=F * GB=S * BA=F)
AB7	OG=F * (AA=S * GB=F + GA=F * BA=S)
AB6	OG=F * GA=S * GB=S * AA=F * BA=F
AB5	OG=S * AA=F * -LASD * BA=F * -LBSD
AB4	OG=F * GA=S * GB=S * (AA=F + BA=F)
AB3	OG=S * (AA=F * -LASD + BA=F * -LBSD)
AB2	OG=F * AA=S * BA=S
AB1	OG=S * (AA=S + LASD) * (BA=S + LBSD)
A1U2F	AB=F
A1U21	AB=S
A2U2F	AB=F
A2U21	AB=S
VT2AF	A1U2=F
VT2A1	1

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: ELECT2

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Page 2

SF..... Split Fraction Logic.....

VT2ARS	VT2A=S
VT2AR1	1
DCF	INIT=LVBB3
DC1	A1U2=S
DC2	A1U2=F
DHF	A1U2=F
DHS	1
FDS	OG=S + OGR1=S
FD4	FA=F * FB=F * FC=F
FD3	(FA=F * (FB=F + FC=F) + FB=F * FC=F)
FD2	(FA=F + FB=F + FC=F)
FD1	FA=S * FB=S * FC=S
GDS	OG=S + OGR1=S
GDF	FD=F
GD7	FA=F * FB=F * FC=F
GD10	(FA=S * GA=F * FB=F * FC=F + FA=F * FB=S * GB=F * FC=F + FA=F * FB=F * FC=S * GC=F)
GD6	(GA=S * FB=F * FC=F + FA=F * GB=S * FC=F + FA=F * FB=F * GC=S)
GD9	(FA=S * GA=F * FB=S * GB=F * FC=F + FA=S * GA=F * FB=F * FC=S * GC=F + FA=F * FB=S * GB=F * FC=S * GC=F)
GD8	(FA=S * FB=S * FC=F * (GA=F + GB=F) + FA=S * FB=F * FC=S * (GA=F + GC=F) + FA=F * FB=S * FC=S * (GB=F + GC=F))
GD5	(FA=S * FB=S * FC=F * GA=S * GB=S + FA=S * FB=F * FC=S * GA=S * GC=S + FA=F * FB=S * FC=S * GB=S * GC=S)
GD4	FA=S * FB=S * FC=S * GA=F * GB=F * GC=F
GD3	FA=S * FB=S * FC=S * (GA=F * (GB=F + GC=F) + GB=F * GC=F)
GD2	FA=S * FB=S * FC=S * (GA=F + GB=F + GC=F)
GD1	GA=S * GB=S * GC=S
BBF	OG=F * GD=F * -OGR1=S

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: ELECT2

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Page 3

SF..... Split Fraction Logic.....

BB10	OG=F * GA=F * GB=F * GC=F
BB12	OG=F * (GA=S * AA=F * GB=F * GC=F + GA=F * GB=S * BA=F * GC=F + GA=F * GB=F * GC=S * AB=F)
BB9	OG=F * (AA=S * GB=F * GC=F + GA=F * BA=S * GC=F + GA=F * GB=F * AB=S)
BB13	OG=F * (GA=S * AA=F * GB=S * BA=F * GC=F + GA=S * AA=F * GB=F * GC=S * AB=F + GA=F * GB=S * BA=F * GC=S * AB=F)
BB11	OG=F * (GA=S * GB=S * GC=F * (AA=F + BA=F) + GA=S * GB=F * GC=S * (AA=F + AB=F) + GA=F * GB=S * GC=S * (BA=F + AB=F))
BB8	OG=F * (GA=S * GB=S * GC=F * AA=S * BA=S + GA=S * GB=F * GC=S * AA=S * AB=S + GA=F * GB=S * GC=S * BA=S * AB=S)
BB14	OG=F * GA=S * GB=S * GC=S * AA=F * BA=F * AB=F
BB7	OG=F * GA=S * GB=S * GC=S * (AA=F * (BA=F + AB=F) + BA=F * AB=F)
BB6	OG=F * GA=S * GB=S * GC=S * (AA=F + BA=F + AB=F)
BB5	OG=F * AA=S * AB=S * BA=S
BB4	OG=S * AA=F * -LASD * AB=F * BA=F * -LBSD
BB3	OG=S * (AA=F * -LASD * (AB=F+ BA=F * -LBSD) + AB=F * BA=F * -LBSD)
BB2	OG=S * (AA=F * -LASD + AB=F + BA=F * -LBSD)
BB1	OG=S * (AA=S + LASD) * AB=S * (BA=S + LBSD)
B1U2F	BB=F
B1U21	1
B2U2F	BB=F
B2U21	1
VT2BF	B1U2=F
VT2B2	OG=F
VT2B1	1
VT2BRS	VT2B=S
VT2BR1	1
DDF	INIT=LVBB4
DD1	B2U2=S

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: ELECT2

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Page 4

SF..... Split Fraction Logic.....

DD2	B2U2=F
V21	V1=S * OG=S * A2=S * B2=S * A2U2=S * B2U2=S
V22	V1=F * OG=S * A2=S * B2=S * A2U2=S * B2U2=S
V23	V1=S * OG=S * A2=F * B2=F * A2U2=S * B2U2=S
V24	V1=S * OG=S * A2=F * B2=S * A2U2=S * B2U2=S
V25	V1=S * OG=S * A2=S * B2=F * A2U2=S * B2U2=S
V26	V1=S * OG=S * A2=S * B2=S * A2U2=F * B2U2=S
V27	V1=S * OG=S * A2=S * B2=S * A2U2=S * B2U2=F
V28	V1=S * OG=S * A2=F * B2=S * A2U2=F * B2U2=S + V1=S * OG=S * A2=S * B2=F * A2U2=S * B2U2=F
V29	V1=S * OG=S * A2=F * B2=S * A2U2=S * B2U2=F + V1=S * OG=S * A2=S * B2=F * A2U2=F * B2U2=S
V210	V1=F * OG=S * A2=F * B2=S * A2U2=S * B2U2=S
V211	V1=F * OG=S * A2=S * B2=F * A2U2=S * B2U2=S
V212	V1=F * OG=S * A2=S * B2=S * A2U2=F * B2U2=S
V213	V1=F * OG=S * A2=S * B2=S * A2U2=S * B2U2=F
V214	V1=F * OG=S * A2=F * B2=S * A2U2=F * B2U2=S
V215	V1=F * OG=S * A2=F * B2=S * A2U2=S * B2U2=F
V216	V1=S * OG=S * A2=F * B2=F * A2U2=S * B2U2=S
V217	V1=S * OG=S * A2=F * B2=F * A2U2=F * B2U2=S
V218	V1=S * OG=S * A2=F * B2=F * A2U2=S * B2U2=F
V219	V1=S * OG=F * A2=S * B2=S * A2U2=S * B2U2=S
V220	V1=S * OG=F * (A2=F + B2=F) * A2U2=S * B2U2=S
V221	V1=S * OG=F * A2=S * B2=S * (A2U2=F + B2U2=F)
V222	V1=S * OG=F * (A2=F + B2=F) * (A2U2=F + B2U2=F)
V223	V1=F * OG=F * A2=S * B2=S * A2U2=S * B2U2=S
V224	V1=F * OG=F * (A2=F + B2=F) * A2U2=S * B2U2=S
V225	V1=F * OG=F * A2=S * B2=S * (A2U2=F + B2U2=F)
V226	V1=F * OG=F * (A2=F + B2=F) * (A2U2=F + B2U2=F)

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: ELECT2

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Page 5

SF..... Split Fraction Logic.....

V227	V1=S * OG=F * A2=F * B2=F * A2U2=S * B2U2=S
V228	V1=S * OG=F * A2=F * B2=F * (A2U2=F + B2U2=F)
V2F	A2U2=F * B2U2=F
V2F	1
V2RF	AB=F * BB=F
V2RS	V2=S
V2R1	1
VINV2F	B2U2=F
VINV22	OG=F
VINV21	1
VNV2RS	VINV2=S
VNV2R1	1
DCACF	DC=F * A1U2=F + VINV2=F * VNV2R=F + LDCAC
DCAC3	A1U2=F
DCAC2	DC=F
DCAC1	1
DDACF	DD=F * B1U2=F + VINV2=F * VNV2R=F + LDDAC
DDAC3	B1U2=F
DDAC2	DD=F
DDAC1	1

Page No. 1

MODEL Name: WBNNEW
Event Tree: GTBINS

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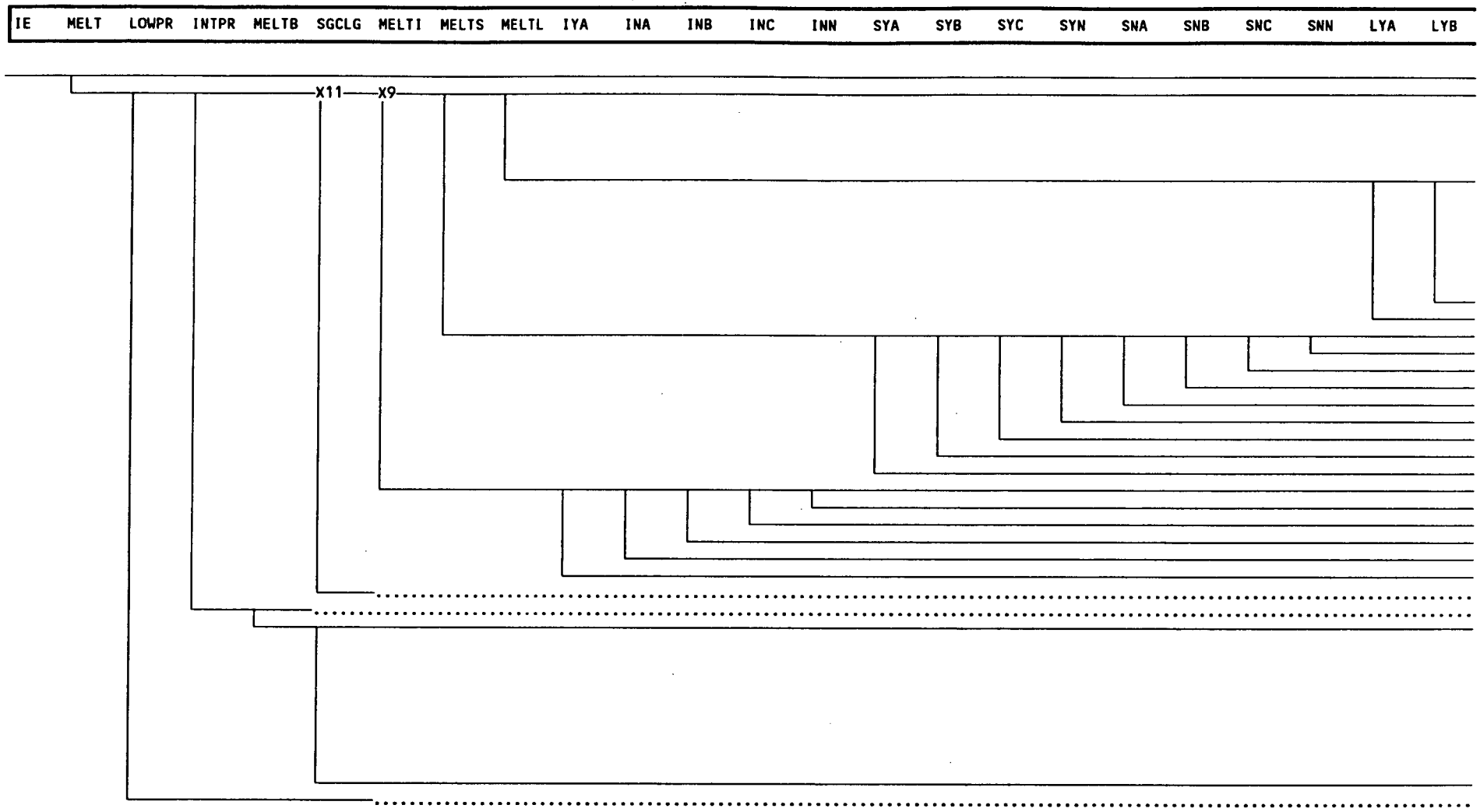

MODEL Name: WBNNEW
Event Tree: GTBINS

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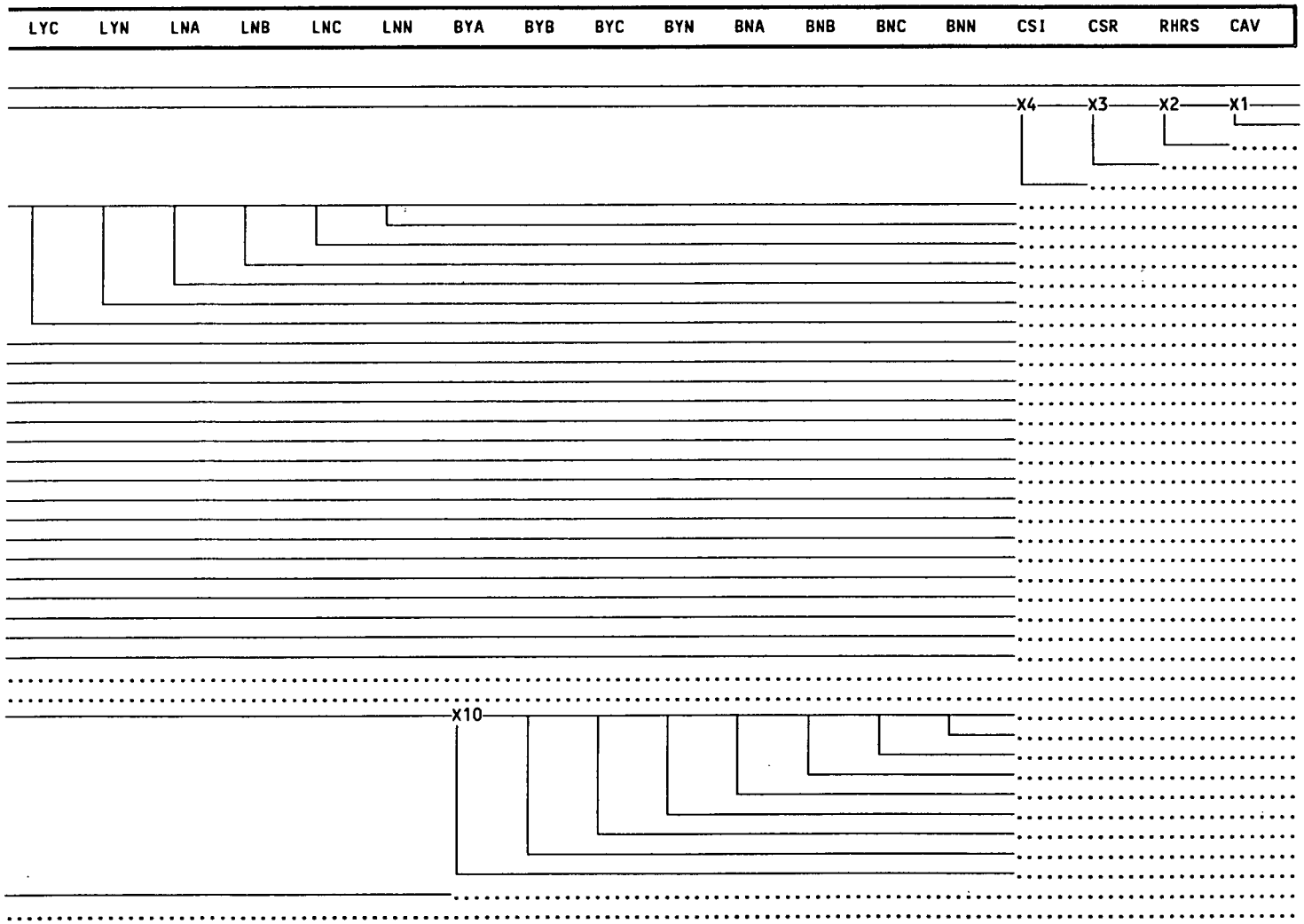

1		1
2		2
3		3
4	X1	4-5
5	X2	6-9
6	X3	10-17
7	X4	18-33
8	X4	34-49
9	X4	50-65
10	X4	66-81
11	X4	82-97
12	X4	98-113
13	X4	114-129
14	X4	130-145
15	X4	146-161
16	X4	162-177
17	X4	178-193
18	X4	194-209
19	X4	210-225
20	X4	226-241
21	X4	242-257
22	X4	258-273
23	X4	274-289
24	X4	290-305
25	X4	306-321
26	X4	322-337
27	X4	338-353
28	X4	354-369
29	X4	370-385
30	X4	386-401
31	X9	402-801
32	X11	802-1601
33	X4	1602-1617
34	X4	1618-1633
35	X4	1634-1649
36	X4	1650-1665
37	X4	1666-1681
38	X4	1682-1697
39	X4	1698-1713
40	X4	1714-1729
41	X4	1730-1745
42	X10	1746-1889
43	X9	1890-2289

MODEL Name: WBNNEW

Top Event Legend for Tree: GTBINS

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Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
MELT	NO CORE MELT
LOWPR	NO LOW PRESSURE
INTPR	NO INTERMEDIATE PRESSURE
MELTB	MELT WITH SGTR BYPASS
SGCLG	LOSS OF STEAM GENERATOR COOLING
MELTI	MELT WITH SUCCESSFUL CONTAINMENT ISOLATION
MELTS	MELT WITH CI FAILURE AND CONT. PURGE SUCCESS
MELTL	MELT WITH CONTAINMENT PURGE FAILURE
IYA	MELT * CI=S * CP=S * IC=S * AR=S * HH=S
INA	
INB	
INC	
INN	
SYA	
SYB	
SYC	
SYN	
SNA	
SNB	
SNC	
SNN	
LYA	
LYB	
LYC	
LYN	
LNA	
LNB	

MODEL Name: WBNNEW

Top Event Legend for Tree: GTBINS

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Top Event Designator.....	Top Event Description.....
LNC	
LNN	
BYA	
BYB	
BYC	
BYN	
BNA	
BNB	
BNC	
BNN	
CSI	FAILURE OF CONTAINMENT SPRAY INJECTION
CSR	FAILURE OF CONTAINMENT SPRAY RECIRCULATION
RHRS	FAILURE OF RHR SPRAY RECIRCULATION
CAV	WATER IN REACTOR CAVITY

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTBINS

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```
SF........ Split Fraction Logic.............................................

MELTBF     MELT * (SGTR * (SL=F + DP=F) + ITR*SL=F)

MELTBS     1

           MELTB:= MELTB=F

MELTF      REC=F * -RQ=S * (CM=F + (RR=F + (RA=F + RVA=F) * (RB=F + RVB=F) +
           SU=F + RL=F) * (MU=F + -CH=S) + RR=F * -(RRFAIL))

           MELT:= MELT=F

MELTS      1

MELTIF     MELT * CI=S * CP=S

           MELTI:= MELTI=F

MELTIS     1

MELTSF     MELT * CI=F * CP=S

           MELTS:= MELTS=F

MELTSS     1

MELTLF     MELT * CP=F

           MELTL:= MELTL=F

MELTLS     1

IYAF       MELTI * IC=S

IYAS       1

SYAF       MELTS * IC=S * AR=S * HH=S

SYAS       1

SYBF       MELTS * IC=S * AR=S * HH=F

SYBS       1

SYCF       MELTS * IC=S * AR=F * HH=S

SYCS       1

SYNF       MELTS * IC=S * AR=F * HH=F

SYNS       1

LYAF       MELTL * IC=S * AR=S * HH=S

LYAS       1
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTBINS

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SF..... Split Fraction Logic.....

LYBF	MELTL * IC=S * AR=S * HH=F
LYBS	1
LYCF	MELTL * IC=S * AR=F * HH=S
LYCS	1
LYNF	MELTL * IC=S * AR=F * HH=F
LYNS	1
INAF	MELTI * IC=F * AR=S * HH=S
INAS	1
INBF	MELTI * IC=F * AR=S * HH=F
INBS	1
INCF	MELTI * IC=F * AR=F * HH=S
INCS	1
INNF	MELTI * IC=F * AR=F * HH=F
INNS	1
SNAF	MELTS * IC=F * AR=S * HH=S
SNAS	1
SNBF	MELTS * IC=F * AR=S * HH=F
SNBS	1
SNCF	MELTS * IC=F * AR=F * HH=S
SNCS	1
SNNF	MELTS * IC=F * AR=F * HH=F
SNNS	1
LNAF	MELTL * IC=F * AR=S * HH=S
LNAS	1
LNBF	MELTL * IC=F * AR=S * HH=F
LNBS	1
LNCF	MELTL * IC=F * AR=F * HH=S
LNCS	1

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTBINS

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SF..... Split Fraction Logic.....

LNNF	MELTL * IC=F * AR=F * HH=F
LNNS	1
BYAF	MELTB * IC=S * AR=S * HH=S
BYAS	1
BYBF	MELTB * IC=S * AR=S * HH=F
BYBS	1
BYCF	MELTB * IC=S * AR=F * HH=S
BYCS	1
BYNF	MELTB * IC=S * AR=F * HH=F
BYNS	1
BNAF	MELTB * IC=F * AR=S * HH=S
BNAS	1
BNBF	MELTB * IC=F * AR=S * HH=F
BNBS	1
BNCF	MELTB * IC=F * AR=F * HH=S
BNCS	1
BNNF	MELTB * IC=F * AR=F * HH=F
BNNS	1
CSIS	CSA=S + CSB=S
CSIF	1
	XCSI:= CSI=F
CSRS	(CSA=S + CSB=S) * CH=S
CSRF	1
RHRSS	(RA=S * RVA=S * RB=S * RVB=S) * RR=S * RI=S * RS=S
RHRSF	1
	XRHRS:= RHRS=F
CAVS	IC=S * ((S1=S + S2=S) * SI=S + (RA=S + RB=S) * RI=S + CSA=S + CSB=S + VS=S * VC=S * (VA=S + VB=S)) * SU=S * -DRYSUMP

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTBINS

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```
SF........ Split Fraction Logic.............................................

CAVF      1

          XCAV:= CAV=F

LOWPRF    RT=F * MR=F * (PL=F * FW=F + SR=F)

LOWPRS    1

          LOWPR:= LOWPR=F

          HIGHPR:= (TP=F * TPR=F * MA=F * MB=F + AF=F) * (-MF=S + -OF=S)
          *(-HPI + -OB=S)

INTPRF    SLOCA + SGTR + ITR + SE=F + PI=F + PR=F + OB=S

INTPRS    1

          INTPR:= INTPR=F

SGCLGS    (TP=S + TPR=S + MA=S + MB=S) * AF=S + MF=S * OF=S + RT=F*FW=S

SGCLGF    1

          SGCLG:= SGCLG=S

          IYA:= IYA=F

          IYB:= IYB=F

          IYC:= IYC=F

          IYN:= IYN=F

          SYA:= SYA=F

          SYB:= SYB=F

          SYC:= SYC=F

          SYN:= SYN=F

          LYA:= LYA=F

          LYB:= LYB=F

          LYC:= LYC=F

          LYN:= LYN=F

          INA:= INA=F

          INB:= INB=F

          INC:= INC=F
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTBINS

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SF..... Split Fraction Logic.....

INN:= INN=F

SNA:= SNA=F

SNB:= SNB=F

SNC:= SNC=F

SNN:= SNN=F

LNA:= LNA=F

LNB:= LNB=F

LNC:= LNC=F

LNN:= LNN=F

BYA:= BYA=F

BYB:= BYB=F

BYC:= BYC=F

BYN:= BYN=F

BNA:= BNA=F

BNB:= BNB=F

BNC:= BNC=F

BNN:= BNN=F

CSI:= CSI=S

CSR:= CSR=S

XCSR:= CSR=F

RHRS:= RHRS=S

CAV:= CAV=S

MODEL Name: WBNNEW

Binning Logic for Event Tree: GTBINS

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Bin.....	Binning Rules.....
ACI	LOWPR*MELTI*XCAV*CSR
BCI	LOWPR*MELTI*CAV*CSR
AEI	LOWPR*MELTI*XCAV*CSI*RHRS*XCSR
BEI	LOWPR*MELTI*CAV*CSI*RHRS*XCSR
AGI	LOWPR*MELTI*XCAV*CSI*XCSR*XRHRS
BGI	LOWPR*MELTI*CAV*CSI*XCSR*XRHRS
AII	LOWPR*MELTI*XCAV*XCSI*XCSR*RHRS
BII	LOWPR*MELTI*CAV*XCSI*XCSR*RHRS
ANI	LOWPR*MELTI*XCAV*XCSI*XCSR*XRHRS
BNI	LOWPR*MELTI*CAV*XCSI*XCSR*XRHRS
ACS	LOWPR*MELTS*XCAV*CSR
BCS	LOWPR*MELTS*CAV*CSR
AES	LOWPR*MELTS*XCAV*CSI*XCSR*RHRS
BES	LOWPR*MELTS*CAV*CSI*XCSR*RHRS
AGS	LOWPR*MELTS*XCAV*CSI*XCSR*XRHRS
BGS	LOWPR*MELTS*CAV*CSI*XCSR*XRHRS
AIS	LOWPR*MELTS*XCAV*XCSI*XCSR*RHRS
BIS	LOWPR*MELTS*CAV*XCSI*XCSR*RHRS
ANS	LOWPR*MELTS*XCAV*XCSI*XCSR*XRHRS
BNS	LOWPR*MELTS*CAV*XCSI*XCSR*XRHRS
APL	LOWPR*MELTL*XCAV*CSR
BPL	LOWPR*MELTL*CAV*CSR
AQL	LOWPR*MELTL*XCAV*CSI*XCSR*RHRS
BQL	LOWPR*MELTL*CAV*CSI*XCSR*RHRS
ARL	LOWPR*MELTL*XCAV*CSI*XCSR*XRHRS
BRL	LOWPR*MELTL*CAV*CSI*XCSR*XRHRS
ASL	LOWPR*MELTL*XCAV*XCSI*XCSR*RHRS
BSL	LOWPR*MELTL*CAV*XCSI*XCSR*RHRS
ATL	LOWPR*MELTL*XCAV*XCSI*XCSR*XRHRS
BTL	LOWPR*MELTL*CAV*XCSI*XCSR*XRHRS
ECI	INTPR*MELTI*SGCLG*XCAV*CSR
FCI	INTPR*MELTI*SGCLG*CAV*CSR
EEI	INTPR*MELTI*SGCLG*XCAV*CSI*RHRS*XCSR

FEI	INTPR*MELTI*SGCLG*CAV*CSI*RHRS*XCSR
EGI	INTPR*MELTI*SGCLG*XCAV*CSI*XCSR*XRHRS
FGI	INTPR*MELTI*SGCLG*CAV*CSI*XCSR*XRHRS
EII	INTPR*MELTI*SGCLG*XCAV*XCSI*XCSR*RHRS
FII	INTPR*MELTI*SGCLG*CAV*XCSI*XCSR*RHRS

MODEL Name: WBNNEW

Binning Logic for Event Tree: GTBINS

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Bin.....	Binning Rules.....
ENI	INTPR*MELTI*SGCLG*XCAV*XCSI*XCSR*XRHRS
FNI	INTPR*MELTI*SGCLG*CAV*XCSI*XCSR*XRHRS
ECS	INTPR*MELTS*SGCLG*XCAV*CSR
FCS	INTPR*MELTS*SGCLG*CAV*CSR
EES	INTPR*MELTS*SGCLG*XCAV*CSI*XCSR*RHRS
FES	INTPR*MELTS*SGCLG*CAV*CSI*XCSR*RHRS
EGS	INTPR*MELTS*SGCLG*XCAV*CSI*XCSR*XRHRS
FGS	INTPR*MELTS*SGCLG*CAV*CSI*XCSR*XRHRS
EIS	INTPR*MELTS*SGCLG*XCAV*XCSI*XCSR*RHRS
FIS	INTPR*MELTS*SGCLG*CAV*XCSI*XCSR*RHRS
ENS	INTPR*MELTS*SGCLG*XCAV*XCSI*XCSR*XRHRS
FNS	INTPR*MELTS*SGCLG*CAV*XCSI*XCSR*XRHRS
EPL	INTPR*MELTL*SGCLG*XCAV*CSR
FPL	INTPR*MELTL*SGCLG*CAV*CSR
EQL	INTPR*MELTL*SGCLG*XCAV*CSI*XCSR*RHRS
FQL	INTPR*MELTL*SGCLG*CAV*CSI*XCSR*RHRS
ERL	INTPR*MELTL*SGCLG*XCAV*CSI*XCSR*XRHRS
FRL	INTPR*MELTL*SGCLG*CAV*CSI*XCSR*XRHRS
ESL	INTPR*MELTL*SGCLG*XCAV*XCSI*XCSR*RHRS
FSL	INTPR*MELTL*SGCLG*CAV*XCSI*XCSR*RHRS
ETL	INTPR*MELTL*SGCLG*XCAV*XCSI*XCSR*XRHRS
FTL	INTPR*MELTL*SGCLG*CAV*XCSI*XCSR*XRHRS
ECB	INTPR*MELTB*SGCLG*XCAV*CSR
FCB	INTPR*MELTB*SGCLG*CAV*CSR
EEB	INTPR*MELTB*SGCLG*XCAV*CSI*XCSR*RHRS
FEB	INTPR*MELTB*SGCLG*CAV*CSI*XCSR*RHRS
EGB	INTPR*MELTB*SGCLG*XCAV*CSI*XCSR*XRHRS
FGB	INTPR*MELTB*SGCLG*CAV*CSI*XCSR*XRHRS
EIB	INTPR*MELTB*SGCLG*XCAV*XCSI*XCSR*RHRS
FIB	INTPR*MELTB*SGCLG*CAV*XCSI*XCSR*RHRS
ENB	INTPR*MELTB*SGCLG*XCAV*XCSI*XCSR*XRHRS
FNB	INTPR*MELTB*SGCLG*CAV*XCSI*XCSR*XRHRS

GCI	INTPR*MELTI*-SGCLG*XCAV*CSR
HCI	INTPR*MELTI*-SGCLG*CAV*CSR
GEI	INTPR*MELTI*-SGCLG*XCAV*CSI*RHRS*XCSR
HEI	INTPR*MELTI*-SGCLG*CAV*CSI*RHRS*XCSR
GGI	INTPR*MELTI*-SGCLG*XCAV*CSI*XCSR*XRHRS

MODEL Name: WBNNEW

Binning Logic for Event Tree: GTBINS

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Bin.....	Binning Rules.....
HGI	INTPR*MELTI*-SGCLG*CAV*CSI*XCSR*XRHRS
GII	INTPR*MELTI*-SGCLG*XCAV*XCSI*XCSR*RHRS
HII	INTPR*MELTI*-SGCLG*CAV*XCSI*XCSR*RHRS
GNI	INTPR*MELTI*-SGCLG*XCAV*XCSI*XCSR*XRHRS
HNI	INTPR*MELTI*-SGCLG*CAV*XCSI*XCSR*XRHRS
GCS	INTPR*MELTS*-SGCLG*XCAV*CSR
HCS	INTPR*MELTS*-SGCLG*CAV*CSR
GES	INTPR*MELTS*-SGCLG*XCAV*CSI*XCSR*RHRS
HES	INTPR*MELTS*-SGCLG*CAV*CSI*XCSR*RHRS
GGS	INTPR*MELTS*-SGCLG*XCAV*CSI*XCSR*XRHRS
HGS	INTPR*MELTS*-SGCLG*CAV*CSI*XCSR*XRHRS
GIS	INTPR*MELTS*-SGCLG*XCAV*XCSI*XCSR*RHRS
HIS	INTPR*MELTS*-SGCLG*CAV*XCSI*XCSR*RHRS
GNS	INTPR*MELTS*-SGCLG*XCAV*XCSI*XCSR*XRHRS
HNS	INTPR*MELTS*-SGCLG*CAV*XCSI*XCSR*XRHRS
GPL	INTPR*MELTL*-SGCLG*XCAV*CSR
HPL	INTPR*MELTL*-SGCLG*CAV*CSR
GQL	INTPR*MELTL*-SGCLG*XCAV*CSI*XCSR*RHRS
HQL	INTPR*MELTL*-SGCLG*CAV*CSI*XCSR*RHRS
GRL	INTPR*MELTL*-SGCLG*XCAV*CSI*XCSR*XRHRS
HRL	INTPR*MELTL*-SGCLG*CAV*CSI*XCSR*XRHRS
GSL	INTPR*MELTL*-SGCLG*XCAV*XCSI*XCSR*RHRS
HSL	INTPR*MELTL*-SGCLG*CAV*XCSI*XCSR*RHRS
GTL	INTPR*MELTL*-SGCLG*XCAV*XCSI*XCSR*XRHRS
HTL	INTPR*MELTL*-SGCLG*CAV*XCSI*XCSR*XRHRS
GCB	INTPR*MELTB*-SGCLG*XCAV*CSR
HCB	INTPR*MELTB*-SGCLG*CAV*CSR
GEB	INTPR*MELTB*-SGCLG*XCAV*CSI*XCSR*RHRS
HEB	INTPR*MELTB*-SGCLG*CAV*CSI*XCSR*RHRS
GGB	INTPR*MELTB*-SGCLG*XCAV*CSI*XCSR*XRHRS
HGB	INTPR*MELTB*-SGCLG*CAV*CSI*XCSR*XRHRS
GIB	INTPR*MELTB*-SGCLG*XCAV*XCSI*XCSR*RHRS
HIB	INTPR*MELTB*-SGCLG*CAV*XCSI*XCSR*RHRS

GNB	INTPR*MELTB*-SGCLG*XCAV*XCSI*XCSR*XRHRS
HNB	INTPR*MELTB*-SGCLG*CAV*XCSI*XCSR*XRHRS
ICI	MELTI*SGCLG*XCAV*CSR
JCI	MELTI*SGCLG*CAV*CSR
IEI	MELTI*SGCLG*XCAV*CSI*RHRS*XCSR

MODEL Name: WBNNEW

Binning Logic for Event Tree: GTBINS

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Bin.....	Binning Rules.....
JEI	MELTI*SGCLG*CAV*CSI*RHRS*XCSR
IGI	MELTI*SGCLG*XCAV*CSI*XCSR*XRHRS
JGI	MELTI*SGCLG*CAV*CSI*XCSR*XRHRS
III	MELTI*SGCLG*XCAV*XCSI*XCSR*RHRS
JII	MELTI*SGCLG*CAV*XCSI*XCSR*RHRS
INI	MELTI*SGCLG*XCAV*XCSI*XCSR*XRHRS
JNI	MELTI*SGCLG*CAV*XCSI*XCSR*XRHRS
ICS	MELTS*SGCLG*XCAV*CSR
JCS	MELTS*SGCLG*CAV*CSR
IES	MELTS*SGCLG*XCAV*CSI*XCSR*RHRS
JES	MELTS*SGCLG*CAV*CSI*XCSR*RHRS
IGS	MELTS*SGCLG*XCAV*CSI*XCSR*XRHRS
JGS	MELTS*SGCLG*CAV*CSI*XCSR*XRHRS
IIS	MELTS*SGCLG*XCAV*XCSI*XCSR*RHRS
JIS	MELTS*SGCLG*CAV*XCSI*XCSR*RHRS
INS	MELTS*SGCLG*XCAV*XCSI*XCSR*XRHRS
JNS	MELTS*SGCLG*CAV*XCSI*XCSR*XRHRS
IPL	MELTL*SGCLG*XCAV*CSR
JPL	MELTL*SGCLG*CAV*CSR
IQL	MELTL*SGCLG*XCAV*CSI*XCSR*RHRS
JQL	MELTL*SGCLG*CAV*CSI*XCSR*RHRS
IRL	MELTL*SGCLG*XCAV*CSI*XCSR*XRHRS
JRL	MELTL*SGCLG*CAV*CSI*XCSR*XRHRS
ISL	MELTL*SGCLG*XCAV*XCSI*XCSR*RHRS
JSL	MELTL*SGCLG*CAV*XCSI*XCSR*RHRS
ITL	MELTL*SGCLG*XCAV*XCSI*XCSR*XRHRS
JTL	MELTL*SGCLG*CAV*XCSI*XCSR*XRHRS
KCI	MELTI*-SGCLG*XCAV*CSR
LCI	MELTI*-SGCLG*CAV*CSR
KEI	MELTI*-SGCLG*XCAV*CSI*RHRS*XCSR
LEI	MELTI*-SGCLG*CAV*CSI*RHRS*XCSR
KGI	MELTI*-SGCLG*XCAV*CSI*XCSR*XRHRS

LGI	MELTI*-SGCLG*CAV*CSI*XCSR*XRHRS
KII	MELTI*-SGCLG*XCAV*XCSI*XCSR*RHRS
LII	MELTI*-SGCLG*CAV*XCSI*XCSR*RHRS
KNI	MELTI*-SGCLG*XCAV*XCSI*XCSR*XRHRS
LNI	MELTI*-SGCLG*CAV*XCSI*XCSR*XRHRS

MODEL Name: WBNNEW

Binning Logic for Event Tree: GTBINS

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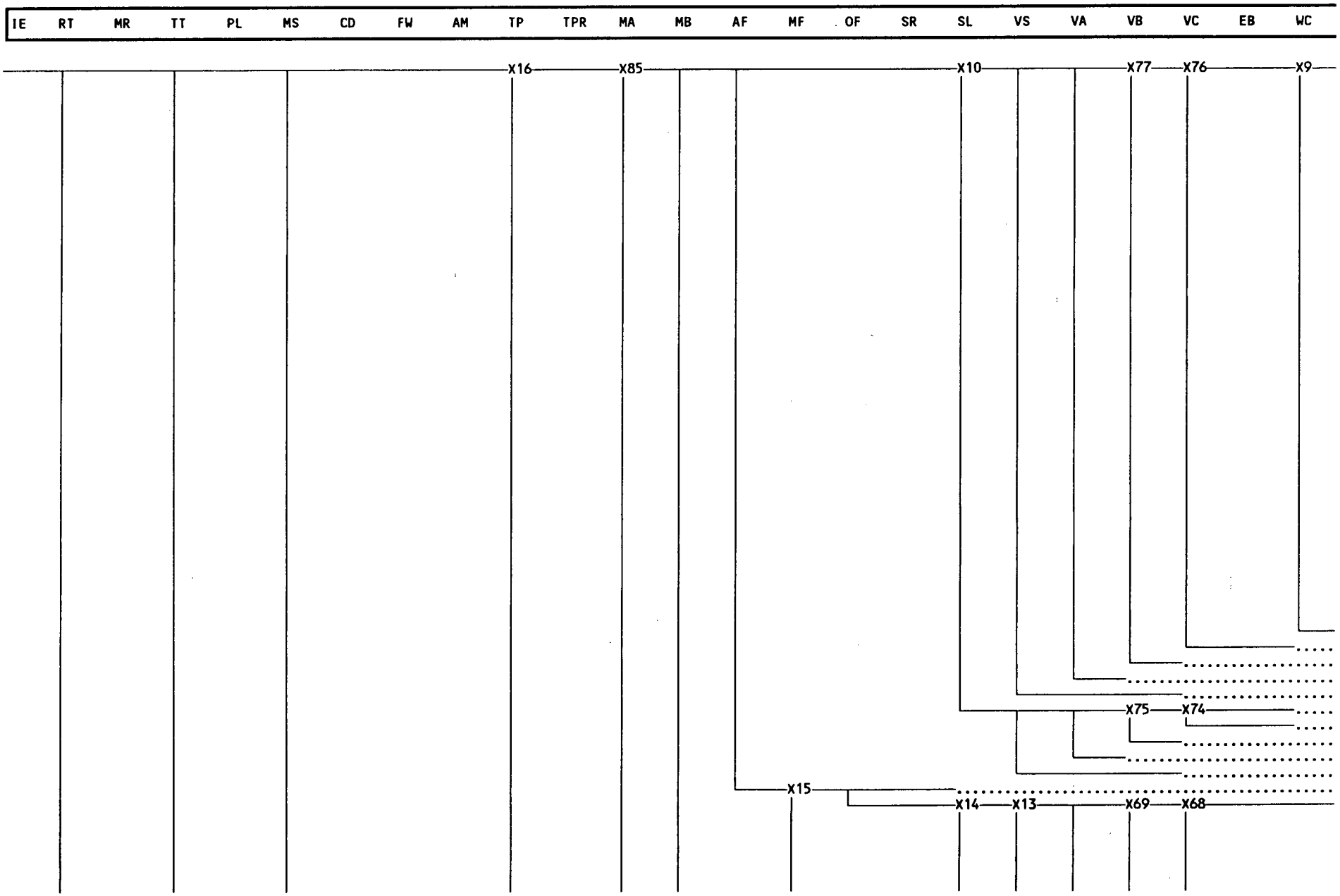
Bin.....	Binning Rules.....
KCS	MELTS*-SGCLG*XCAV*CSR
LCS	MELTS*-SGCLG*CAV*CSR
KES	MELTS*-SGCLG*XCAV*CSI*XCSR*RHRS
LES	MELTS*-SGCLG*CAV*CSI*XCSR*RHRS
KGS	MELTS*-SGCLG*XCAV*CSI*XCSR*XRHRS
LGS	MELTS*-SGCLG*CAV*CSI*XCSR*XRHRS
KIS	MELTS*-SGCLG*XCAV*XCSI*XCSR*RHRS
LIS	MELTS*-SGCLG*CAV*XCSI*XCSR*RHRS
KNS	MELTS*-SGCLG*XCAV*XCSI*XCSR*XRHRS
LNS	MELTS*-SGCLG*CAV*XCSI*XCSR*XRHRS
KPL	MELTL*-SGCLG*XCAV*CSR
LPL	MELTL*-SGCLG*CAV*CSR
KQL	MELTL*-SGCLG*XCAV*CSI*XCSR*RHRS
LQL	MELTL*-SGCLG*CAV*CSI*XCSR*RHRS
KRL	MELTL*-SGCLG*XCAV*CSI*XCSR*XRHRS
LRL	MELTL*-SGCLG*CAV*CSI*XCSR*XRHRS
KSL	MELTL*-SGCLG*XCAV*XCSI*XCSR*RHRS
LSL	MELTL*-SGCLG*CAV*XCSI*XCSR*RHRS
KTL	MELTL*-SGCLG*XCAV*XCSI*XCSR*XRHRS
LTL	MELTL*-SGCLG*CAV*XCSI*XCSR*XRHRS
MELT	MELT
SUCCESS	1

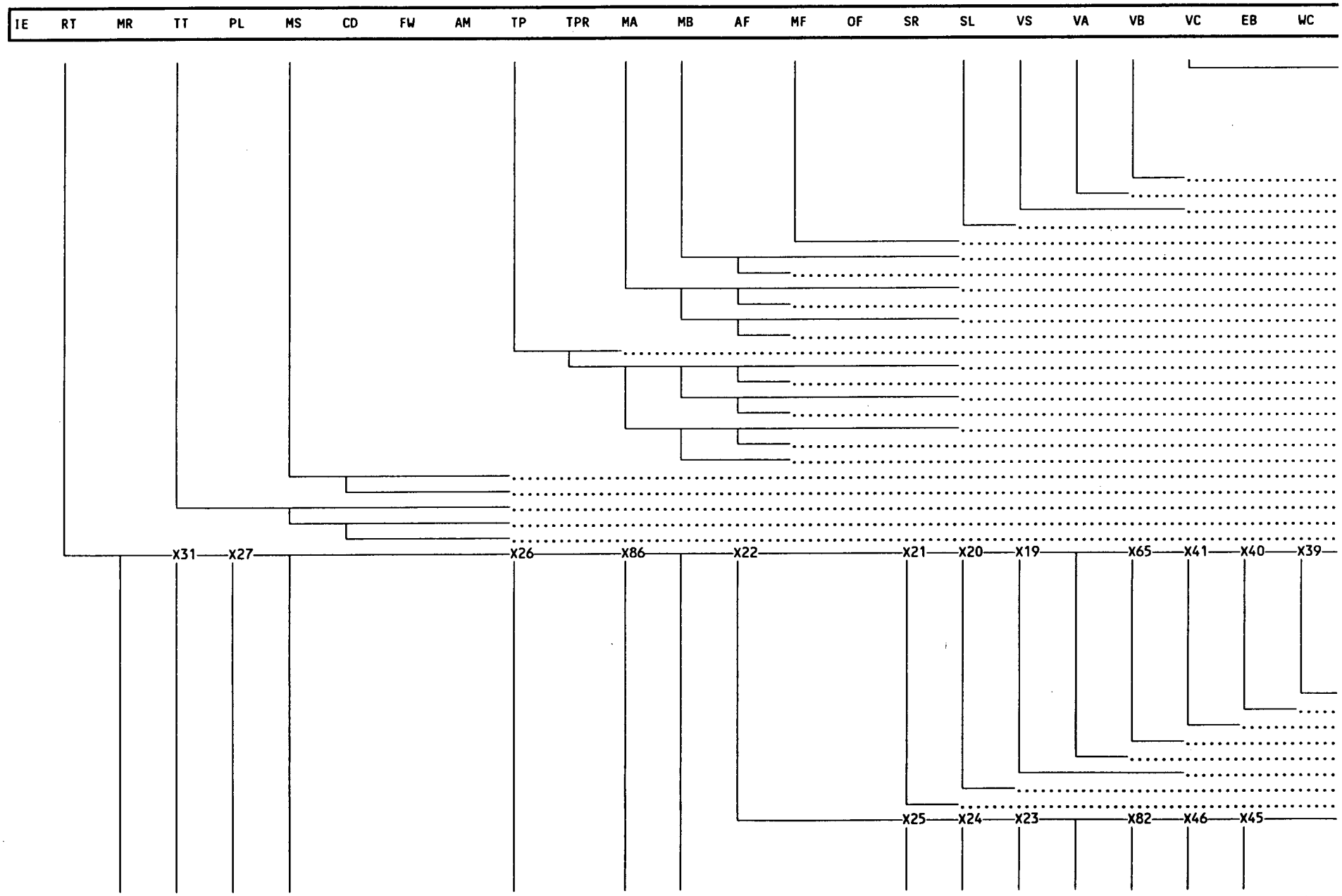
MODEL Name: WBNNEW
Event Tree: GTRAN4

14:12:25 03 AUG 1992



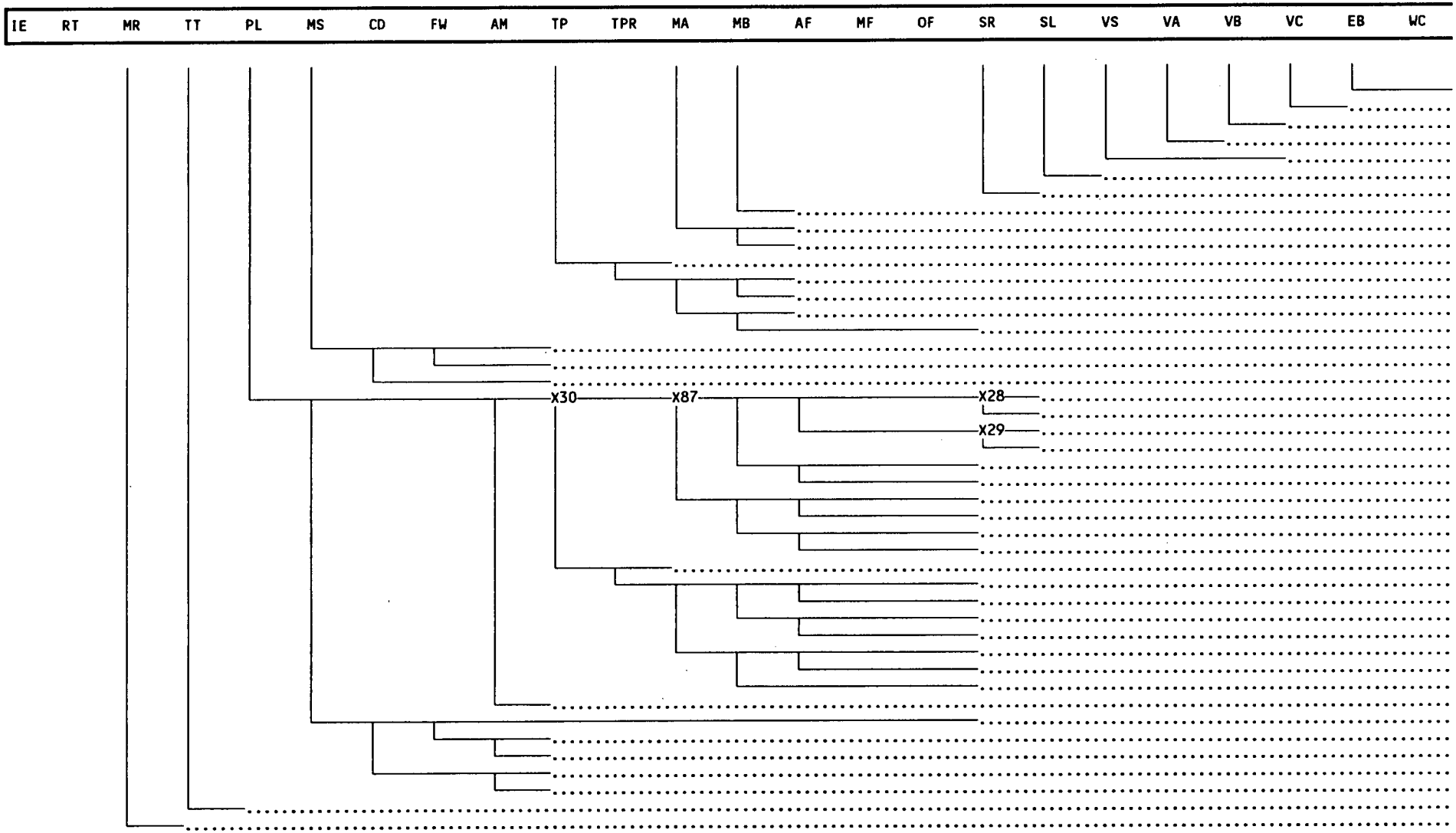
MODEL Name: WBNNEW
Event Tree: GTRAN4

14:12:30 03 AUG 1992



MODEL Name: WBNNEW
Event Tree: GTRAN4

14:12:35 03 AUG 1992



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MODEL Name: WBNNEW
Event Tree: GTRAN4

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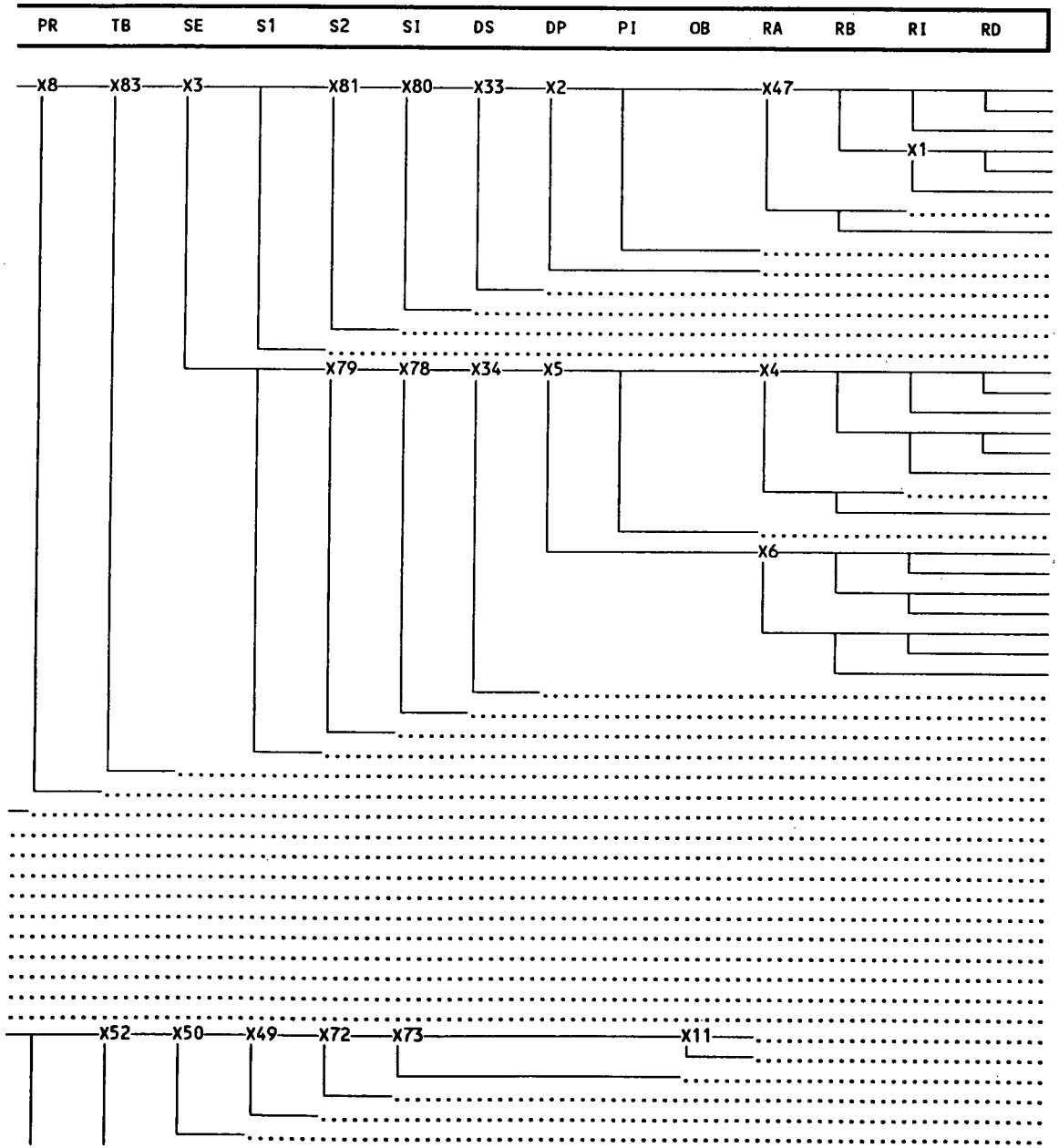

1		1
2		2
3		3
4		4
5		5
6		6
7	X1	7-9
8		10
9	X47	11-20
10	X47	21-30
11	X2	31-60
12	X33	61-120
13	X80	121-240
14	X81	241-480
15		481
16		482
17		483
18		484
19		485
20		486
21	X1	487-489
22		490
23	X4	491-500
24		501
25		502
26		503
27		504
28		505
29		506
30		507
31	X5	508-534
32	X34	535-588
33	X78	589-696
34	X79	697-912
35	X3	913-1824
36	X83	1825-3648
37	X8	3649-7296
38	X9	7297-14592
39	X76	14593-29184
40	X77	29185-58368
41	X76	58369-72960
42	X9	72961-80256
43	X9	80257-87552
44	X74	87553-102144
45	X75	102145-131328
46	X74	131329-145920
47	X10	145921-291840
48	X6	291841-291847
49	X6	291848-291854
50	X11	291855-291868
51	X73	291869-291896
52	X72	291897-291952
53	X49	291953-292064

54	X50	292065-292288
55	X52	292289-292736

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MODEL Name: WBNNEW
Event Tree: GTRAN4

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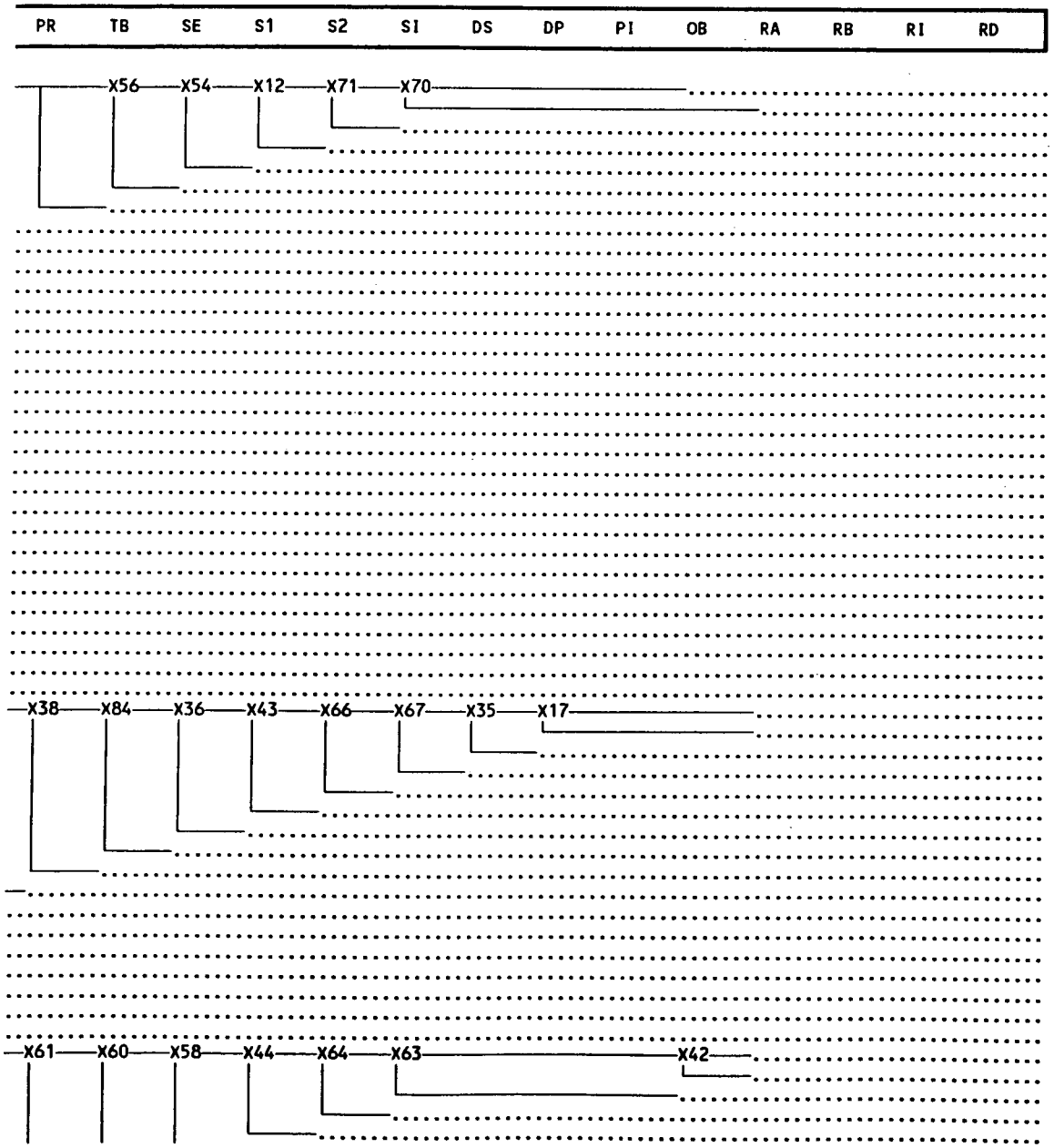

56	X11	292737-292750
57	X6	292751-292757
58	X70	292758-292778
59	X71	292779-292820
60	X12	292821-292904
61	X54	292905-293072
62	X56	293073-293408
63	X68	293409-294976
64	X69	294977-298112
65	X68	298113-299680
66	X13	299681-307520
67	X14	307521-323200
68	X10	323201-469120
69	X15	469121-646400
70	X10	646401-792320
71	X15	792321-969600
72	X10	969601-1115520
73	X15	1115521-1292800
74	X85	1292801-2585600
75	X10	2585601-2731520
76	X15	2731521-2908800
77	X10	2908801-3054720
78	X15	3054721-3232000
79	X10	3232001-3377920
80	X15	3377921-3555200
81	X15	3555201-3732480
82	X16	3732481-7464960
83	X16	7464961-11197440
84	X16	11197441-14929920
85	X16	14929921-18662400
86	X16	18662401-22394880
87	X6	22394881-22394887
88	X6	22394888-22394894
89	X17	22394895-22394908
90	X35	22394909-22394936
91	X67	22394937-22394992
92	X66	22394993-22395104
93	X43	22395105-22395328
94	X36	22395329-22395776
95	X84	22395777-22396672
96	X38	22396673-22398464
97	X39	22398465-22402048
98	X40	22402049-22409216
99	X41	22409217-22423552
100	X65	22423553-22452224
101	X41	22452225-22466560
102	X19	22466561-22538240
103	X20	22538241-22681600
104	X6	22681601-22681607
105	X6	22681608-22681614
106	X42	22681615-22681628
107	X63	22681629-22681656
108	X64	22681657-22681712

109	X44	22681713-22681824
110	X58	22681825-22682048

MODEL Name: WBNNEW
Event Tree: GTRAN4

PR	TB	SE	S1	S2	SI	DS	DP	PI	OB	RA	RB	RI	RD			
														111	X60	22682049-22682496
														112	X61	22682497-22683392
														113	X45	22683393-22685184
														114	X46	22685185-22688768
														115	X82	22688769-22695936
														116	X46	22695937-22699520
														117	X23	22699521-22717440
														118	X24	22717441-22753280
														119	X22	22753281-23111680
														120	X22	23111681-23470080
														121	X22	23470081-23828480
														122	X86	23828481-25262080
														123	X22	25262081-25620480
														124	X22	25620481-25978880
														125	X22	25978881-26337280
														126	X25	26337281-26408960
														127	X26	26408961-30423040
														128	X26	30423041-34437120
														129	X26	34437121-38451200
														130	X20	38451201-38594560
														131	X24	38594561-38630400
														132	X24	38630401-38666240
														133	X24	38666241-38702080
														134	X28	38702081-38881280
														135	X29	38881281-38952960
														136	X28	38952961-39132160
														137	X28	39132161-39311360
														138	X28	39311361-39490560
														139	X29	39490561-39562240
														140	X87	39562241-40673280
														141	X28	40673281-40852480
														142	X29	40852481-40924160
														143	X29	40924161-40995840
														144	X29	40995841-41067520
														145	X29	41067521-41139200
														146	X29	41139201-41210880
														147	X29	41210881-41282560
														148	X30	41282561-44113920
														149	X21	44113921-44400640
														150	X30	44400641-47232000
														151	X30	47232001-50063360
														152	X30	50063361-52894720
														153	X30	52894721-55726080
														154	X27	55726081-89057280
														155	X31	89057281-155719680

MODEL Name: WBNNEW

Top Event Legend for Tree: GTRAN4

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Top Event Designator.....	Top Event Description.....
IE	INITIATING EVENT
RT	FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT
MR	FAILURE TO MANUALLY INSERT RODS (ATWS ONLY)
TT	FAILURE TO TRIP TURBINE, INCLUDES TURBINE STOP & GOVERNOR VALVES & MOISTURE SEPERATOR REHEATER BYPASS VALVES
PL	POWER LEVEL IS GREATER THAN 40%
MS	TWO OUT OF FOUR MSIVS STAY OPEN
CD	FAILURE TO COOLDOWN USING STEAM DUMPS, CONDENSER, & HOTWELL PUMPS TO SUPPLY MFW OR CST
FW	MAIN FEEDWATER FAILS TO CONTINUE DURING ATWS EVENT
AM	AMSAC FAILS TO TRIP TURBINE & STARTS AFW
TP	FAILURE OF TURBINE DRIVEN AFW PUMP
TPR	FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES
MA	LOSS OF MOTOR DRIVEN AFW PUMP 1A-A
MB	LOSS OF MOTOR DRIVEN AFW PUMP 1B-B
AF	FAILURE OF DISCHARGE PATH FROM THE AFW PUMPS TO THE STEAM GENERATORS
MF	FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER
OF	FAILURE OT OPERATOR ACTIONS TO RECOVER MAIN FEEDWATER
SR	FAILURE OF STEAM RELIEF, ATWS ONLY, REACTOR PRESSURE IS LESS THAN 3200 PSIG
SL	OPERATOR FAILS TO IDENTIFY & ISOLATE RUPTURED STEAM GENERATOR
VS	FAILURE OF SUPPLY TO CVCS
VA	LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A
VB	LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B
VC	LOSS OF COLD LEG INJECTION PATH FROM CCP
EB	FAILURE OF EMERGENCY BORATION (OPERATOR ACTIONS &

MODEL Name: WBNNEW

Top Event Legend for Tree: GTRAN4

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Page 2

Top Event Designator.....	Top Event Description.....
	EQUIPEMENT)
WC	NO WATER CHALLENGE TO PRESSURIZER PORVS
PR	FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE
TB	FAILURE OF THERMAL BARRIERS TO THE RCPS
SE	RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS
S1	FAILURE OF SAFETY INJECTION PUMP 1A-A
S2	FAILURE OF SAFETY INJECTION PUMP 1B-B
SI	LOSS OF COLD LEG INJECTION PATHS
DS	OPERATOR FAILS TO DEPRESSURIZE THE RCS USING SG PORVS
DP	OPERATOR FAILS TO DEPRESSURIZE THE RCS USING THE PZR SPRAYS AND PORVS
PI	FAILURE OF PORVS RECLOSED IF OPENED IN DP
OB	FAILURE OF OPERATOR ACTION TO FEED & BLEED RCS
RA	LOSS OF RHR PUMP 1A-A
RB	LOSS OF RHR PUMP 1B-B
RI	LOSS OF COLD LEG INJECTION PATH
RD	LOSS OF RHR NORMAL DECAY HEAT REMOVAL

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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```
SF........ Split Fraction Logic.............................................

          VASUC:= AAL=S * A1L=S * (AC=S + CE=S * CCPR=S) * CE=S * GE=S

          VAFAI:= AAL=F + A1L=F + AC=F * (CE=F + CCPR=F) + CE=F + GE=F

          VBSUC:= BAL=S * B1L=S * DB=S * BC=S * DE=S * HE=S * (ZB=S + OS=S)

          VBFAI:= BAL=F + B1L=F + DB=F + BC=F + DE=F + HE=F + (ZB=F * OS=F)

          S1SUC:= AAL=S * A1L=S * DA=S * CE=S * GE=S * AC=S * (ZA=S + OS=S)

          S1FAI:= AAL=F + A1L=F + DA=F + CE=F + GE=F + AC=F + (ZA=F * OS=F)

          S2SUC:= BAL=S * B1L=S * DB=S * DE=S * HE=S * BC=S * (ZB=S + OS=S)

          S2FAI:= BAL=F + B1L=F + DB=F + DE=F + HE=F + BC=F + (ZB=F * OS=F)

          RASUC:= AAL=S * A1L=S * DA=S * CE=S * GE=S * AC=S * (ZA=S + OS=S)

          RAFAI:= AAL=F + A1L=F + DA=F + CE=F + GE=F + AC=F + (ZA=F * OS=F) +
          FLAB2 + FLAB3C + FLAB3R

          RBSUC:= BAL=S * B1L=S * DB=S * DE=S * HE=S * BC=S * (ZB=S + OS=S)

          RBFAI:= BAL=F + B1L=F + DB=F + DE=F + HE=F + BC=F + (ZB=F * OS=F)

          ERSUPA:= A2L=F + AE=F

          ERSUPB:= B2L=F + BE=F

          ALTSUC:= CT=F + RT=F * CTMU=F

          TPSUP1:= DC=F + DCAC=F + OS=F * -AM=S * (DAAC=F + ZA=F) * (DBAC=F +
          ZB=F)

          MASUP1:= DA=F + PA=F + AAL=F + V3=F + (ZA=F * OS=F * -AM=S)

          IERPS:= -RT + -LOSP

          MFW:= (TLMFW + EXMFW) + LOCV

          AFPTP:= ZA=F * ZB=F * OS=F * ( RT=S + RT=F * AM=F) + (SLBOC
          * MS=F)

          AFPMA:= ZA=F * OS=F * (RT=S + RT=F * AM=F)

          AFPMB:= ZB=F * OS=F * (RT=S + RT=F * AM=F)

          AFW50:= ((TP=S * PA=S * DCAC=S * PB=S * DDAC=F) + MA=S * MB=S) *
          AF=S

          IECIB:= SLOCAN + SLOCAI + SLBIC

          MSISOL:= IECIB + SLBOC + SLBIC + MSVO + TT=F * RT=S + (DA=F + DB=F
          + PD=F)
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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Page 2

```
SF........ Split Fraction Logic.............................................

          IESI:= IECIB + SLOCAI + SLOCAN+ SGTR + ISI + SLBOC + SLBIC +
          MSVO + IMSIV

          IECIA:= IESI

          NSPRAY:= IECIB + LRCP + AAL=F + PA=F + PB=F + DB=F + LOSP

          NPORV:= DA=F * DB=F

          ITR:= RT=F * PL=F * FW=F

          DSSUPF:= PA=F * PB=F + DAAC=F * DDAC=F + MA=F * MB=F * (TP=F
          + DCAC=F * DDAC=F) + DDAC=F * PB=F * MA=F + DAAC=F * TP=F * (
          PA=F * MA=F + PB=F * MB=F) + DCAC=F * DAAC=F * PB=F * MB=F

          RHRCOOL:= SGTR

          STEAM:= (PA=F + DA=F + DAAC=F) * (PB=F + DB=F + DBAC=F) + (DA=F +
          PA=F * PB=F + LRCP)

RTB       LOSP

RTS       RT + FLPH1A + FLPH1B + FLAB2 + FLTB + FLAB3C +
          FLAB3R + ERCWTL + ERCWA + ERCWB + CPEX

RTA       ZA=F * ZB=F * DA=F * DB=F * IERPS

RT1       ZA=S * ZB=S * DA=S * DB=S * IERPS

RT3       ZA=S * ZB=S * DA=F * DB=F * IERPS

RT2       ZA=S * ZB=S * (DA=F + DB=F) * IERPS

RT8       ZA=F * ZB=F * DA=S * DB=S * IERPS

RT9       ZA=F * ZB=F * (DA=F + DB=F) * IERPS

RT4       (ZA=F + ZB=F) * DA=S * DB=S * IERPS

RT7       (ZA=F + ZB=F) * DA=F * DB=F * IERPS

RT6       (ZA=F * DB=F + ZB=F * DA=F) * IERPS

RT5       (ZA=F * DA=F + ZB=F * DB=F) * IERPS

MRF       OG=F

MR1       -OG=F

TTS       TT

TT1       -TT * D1=S * D2=S

TT2       -TT * (D1=F * D2=S + D1=S * D2=F)
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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SF..... Split Fraction Logic.....

TTF	D1=F * D2=F
PL1	1
MSS	IMSIV
MS1	MSISOL * (ZA=S + ZB=S)
MSF	-MSISOL + ZA=F * ZB=F
CDF	FLTB + LOCV + IMSIV + OG=F + MS=S + DA=F + DB=F + PD=F + AAL=F + D1=F
CD1	1
FWF	FLTB + MFW + PLMFW + IESI + CD=F + RT=S
FW1	1
AMF	D1=F
AM1	D1=S
TPF	TPSUP1 + ALTSUC * (DCAC=F + ERSUPA * ERSUPB) + (SLBOC + SLBIC) * MS=F + FLAB3C
TP3	DG=F
TP8	SGTR * A1L=F
TP7	SGTR * A1L=S
TP6	ALTSUC * (ERSUPA + ERSUPB) * DG=F
TP5	ALTSUC * (ERSUPA + ERSUPB)
TP4	ALTSUC * DG=F
TP2	ALTSUC
TP1	-TPSUP1 * -ALTSUC
TPRS	TP=S
TPRF	TPSUP1 + DC=F * DG=F + ALTSUC * (DC=F + ERSUPA * ERSUPB)
TPR1	1
MAF	MASUP1
MA2	ALTSUC * TPSUP1
MA14	ALTSUC * ERSUPB * DG=F * TP=F
MA13	ALTSUC * ERSUPB * DG=F

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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SF..... Split Fraction Logic.....

MA12	ALTSUC * ERSUPB * TP=F
MA11	ALTSUC * ERSUPB
MA10	ALTSUC * DG=F * TP=F
MA9	ALTSUC * DG=F
MA8	ALTSUC * TP=F
MA7	ALTSUC
MA1	-ALTSUC * TPSUP1
MA6	-ALTSUC * DG=F * TP=F
MA5	-ALTSUC * DG=F
MA4	-ALTSUC * TP=F
MA3	-ALTSUC
MBF	DB=F + PB=F + BAL=F + V3=F + ZB=F * OS=F * -AM=S + ALTSUC * (ERSUPB)
MB2	ALTSUC * TPSUP1 * MASUP1
MB26	ALTSUC * TPSUP1 * MA=F
MB25	ALTSUC * TPSUP1
MB24	ALTSUC * DG=F * ERSUPA * TP=F * MASUP1
MB23	ALTSUC * DG=F * ERSUPA * TP=S * MASUP1
MB22	ALTSUC * DG=F * TP=F * MASUP1
MB34	ALTSUC * DG=F * TP=F * MA=F
MB33	ALTSUC * DG=F * TP=F
MB21	ALTSUC * DG=F * MASUP1
MB32	ALTSUC * DG=F * MA=F
MB31	ALTSUC * DG=F
MB20	ALTSUC * ERSUPA * TP=F * MASUP1
MB19	ALTSUC * ERSUPA * MASUP1
MB18	ALTSUC * TP=F * MASUP1
MB30	ALTSUC * TP=F * MA=F

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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SF..... Split Fraction Logic.....

```
MB29      ALTSUC * TP=F

MB17      ALTSUC * MASUP1

MB28      ALTSUC * MA=F

MB27      ALTSUC

MB1       -ALTSUC * TPSUP1 * TP=F * MASUP1 * MA=F

MB8       -ALTSUC * TPSUP1 * TP=F * MA=F

MB7       -ALTSUC * TPSUP1 * TP=F

MB6       -ALTSUC * DG=F * TP=F * MASUP1 * MA=F

MB16      -ALTSUC * DG=F * TP=F * MA=F

MB15      -ALTSUC * DG=F * TP=F

MB5       -ALTSUC * DG=F * MASUP1 * MA=F

MB14      -ALTSUC * DG=F * MA=F

MB13      -ALTSUC * DG=F

MB4       -ALTSUC * TP=F * MASUP1

MB12      -ALTSUC * TP=F * MA=F

MB11      -ALTSUC * TP=F

MB3       -ALTSUC * MASUP1

MB10      -ALTSUC * MA=F

MB9       -ALTSUC

AFR1      (TP=S + TPR=S) * (PA=F + DCAC=F) * (PB=F + DDAC=F) * MA=F * MB=F

AFF       (TP=F * TPR=F + (PA=F + DCAC=F) * (PB=F + DDAC=F) * -SBO * -U1BO) *
          (RT=F * PL=F * FW=F) * ((TP=F * TPR=F + (PA=F + DCAC=F) * (PB=F + D
          (MA=F + MB=F) + MB=F * (PA=F + DCAC=F) + MA=F * (PB=F + DDAC=F))

AF7       (RT=S + -PL=F + -FW=F) * SBO

AF6       (RT=S + -PL=F + -FW=F) * ((TP=F * TPR=F +
          (PA=F + DCAC=F) * (PB=F + DDAC=F)) * (MA=F + MB=F) +
          MB=F * (PA=F + DCAC=F) + MA=F * (PB=F + DDAC=F))

AF5       (RT=S + -PL=F + -FW=F) * ((TP=F * TPR=F +
          (PA=F + DCAC=F) * (PB=F + DDAC=F)) + (MA=F * MB=F))

AF4       (RT=S + -PL=F + -FW=F) * (MA=F * (PA=F + DCAC=F) + MB=F * (PB=F +
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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SF..... Split Fraction Logic.....

```
          DDAC=F))

AF3       (RT=S + -PL=F + -FW=F) * (MA=F + MB=F)

AF2       (RT=S + -PL=F + -FW=F) * (PA=F + DCAC=F + PB=F + DDAC=F)

AF1       RT=S + -PL=F + -FW=F

AFA5      RT=F * PL=F * FW=F * (TP=F + (PA=F + DCAC=F) * (PB=F + DDAC=F) +
          MA=F * MB=F)

AFA4      RT=F * PL=F * FW=F * MA=F * (PA=F + DCAC=F) * MB=F * (PB=F +
          DDAC=F)

AFA3      RT=F * PL=F * FW=F * (MA=F + MB=F)

AFA2      RT=F * PL=F * TP=F * (PA=F + DCAC=F + PB=F + DDAC=F)

AFA1      RT=F * PL=F * FW=F

MFF       FLTB + MFW + CD=F + DB=F + PD=F + AAL=F + D2=F + A2L=F + D1=F +
          DA=F + OG=F

MF1       1

OFF       MF=F

OF1       -IESI * RT=S

OF2       IESI * RT=S

SRS       FW=S + PL=S

SRF       -AFW50 + (TT=F + AM=F) * PL=F * FW=F

SR1       AFW50 * MR=S * DA=S * DB=S

SR3       AFW50 * MR=S * DA=F * DB=F

SR2       AFW50 * MR=S * (DA=F + DB=F)

SR4       AFW50 * MR=F * DA=S * DB=S

SR6       AFW50 * MR=F * DA=F * DB=F

SR5       AFW50 * MR=F * (DA=F + DB=F)

SLS       -SGTR * -ITR * -SLBOC

SL1       SGTR * -ITR * A2L=S * DA=S * PA=S

SLF       (SGTR) * (ITR + A2L=F + DA=F + PA=F)

SL2       (SLBOC) * (A2L=F + DA=F + PA=F + MS=F )
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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```
SF........ Split Fraction Logic.............................................
SL3       ITR
SLS       1
SEF       SLOCAN + TB=F * ((VA=F * VB=F) + VS=F)
SE1       TB=S * (VA=S + VB=S) * -LOSP * -IECIA * -IECIB * AC=S
SE2       TB=S * (VA=S + VB=S) * -LOSP * -IECIA * -IECIB * AC=F
SE1       TB=S * (VA=S + VB=S) * -LOSP * IECIA * -IECIB * AC=S
SE2       TB=S * (VA=S + VB=S) * -LOSP * IECIA * -IECIB * AC=F
SE5       TB=S * (VA=S + VB=S) * -LOSP * IECIA * IECIB
SES       TB=S * (VA=S + VB=S) * LOSP * -IECIA * -IECIB * AC=S
SES       TB=S * (VA=S + VB=S) * LOSP * -IECIA * -IECIB * AC=F
SES       TB=S * (VA=S + VB=S) * LOSP * IECIA
SE9       TB=S * (VA=F * VB=F + VS=F) * -LOSP * -IECIB * AC=S
SEA       TB=S * (VA=F * VB=F + VS=F) * -LOSP * (IECIB + AC=F)
SES       TB=S * (VA=F * VB=F + VS=F) * LOSP
SEC       TB=F * (VA=S + VB=S) * -LOSP * -IECIA * -IECIB * AC=S
SED       TB=F * (VA=S + VB=S) * -LOSP * -IECIA * -IECIB * AC=F
SEC       TB=F * (VA=S + VB=S) * -LOSP * IECIA * -IECIB * AC=S
SED       TB=F * (VA=S + VB=S) * -LOSP * IECIA * -IECIB * AC=F
SEH       TB=F * (VA=S + VB=S) * -LOSP * IECIA * IECIB
SEI       TB=F * (VA=S + VB=S) * LOSP * -IECIA * AC=S
SEI       TB=F * (VA=S + VB=S) * LOSP * -IECIA * AC=F
SEI       TB=F * (VA=S + VB=S) * LOSP * IECIA * AC=F
VS1       IESI * RW=S * A1L=S * B1L=S * (ZA=S * ZB=S + OS=S)
VS2       IESI * RW=S * ((A1L=F + OS=F * ZA=F) * (B1L=S * (ZB=S + OS=S))
          + (B1L=F + OS=F * ZB=F) * (A1L=S * (ZA=S + OS=S)))
VSF       IESI * ((A1L=F + OS=F * ZA=F) * (B1L=F + OS=F * ZB=F) + RW=F)
VS3       -IESI
VA1       VASUC * OG=S * VS=S
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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SF..... Split Fraction Logic.....

VA2	VASUC * OG=F * (ZA=S + OS=S) * DA=S * VS=S
VAF	VAFAI + OG=F * ((ZA=F * OS=F) + DA=F) + VS=F
VB1	OG=S * VA=S * VBSUC * (ZB=S + OS=S)
VB3	OG=S * VA=F * VASUC * VBSUC * (ZB=S + OS=S)
VB2	OG=S * VAFAI * VS=S * VBSUC * (ZB=S + OS=S)
VB4	OG=F * VA=S * VBSUC * (ZB=S + OS=S)
VB5	OG=F * (VAFAI + DA=F + ZA=F * OS=F) * VBSUC * (ZB=S + OS=S)
VB6	OG=F * VA=F * VASUC * DA=S * (ZA=S + OS=S) * VBSUC * (ZB=S + OS=S)
VBF	VS=F + VBFAI + (ZB=F * OS=F)
VCF	(A1L=F + OS=F * ZA=F) * (B1L=F + OS=F * ZB=F) + (VA=F * VB=F) + VS=F
VC1	A1L=S * B1L=S * (ZA=S * ZB=S + OS=S)
VC2	(A1L=F + OS=F * ZA=F) * (B1L=S * (ZB=S + OS=S)) + (B1L=F + OS=F * ZB=F) * (A1L=S * (ZA=S + OS=S))
EBF	OG=F * (A1L=F + B1L=F + A1U2=F * B1U2=F + DAAC=F * DBAC=F)
EB7	OG=S * (A1L=F + B1L=F + (A1U2=F* B1U2=F) + (DAAC=F * DBAC=F))
EB1	OG=S * A1L=S * B1L=S * A1U2=S * B1U2=S * DAAC=S * DBAC=S
EB2	OG=F * A1L=S * B1L=S * A1U2=S * B1U2=S * DAAC=S * DBAC=S
EB5	OG=S * A1L=S * B1L=S * ((A1U2=F + B1U2=F) * (DAAC=F + DBAC=F))
EB3	OG=S * A1L=S * B1L=S * (A1U2=F + B1U2=F + DAAC=F + DBAC=F)
EB6	OG=F * A1L=S * B1L=S * ((A1U2=F + B1U2=F) * (DAAC=F + DBAC=F))
EB4	OG=F * A1L=S * B1L=S * (A1U2=F + B1U2=F + DAAC=F + DBAC=F)
WC1	(VA=S + VB=S) * VC=S * (IESI * -(SLOCAN + SLOCAI + SGTR) + ISI)
WCS	1
PRF	SLOCAI * B1L=F + RT=F
PRS	-WC=F * -STEAM * -RT * -TT + -WC=F * (RT + TT) * (PA=S * DA=S * DAAC=S + PB=S * DB=S * DBAC=S) + LOSP
PR1	STEAM * -WC=F * A1L=S * B1L=S * DA=S * DB=S
PR2	STEAM * -WC=F * (DA=F * DB=S + DB=F * DA=S)

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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SF..... Split Fraction Logic.....

PR3	STEAM * -WC=F * (DA=F * DB=F)
PR4	STEAM * -WC=F * (A1L=F * B1L=S + A1L=S * B1L=F)
PR5	STEAM * -WC=F * (B1L=F * DA=F * DB=S + A1L=F * DB=F * DA=S)
PR6	STEAM * -WC=F * A1L=F * B1L=F
PRA	WC=F * DA=S * DB=S * A1L=S * B1L=S
PRB	WC=F * (DA=F * DB=S + DA=S * DB=F)
PRC	WC=F * DA=F * DB=F
PRD	WC=F * (A1L=F * B1L=S + A1L=S * B1L=F)
PRE	WC=F * (B1L=F * DA=F * DB=S + A1L=F * DB=F * DA=S)
PRG	WC=F * A1L=F * B1L=F
PRH	SLOCAI * B1L=S
TBF	IECIB + AC=F + (A1L=F + CE=F + GE=F) * (B1L=F + DE=F + HE=F)
TB1	-LOSP * AC=S * A1L=S * AE=S * B1L=S * BE=S * GE=S * HE=S * -IECIB
TB2	-LOSP * ((A1L=F + CE=F + GE=F) * (B1L=S * DE=S * HE=S) + (A1L=S * CE=S * GE=S) * (B1L=F + DE=F + HE=F))
TB3	LOSP * A1L=S * B1L=S * CE=S * DE=S * GE=S * HE=S
TB4	LOSP * ((A1L=F + CE=F + GE=F) * (B1L=S * DE=S * HE=S) + (A1L=S * CE=S * GE=S) * (B1L=F + DE=F + HE=F))
S1F	S1FAI + RW=F
S11	S1SUC
S21	S1=S * S2SUC
S23	S1=F * S1SUC * RW=S * S2SUC
S22	S1FAI * RW=S * S2SUC
S2F	RW=F + S2FAI
SIF	RW=F + (S1=F * S2=F)
SI1	RW=S * (S1=S + S2=S)
DSNN	-SGTR * -SBO * -U1BO
DSF	(SBO + U1BO) * -AF=S + SGTR * (-CD=S * -AF=S + -CD=S * DSSUPF + -AF=S * (-MF=S + -OF=S) + SL=F * (-AF=S + DSSUPF))

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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SF..... Split Fraction Logic.....

DS6	(SBO + U1BO) * AF=S
DS2	SGTR * (-CD=S * SL=S * VC=S * AF=S * -DSSUPF)
DS3	SGTR * (-CD=S * SL=S * -VC=S * AF=S * -DSSUPF)
DS8	SGTR * (CD=S * (SL=S * VC=S *(AF=S + MF=S * OF=S)))
DS9	SGTR * (CD=S * (SL=S * VC=F *(AF=S + MF=S * OF=S)))
DS4	SL=F * VC=S * AF=S * -DSSUPF
DS5	SL=F * VC=F * AF=S * -DSSUPF
DS7	(PR=F + SE=F) * -DSSUPF * AF=S
DPF	DS=F + (OG=F + AC=F + DDAC=F + PA=F * PB=F) * DA=F * DB=F
DP8	(OG=F + AC=F + DDAC=F + PA=F * PB=F) * (DA=F + DB=F)
DP7	(OG=F + AC=F + DDAC=F + PA=F * PB=F) * DB=S * DB=S
DP6	OG=S * AC=S * DDAC=S * (PA=F + PB=F) * DA=F * DB=F
DP5	OG=S * AC=S * DDAC=S * (PA=F + PB=F) * (DA=F + DB=F)
DP4	OG=S * AC=S * DDAC=S * (PA=F + PB=F) * DA=S * DB=S
DP3	OG=S * AC=S * DDAC=S * PA=S * PB=S * DA=F * DB=F
DP2	OG=S * AC=S * DDAC=S * PA=S * PB=S * (DA=F + DB=F)
DP1	OG=S * AC=S * DDAC=S * PA=S * PB=S * DA=S * DB=S
PI1	DP=S * A1L=S * B1L=S
PI3	DP=S * A1L=F * B1L=F
PI2	DP=S * (A1L=F + B1L=F)
PIS	-NSPRAY + NPORV + DP=F
OBF	(VA=F * VB=F + VC=F) * (SI=F + S1=F * S2=F) + DA=F + DB=F
OB1	1
RAF	FLAB2 + FLAB3C + FLAB3R + RAFAI
RA1	(MLOCA + LLOCA + ELOCA) * RASUC
RA2	RASUC
RBF	FLAB2 + FLAB3C + FLAB3R + RBFAI
RB1	(MLOCA + LLOCA + ELOCA) * RA=S * RBSUC

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: GTRAN4

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SF..... Split Fraction Logic.....

RB3	(MLOCA + LLOCA + ELOCA) * RA=F * RASUC * RBSUC
RB2	(MLOCA + LLOCA + ELOCA) * RAFAI * RBSUC
RB4	RA=S * RBSUC
RB6	RA=F * RASUC * RBSUC
RB5	RAFAI + RW=S * RBSUC
RIF	RA=F * RB=F
RI1	SI=S * RA=S * RB=S
RI2	SI=S * (RA=S * RB=F + RA=F * RB=S)
RI3	SI=F * (S1=F + S2=F) * RA=S * RB=S
RI4	SI=F * (S1=F + S2=F) * (RA=S * RB=F + RA=F * RB=S)
RI5	SI=F * (S1=S + S2=S) * RA=S * RB=S
RI6	SI=F * (S1=S + S2=S) * (RA=S * RB=F + RA=F * RB=S)
RDF	-RHRCOOL + (AC=F + RA=F + A2L=F) * (RB=F + BC=F + B2L=F) + RI=F + DP=F + PR=F + PI=F + SE=F + RT=F + A1L=F * B1L=F
RD2	(AC=F + RA=F + A2L=F) + (BC=F + RB=F + B2L=F)
RD1	A1L=S * B1L=S * ((AC=S * RA=S * A2L=S) * (RB=S * BC=S * B2L=S))

MODEL Name: WBNNEW
Event Tree: LARLOC4

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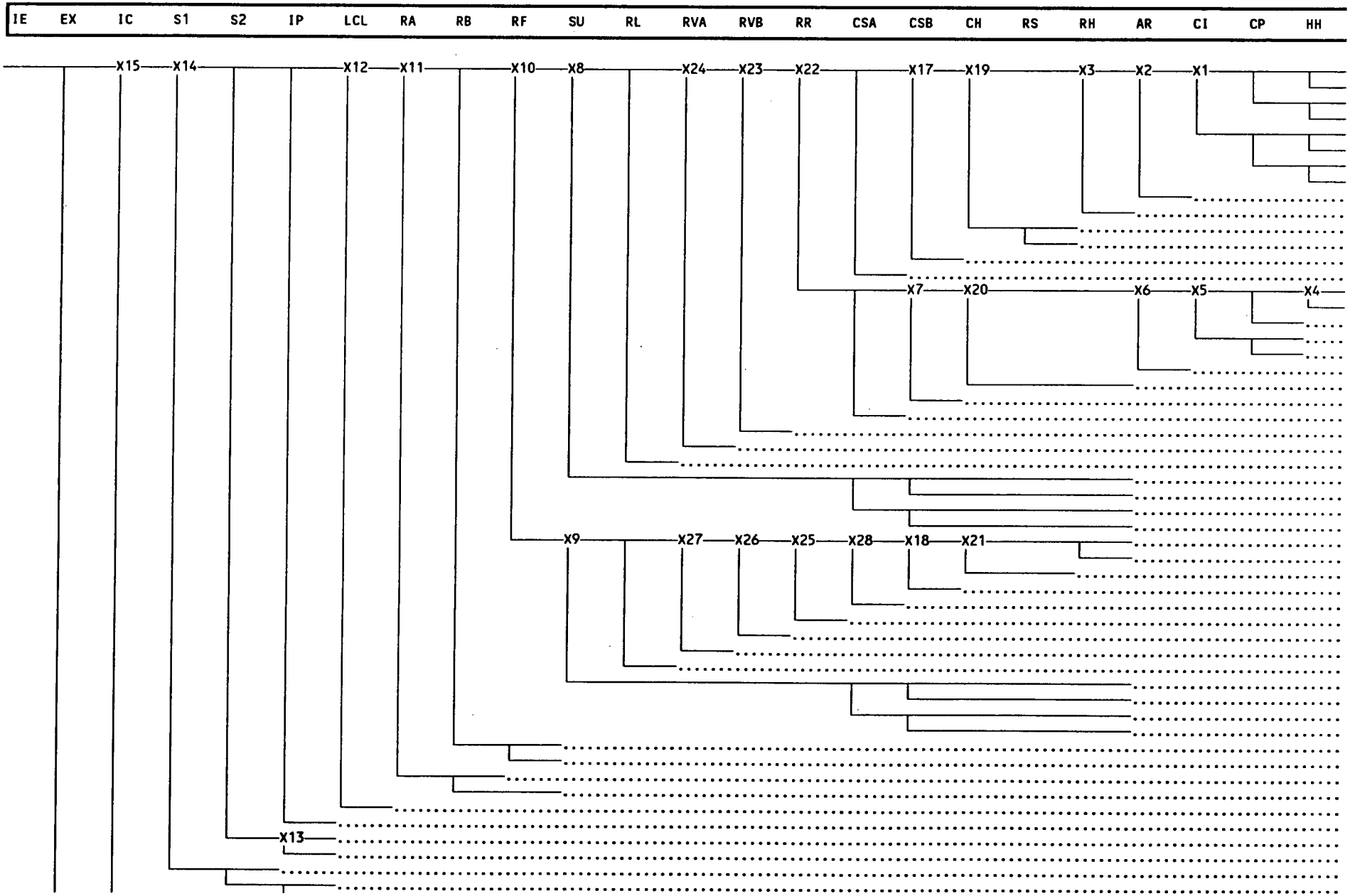

MODEL Name: WBNNEW
Event Tree: LARLOC4

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IE	EX	IC	S1	S2	IP	LCL	RA	RB	RF	SU	RL	RVA	RVB	RR	CSA	CSB	CH	RS	RH	AR	CI	CP	HH

MODEL Name: WBNNEW
Event Tree: LARLOC4

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—	1		1
—	2		2
—	3		3
—	4		4
—	5		5
—	6		6
—	7		7
—	8		8
..	9	X1	9-16
..	10	X2	17-32
..	11	X3	33-64
..	12	X3	65-96
..	13	X19	97-192
..	14	X17	193-384
—	15		385
—	16		386
..	17	X4	387-388
..	18	X4	389-390
..	19	X4	391-392
..	20	X5	393-400
..	21	X6	401-416
..	22	X20	417-448
..	23	X7	449-512
..	24	X22	513-1024
..	25	X23	1025-2048
..	26	X24	2049-4096
..	27	X6	4097-4112
..	28	X6	4113-4128
..	29	X6	4129-4144
..	30	X6	4145-4160
..	31	X2	4161-4176
..	32	X2	4177-4192
..	33	X3	4193-4224
..	34	X21	4225-4288
..	35	X18	4289-4416
..	36	X28	4417-4672
..	37	X25	4673-5184
..	38	X26	5185-6208
..	39	X27	6209-8256
..	40	X6	8257-8272
..	41	X6	8273-8288
..	42	X6	8289-8304
..	43	X6	8305-8320
..	44	X8	8321-12480
..	45	X9	12481-16640
..	46	X10	16641-24960
..	47	X9	24961-29120
..	48	X11	29121-58240
..	49	X12	58241-116480
..	50	X12	116481-174720
..	51	X12	174721-232960
..	52	X13	232961-349440
..	53	X12	349441-407680

..	54	X12	407681-465920
..	55	X14	465921-931840

]

.. 56 X15 931841-1863680

MODEL Name: WBNNEW

Top Event Legend for Tree: LARLOC4

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Page 1

Top Event Designator.....	Top Event Description.....
IE	INITIATING EVENT
EX	EXCESSIVE LOCA
IC	FAILURE OF ICE CONDENSER
S1	LOSS OF SAFETY INJECTION PUMP 1A-A
S2	LOSS OF SAFETY INJECTION PUMP 1B-B
IP	LOSS OF 2/3 SIS COLD LEG INJECTION PATHS
LCL	LOSS OF 1/3 COLD LEG ACCUMULATORS
RA	LOSS OF RHR PUMP 1A-A
RB	LOSS OF RHR PUMP 1B-B
RF	FAILURE OF 2/3 RHR COLD LEG INJECTION PATHS
SU	LOSS OF CONTAINMENT SUMP
RL	FAILURE OF SWAP SWAPOVER INSTRUMENTS
RVA	FAILURE OF SUMP SWAPOVER VALVE, 1-FCV-63-72
RVB	FAILURE OF SUMP SWAPOVER VALVE 1-FCV-63-73
RR	FAILURE OF AUTOMATIC/MANUAL SWAPOVER FROM THE RWST TO THE CONTAINMENT SUMP
CSA	FAILURE OF TRAIN A CONTAINMENT SPRAY
CSB	FAILURE OF TRAIN B CONTAINMENT SPRAY
CH	FAILURE OF CONTAINMENT SPRAY HEAT EXCHANGERS
RS	FAILURE OF RHR SPRAY
RH	FAILURE OF RHR & SIS HOT LEG RECIRCULATION
AR	FAILURE OF AIR RETURN FANS
CI	FAILURE OF CONTAINMENT ISOLATION
CP	CONTAINMENT PURGE FAILS TO CLOSE
HH	FAILURE OF HYDROGEN IGNITORS

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: LARLOC4

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Page 1

```
SF........ Split Fraction Logic.............................................

          S1SUC:= AAL=S * A1L=S * DA=S * CE=S * GE=S * AC=S * (ZA=S + OS=S)

          S1FAI:= AAL=F + A1L=F + DA=F + CE=F + GE=F + AC=F + (ZA=F * OS=F)

          S2SUC:= BAL=S * B1L=S * DB=S * DE=S * HE=S * BC=S * (ZB=S + OS=S)

          S2FAI:= BAL=F + B1L=F + DB=F + DE=F + HE=F + BC=F + (ZB=F * OS=F)

          RASUC:= AAL=S * A1L=S * DA=S * CE=S * GE=S * AC=S * (ZA=S + OS=S)

          RAFAI:= AAL=F + A1L=F + DA=F + CE=F + GE=F + AC=F + (ZA=F * OS=F) +
          FLAB2 + FLAB3C + FLAB3R

          RBSUC:= BAL=S * B1L=S * DB=S * DE=S * HE=S * BC=S * (ZB=S + OS=S)

          RBFAI:= BAL=F + B1L=F + DB=F + DE=F + HE=F + BC=F + (ZB=F * OS=F) +
          FLAB2 + FLAB3C + FLAB3R

          CSASUC:= AAL=S * A1L=S * DA=S * CE=S * GE=S * AC=S * (ZA=S + OS=S)

          CSAFAI:= AAL=F + A1L=F + DA=F + CE=F + GE=F + AC=F + (ZA=F * OS=F)
          + FLAB2 + FLAB3C + FLAB3R

          CSBSUC:= BAL=S * B1L=S * DB=S * BC=S * DE=S * HE=S * (ZB=S + OS=S)

          CSBFAI:= BAL=F + B1L=F + DB=F + BC=F + DE=F + HE=F + (ZB=F * OS=F)
          + FLAB2 + FLAB3C + FLAB3R

          RRTRAF:= RA=F + RVA=F + A2L=F + AC=F + (OG=F * (AAFAIL + ABFAIL))

          RRTRBF:= RB=F + RVB=F + B2L=F + BC=F + (OG=F * (BAFAIL + BBFAIL))

          MSISOL:= MLOCA

          MLCIB:= MLOCA

          MLCIA:=  MLOCA

          RRACT1:= ((DA=F * DB=S * DC=S * DD=S) + (DA=S * DB=F *
          DC=S * DD=S) + (DA=S * DB=S * DC=F * DD=S) + (DA=S * DB=S
          * DC=S * DD=F))

          RRACT2:= ((DA=F * DB=F * DC=S * DD=S) + (DA=F * DB=S *
          DC=F * DD=S) + (DA=F * DB=S * DC=S * DD=F) + (DA=S * DB=F
          * DC=F * DD=S) + (DA=S * DB=F * DC=S * DD=F) + (DA=S * DB=S * DC=F

          ARSUPA:= A1L=S * DA=S * ZA=S

          ARSUPB:= B2=S * DB=S * ZB=S

EXF       ELOCA

EXS       1

CP1       (ZA=S * ZB=S) + OS=S
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: LARLOC4

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Page 2

SF..... Split Fraction Logic.....

CP3	ZA=F * ZB=F * OS=F
CP2	(ZA=F + ZB=F) * OS=F
CSA1	RW=S * CSASUC
CSAF	RW=F + CSAFAI
CSB1	CSA=S * CSBSUC
CSB2	CSA=F * CSASUC * RW=S * CSBSUC
CSB3	CSAFAI * RW=S * CSBSUC
CSBF	RW=F + CSBFAI
CH1	RR=S * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=S * DE=S * HE=S * B2L=S)
CH2	RR=S * (CSA=F + CE=F + GE=F + A2L=F) * (CSB=S * DE=S * HE=S* B2L=S)
CH3	RR=S * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=F + DE=F + HE=F + B2L=F)
CH4	RR=F * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=S * DE=S * HE=S * B2L=S)
CH5	RR=F * (CSA=F + CE=F + GE=F + A2L=F) * (CSB=S * DE=S * HE=S* B2L=S)
CH6	RR=F * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=F + DE=F + HE=F + B2L=F)
CHF	(CSA=F + A2L=F + CE=F + GE=F) * (CSB=F + B2L=F + DE=F + HE=F)
RVAF	A1L=F + -RL=S
RVA1	RL=S * A1L=S
RVBF	-RL=S + B1L=F
RVB1	RVA=S * B1L=S
RVB2	RVA=F * A1L=S * RL=S * B1L=S
RVB3	A1L=F * RL=S * B1L=S
RL1	DAAC=S * DBAC=S * DCAC=S * DDAC=S
RLF	DAAC=F * DBAC=F * (DCAC=F + DDAC=F) + (DAAC=F + DBAC=F) * DCAC=F * DDAC=F
RL6	(DAAC=F + DBAC=F) * (DCAC=F + DDAC=F)
RL5	DAAC=F * DBAC=F * DCAC=S * DDAC=S

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: LARLOC4

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Page 3

SF..... Split Fraction Logic.....

RL4	(DAAC=F + DBAC=F) * DCAC=S * DDAC=S
RL3	DCAC=F * DDAC=F
RL2	DCAC=F + DDAC=F
RRF	RL=F + A1L=F * (B1L=F + RRTRBF) + (RRTRAF * RRTRBF)
RRA	RRTRAF * B1L=F
RR9	A1L=F
RR8	B1L=F
RRB	1
RSF	-RR=S + (RA=F + RVA=F + A1L=F) + (RB=F + RVB=F + B1L=F) + (S1=F * S2=F)
RS2	(A1L=S * B1L=F) + (A1L=F * B1L=S)
RS1	RR=S * (RA=S * RVA=S * A1L=S) * (RB=S * RVB=S * B1L=S) * (S1=S + S2=S)
LCL1	IP=S
LCL3	IP=F * RW=S * (S1=S + S2=S)
LCL2	IP=F * (RW=F + S1=F * S2=F)
S2F	RW=F + S2FAI
S21	S1=S * S2SUC
S22	S1=F * S1SUC * RW=S * S2SUC
S23	S1FAI * RW=S * S2SUC
S11	S1SUC * RW=S
S1F	S1FAI + RW=F
ARF	-ARSUPA * -ARSUPB
AR2	ARSUPA + ARSUPB
AR1	ARSUPA * ARSUPB
HH1	A1L=S * B1L=S
HH2	A1L=S * B1L=F + A1L=F * B1L=S
HHF	A1L=F * B1L=F

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: LARLOC4

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```
SF........ Split Fraction Logic.........................................

CI1       (-SBO * -U1BO * A1L=S * B1L=S) * (OS=S + ZA=S * ZB=S)

CIF       OS=F * ZA=F * ZB=F + -SBO * -U1BO * A1L=F * B1L=F

CI2       (-SBO * -U1BO * A1L=S * B1L=S) * OS=F * (ZA=F * ZB=S + ZA=S + ZB=F)

CI5       (SBO + U1BO) * OS=F * (ZA=F * ZB=S + ZA=S + ZB=F)

CI3       -SBO * -U1BO * (A1L=S * B1L=F + A1L=F * B1L=S)

CI4       (SBO + U1BO) * (OS=S + ZA=S * ZB=S)

SU1       1

IC1       1

RAF       RAFAI + RW=F

RA1       RASUC

RBF       RW=F + RBFAI

RB1       RA=S * RBSUC

RB3       RA=F * RASUC * RW=S * RBSUC

RB2       RAFAI * RW=S * RBSUC

RH1       RA=S * RB=S * A1L=S * B1L=S

RH2       B1L=S * RB=S * RVB=S * (A1L=F + RA=F + RVA=F) + (RB=F + RVB=F +
          B1L=F) * RA=S * A1L=S * RVA=S

RHF       (B1L=F + RB=F + RVB=F) * (A1L=F + RA=F + RVA=F)

RFF       RA=F * RB=F

RF1       IP=S * LCL=S * (RA=S + RB=S)

RF2       IP=S * LCL=S * RB=F

RF3       IP=S * LCL=F * (RA=S + RB=S)

RF4       IP=S * LCL=F * RB=F

RF5       IP=F * S1=F * S2=F * LCL=S * (RA=S + RB=S)

RF6       IP=F * S1=F * S2=F * LCL=S * RB=F

RF7       IP=F * S1=F * S2=F * LCL=F * (RA=S + RB=S)

RF8       IP=F * S1=F * S2=F * LCL=F * RB=F

RF9       IP=F * (S1=S + S2=S) * LCL=S * (RA=S + RB=S)
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: LARLOC4

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SF..... Split Fraction Logic.....

RFA	IP=F * (S1=S + S2=S) * LCL=S * RB=F
RFB	IP=F * (S1=S + S2=S) * LCL=F * (RA=S + RB=S)
RFC	IP=F * (S1=S + S2=S) * LCL=F * (RA=S + RB=S)
IPF	(S1=F * S2=F)
IP1	(S1=S + S2=S)

Page No. 1

MODEL Name: WBNNEW
Event Tree: LLBINS

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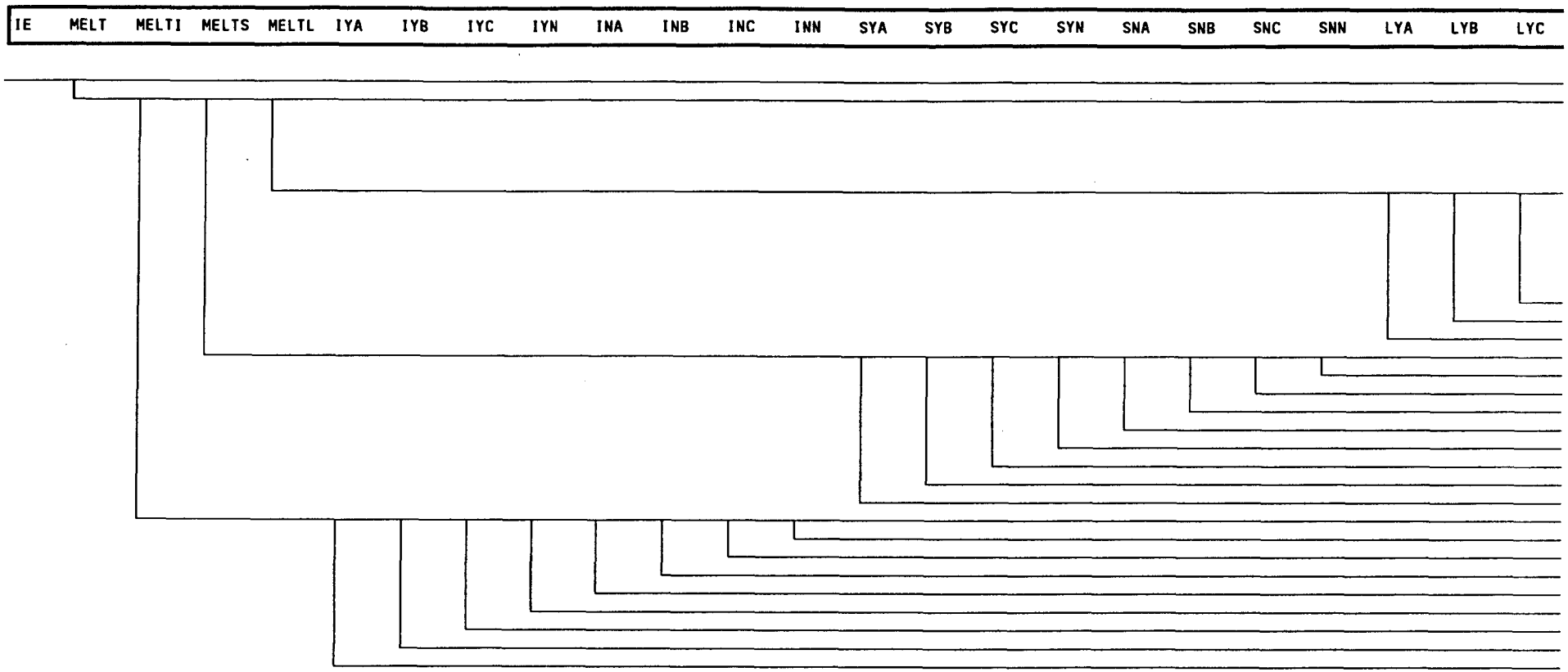

MODEL Name: WBNNEW
Event Tree: LLBINS

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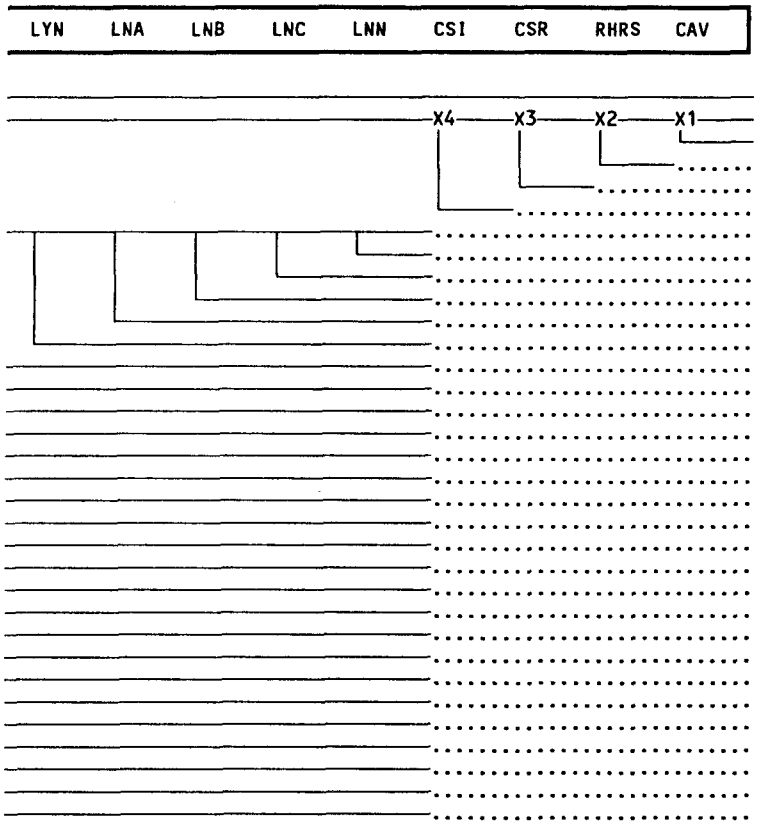

1		1
2		2
3		3
4	X1	4-5
5	X2	6-9
6	X3	10-17
7	X4	18-33
8	X4	34-49
9	X4	50-65
10	X4	66-81
11	X4	82-97
12	X4	98-113
13	X4	114-129
14	X4	130-145
15	X4	146-161
16	X4	162-177
17	X4	178-193
18	X4	194-209
19	X4	210-225
20	X4	226-241
21	X4	242-257
22	X4	258-273
23	X4	274-289
24	X4	290-305
25	X4	306-321
26	X4	322-337
27	X4	338-353
28	X4	354-369
29	X4	370-385
30	X4	386-401
31	X4	402-417
32	X4	418-433
33	X4	434-449

MODEL Name: WBNNEW

Top Event Legend for Tree: LLBINS

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Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
MELT	NO CORE MELT DURING LARGE LOCA
MELTI	MELT WITH SUCCESSFUL CONTAINMENT ISOLATION
MELTS	MELT WITH CI=F * CONT. PURGE SUCCESS
MELTL	MELT WITH CONT. PURGE FAILURE
IYA	MELTI * CI=S * CP=S * IC=S * AR=S * HH=S
IYB	
IYC	
IYN	
INA	
INB	
INC	
INN	
SYA	
SYB	
SYC	
SYN	
SNA	
SNB	
SNC	
SNN	
LYA	
LYB	
LYC	
LYN	
LNA	
LNB	
LNC	

MODEL Name: WBNNEW

Top Event Legend for Tree: LLBINS

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Page 2

Top Event Designator.....	Top Event Description.....
LNN	
CSI	FAILURE OF CONTAINMENT SPRAY INJECTION
CSR	FAILURE OF CONTAINMENT SPRAY RECIRCULATION
RHRS	FAILURE OF RHR SPRAY IN RECIRCULATION
CAV	WATER IN REACTOR CAVITY

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: LLBINS

14:33:24 03 AUG 1992
Page 1

```
SF........ Split Fraction Logic.............................................

MELTF     REC=F * (EX=F + LCL=F + (RA=F + RVA=F) * (RB=F + RVB=F) + RF=F +
          RL=F + RR=F + SU=F + RH=F)

          MELT:= MELT=F

MELTS     1

MELTIF    MELT * CI=S * CP=S

          MELTI:= MELTI=F

MELTIS    1

MELTSF    MELT * CI=F * CP=S

          MELTS:= MELTS=F

MELTSS    1

MELTLF    MELT * CP=F

          MELTL:= MELTL=F

MELTLS    1

IYAF      MELTI * IC=S * AR=S * HH=S

IYAS      1

IYBF      MELTI * IC=S * AR=S * HH=F

IYBS      1

IYCF      MELTI * IC=S * AR=F * HH=S

IYCS      1

IYNF      MELTI * IC=S * AR=F * HH=F

IYNS      1

SYAF      MELTS * IC=S * AR=S * HH=S

SYAS      1

SYBF      MELTS * IC=S * AR=S * HH=F

SYBS      1

SYCF      MELTS * IC=S * AR=F * HH=S

SYCS      1

SYNF      MELTS * IC=S * AR=F * HH=F
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: LLBINS

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Page 2

SF..... Split Fraction Logic.....

SYNS	1
LYAF	MELTL * IC=S * AR=S * HH=S
LYAS	1
LYBF	MELTL * IC=S * AR=S * HH=F
LYBS	1
LYCF	MELTL * IC=S * AR=F * HH=S
LYCS	1
LYNF	MELTL * IC=S * AR=F * HH=F
LYNS	1
INAF	MELTI * IC=F * AR=S * HH=S
INAS	1
INBF	MELTI * IC=F * AR=S * HH=F
INBS	1
INCF	MELTI * IC=F * AR=F * HH=S
INCS	1
INNF	MELTI * IC=F * AR=F * HH=F
INNS	1
SNAF	MELTS * IC=F * AR=S * HH=S
SNAS	1
SNBF	MELTS * IC=F * AR=S * HH=F
SNBS	1
SNCF	MELTS * IC=F * AR=F * HH=S
SNCS	1
SNNF	MELTS * IC=F * AR=F * HH=F
SNNS	1
LNAF	MELTL * IC=F * AR=S * HH=S
LNAS	1
LNBF	MELTL * IC=F * AR=S * HH=F

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: LLBINS

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Page 3

SF..... Split Fraction Logic.....

LNBS	1
LNCF	MELTL * IC=F * AR=F * HH=S
LNCS	1
LNNF	MELTL * IC=F * AR=F * HH=F
LNNS	1
CSIS	CSA=S + CSB=S
CSIF	1
	CSI:= CSI=S
	XCSI:= CSI=F
CSRS	(CSA=S + CSB=S) * CH=S
CSRF	1
	XCSR:= CSR=F
	CSR:= CSR=S
RHRSS	(RA=S * RVA=S + RB=S * RVB=S) * RR=S * RF=S * RS=S
RHRSF	1
	XRHRS:= RHRS=F
	RHRS:= RHRS=S
CAVS	IC=S * ((S1=S + S2=S) * IP=S + (RA=S + RB=S) * RF=S + CSA=S + CSB=S) * SU=S
CAVF	1
	XCAV:= CAV=F
	CAV:= CAV=S
	IYA:= IYA=F
	IYB:= IYB=F
	IYC:= IYC=F
	IYN:= IYN=F
	SYA:= SYA=F
	SYB:= SYB=F

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: LLBINS

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Page 4

SF..... Split Fraction Logic.....

```
SYC:= SYC=F
SYN:= SYN=F
LYA:= LYA=F
LYB:= LYB=F
LYC:= LYC=F
LYN:= LYN=F
INA:= INA=F
INB:= INB=F
INC:= INC=F
INN:= INN=F
SNA:= SNA=F
SNB:= SNB=F
SNC:= SNC=F
SNN:= SNN=F
LNA:= LNA=F
LNB:= LNB=F
LNC:= LNC=F
LNN:= LNN=F
```

MODEL Name: WBNNEW

Binning Logic for Event Tree: LLBINS

16:42:15 03 AUG 1992
Page 1

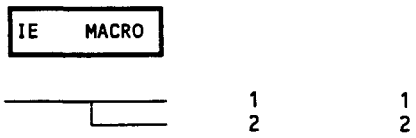
Bin.....	Binning Rules.....
ACI	MELTI*XCAV*CSI*CSR
BCI	MELTI*CAV*CSI*CSR
AEI	MELTI*XCAV*CSI*XCSR*RHRS
BEI	MELTI*CAV*CSI*XCSR*RHRS
AGI	MELTI*XCAV*CSI*XCSR*XRHRS
BGI	MELTI*CAV*CSI*XCSR*XRHRS
AII	MELTI*XCAV*XCSI*XCSR*RHRS
BII	MELTI*CAV*XCSI*XCSR*RHRS
ANI	MELTI*XCAV*XCSI*XCSR*XRHRS
BNI	MELTI*CAV*XCSI*XCSR*XRHRS
ACS	MELTS*XCAV*CSI*CSR
BCS	MELTS*CAV*CSI*CSR
AES	MELTS*XCAV*CSI*XCSR*RHRS
BES	MELTS*CAV*CSI*XCSR*RHRS
AGS	MELTS*XCAV*CSI*XCSR*XRHRS
BGS	MELTS*CAV*CSI*XCSR*XRHRS
AIS	MELTS*XCAV*XCSI*XCSR*RHRS
BIS	MELTS*CAV*XCSI*XCSR*RHRS
ANS	MELTS*XCAV*XCSI*XCSR*XRHRS
BNS	MELTS*CAV*XCSI*XCSR*XRHRS
APL	MELTL*XCAV*CSI*CSR
BPL	MELTL*CAV*CSI*CSR
AQL	MELTL*XCAV*CSI*XCSR*RHRS
BQL	MELTL*CAV*CSI*XCSR*RHRS
ARL	MELTL*XCAV*CSI*XCSR*XRHRS
BRL	MELTL*CAV*CSI*XCSR*XRHRS
ASL	MELTL*XCAV*XCSI*XCSR*RHRS
BSL	MELTL*CAV*XCSI*XCSR*RHRS
ATL	MELTL*XCAV*XCSI*XCSR*XRHRS
BTL	MELTL*CAV*XCSI*XCSR*XRHRS
MELT	MELT
SUCCESS	1

MODEL Name: WBNNEW

Page No. 1

Event Tree: MACRO1

14:13:39 03 AUG 1992



MODEL Name: WBNNEW

Top Event Legend for Tree: MACRO1

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Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
MACRO	TESTING TO SEE IF THIS WORKS

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MACRO1

14:33:48 03 AUG 1992
Page 1

```
SF........ Split Fraction Logic..............................................
MACROS     1
           LDAAC:= INIT=LDAAC
           LDBAC:= INIT=LDBAC
           LDCAC:= INIT=LDCAC
           LDDAC:= INIT=LDDAC
           FLTB:= INIT=FLTB
           FLPH1A:= INIT=FLPH1A
           FLPH1B:= INIT=FLPH1B
           FLAB2:= INIT=FLAB2
           FLAB3C:= INIT=FLAB3C
           FLAB3R:= INIT=FLAB3R
           MSVO:= INIT=MSVO
           RT:= INIT=RTIE
           SLBIC:= INIT=SLBIC
           SLBOC:= INIT=SLBOC
           EXMFW:= INIT=EXMFW
           LOSP:= INIT=LOSP
           CCSTL:= INIT=CCSTL
           CCSA:= INIT=CCSA
           CCSB:= INIT=CCSB
           ERCWTL:= INIT=ERCWTL
           ERCWA:= INIT=ERCWA
           ERCWB:= INIT=ERCWB
           SLOCAN:= INIT=SLOCAN
           SLOCAI:= INIT=SLOCAI
           LLOCA:= INIT=LLOCA
           MLOCA:= INIT=MLOCA
           ELOCA:= INIT=ELOCA
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MACRO1

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Page 2

SF..... Split Fraction Logic.....

```
SGTR:= INIT=SGTR

ISI:= INIT=ISI

TT:= INIT=TTIE

CPEX:= INIT=CPEX

TLMFW:= INIT=TLMFW

PLMFW:= INIT=PLMFW

LOCV:= INIT=LOCV

MSIV:= INIT=MSIV

IMSIV:= INIT=IMSIV

LRCP:= INIT=LRCP

LNEA:= INIT=LNEA

LASD:= INIT=LASD

LBSD:= INIT=LBSD

LVBB1:= INIT=LVBB1

LVBB2:= INIT=LVBB2

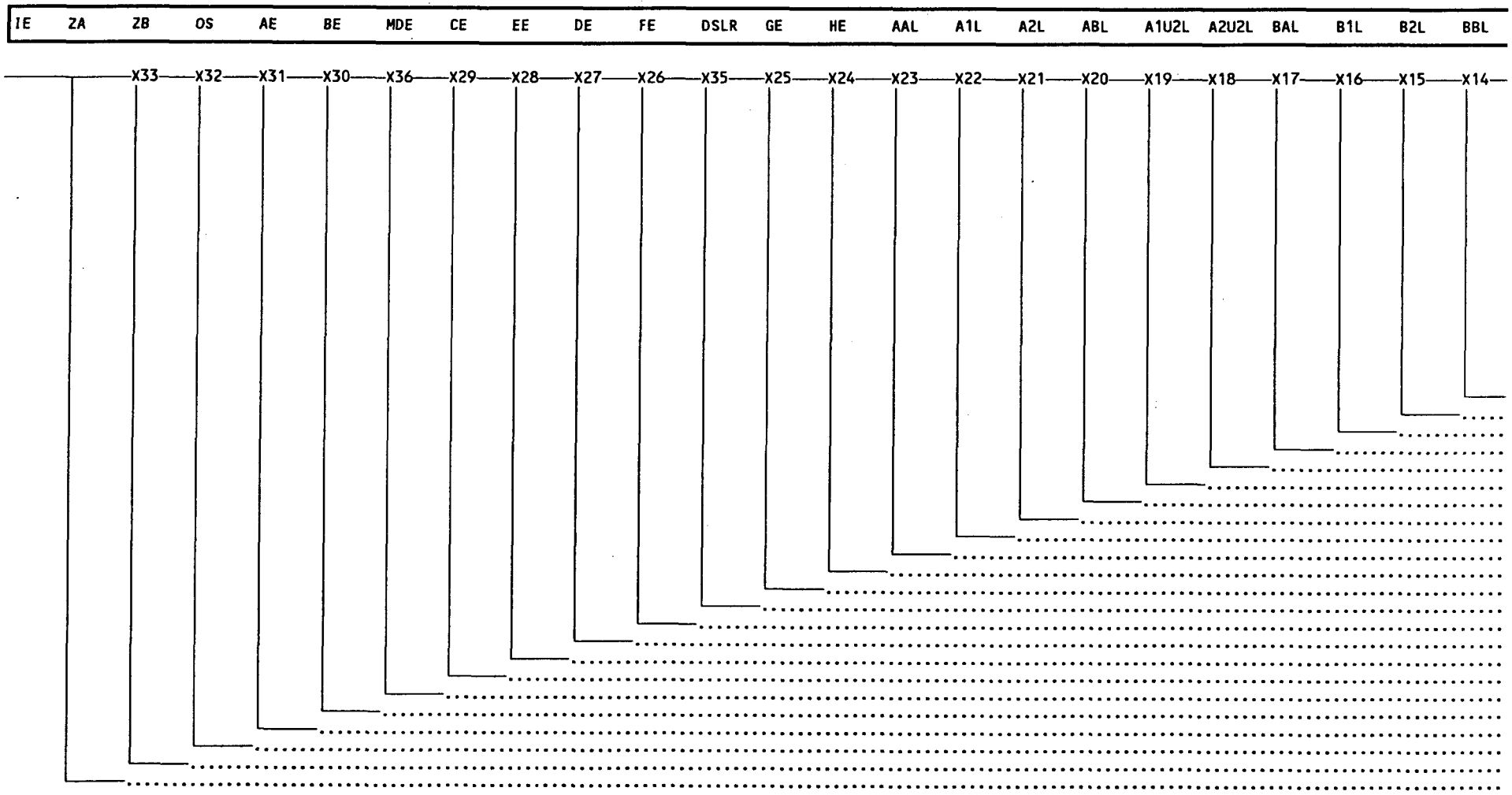
LVBB3:= INIT=LVBB3

LVBB4:= INIT=LVBB4
```

Page No. 1

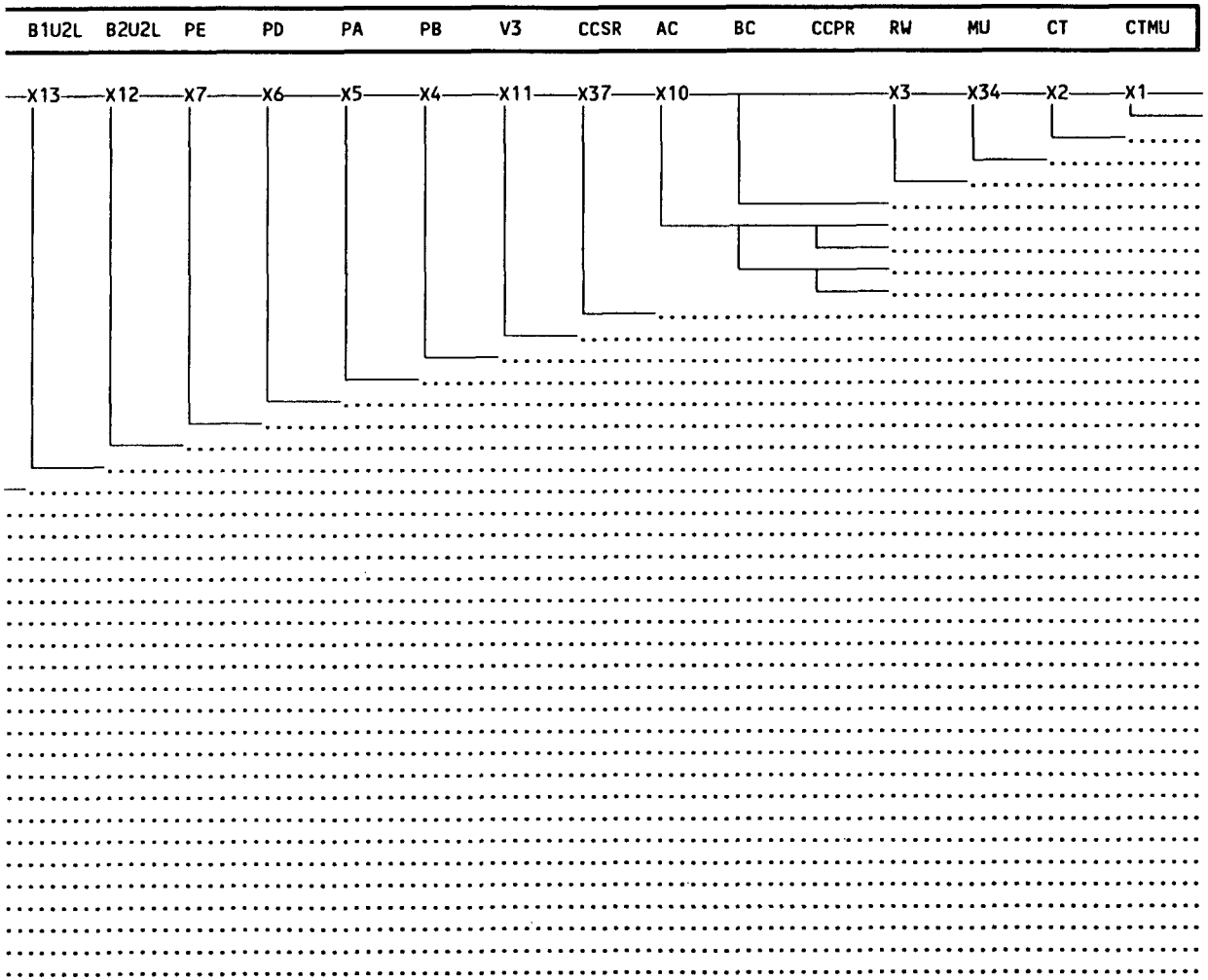
MODEL Name: WBNNEW
Event Tree: MECH2

14:13:50 03 AUG 1992



MODEL Name: WBNNEW
Event Tree: MECH2

14:13:53 03 AUG 1992



1		1
2		2
3	X1	3-4
4	X2	5-8
5	X34	9-16
6	X3	17-32
7	X3	33-48
8	X3	49-64
9	X3	65-80
10	X3	81-96
11	X10	97-192
12	X37	193-384
13	X11	385-768
14	X4	769-1536
15	X5	1537-3072
16	X6	3073-6144
17	X7	6145-12288
18	X12	12289-24576
19	X13	24577-49152
20	X14	49153-98304
21	X15	98305-196608
22	X16	196609-393216
23	X17	393217-786432
24	X18	786433-1572864
25	X19	1572865-3145728
26	X20	3145729-6291456
27	X21	6291457-12582912
28	X22	12582913-25165824
29	X23	25165825-50331648
30	X24	50331649-100663296
31	X25	100663297-201326592
32	X35	201326593-402653184
33	X26	402653185-805306368
34	X27	805306369-1610612736
35	X28	1610612737-3221225472
36	X29	3221225473-6442450944
37	X36	6442450945-12884901888
38	X30	12884901889-25769803776
39	X31	25769803777-51539607552
40	X32	51539607553-103079215104
41	X33	103079215105-206158430208

MODEL Name: WBNNEW

Top Event Legend for Tree: MECH2

14:14:00 03 AUG 1992
Page 1

Top Event Designator.....	Top Event Description.....
IE	INITIATING EVENT
ZA	LOSS OF TRAIN A ESFAS
ZB	LOSS OF TRAIN B ESFAS
OS	FAILURE OF MANUAL OPERATOR BACKUP OF ESFAS ALIGNMENTS
AE	LOSS OF ERCW TRAIN A PUMPS
BE	LOSS OF ERCW TRAIN B PUMPS
MDE	MAINTENANCE ON ERCW HEADER 1B
CE	LOSS OF ERCW HEADER 1A
EE	LOSS OF ERCW HEADER 2A
DE	LOSS OF ERCW HEADER 1B
FE	LOSS OF ERCW HEADER 2B
DSLR	FAILURE TO RECOVER ERCW TO DIESEL FROM OPPOSITE TRAIN
GE	LOSS OF ERCW DISCHARGE HEADER A
HE	LOSS OF ERCW DISCHARGE HEADER B
AAL	NO POWER AT 6.9 SHUTDOWN BD 1A-A
A1L	NO POWER AT 480V SHUTDOWN BD 1A1-A
A2L	NO POWER AT 480V SHUTDOWN BD 1A2-A
ABL	NO POWER AT 6.9 SHUTDOWN BD 2A-A
A1U2L	NO POWER AT 480V SHUTDOWN BD 2A1-A
A2U2L	NO POWER AT 480V SHUTDOWN BD 2A2-A
BAL	NO POWER AT 6.9 SHUTDOWN BD 1B-B
B1L	NO POWER AT 480V SHUTDOWN BD 1B1-B
B2L	NO POWER AT 480V SHUTDOWN BD 1B2-B
BBL	NO POWER AT 6.9 SHUTDOWN BD 2B-B
B1U2L	NO POWER AT 480V SHUTDOWN BD 2B1-B
B2U2L	NO POWER AT 480V SHUTDOWN BD 2B2-B
PE	FAILURE OF ERCW COOLING TO CAS COMPRESSORS

MODEL Name: WBNNEW

Top Event Legend for Tree: MECH2

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Page 2

Top Event Designator.....	Top Event Description.....
PD	FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR)
PA	LOSS OF TRAIN A ESSENTIAL AIR
PB	LOSS OF TRAIN B ESSENTIAL AIR
V3	LOSS OF CCS AND MD AFW PUMPS VENTILIATION
CCSR	FAILURE TO RECOVER CCS HTX BY REALIGNING ERCW
AC	LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM
BC	LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM
CCPR	FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A
RW	FAILURE OF REFUELING WATER STORAGE TANK (RWST)
MU	FAILURE OF MAKEUP TO RWST
CT	FAILURE OF CONDENSATE STORAGE TANK (CST)
CTMU	FAILURE OF MAKEUP TO THE CST

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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Page 1

```
SF........ Split Fraction Logic.............................................

          AALOSS:= AA=F + OG=F * OGR1=F * (CE=F * (FE=F + DSLR=F) + (GE=F *
          HE=F) + DA=F) + V1=F * V1R=F

          ABLOSS:= AB=F + OG=F * OGR1=F * (CE=F * (FE=F + DSLR=F) + (GE=F *
          HE=F) + DC=F) + V2=F * V2R=F

          BALOSS:= BA=F + OG=F * OGR1=F * (DE=F * (EE=F + DSLR=F) + (GE=F *
          HE=F) + DB=F) + V1=F * V1R=F

          BBLOSS:= BB=F + OG=F * OGR1=F * (DE=F * (EE=F + DSLR=F) + (GE=F *
          HE=F) + DD=F) + V2=F *V2R=F

          U1BO:= (AAL=F + A1L=F + A2L=F) * (BAL=F + B1L=F + B2L=F)

          SBO:= OG=F * OGR1=F * GA=F * GB=F * GC=F * GD=F

          GTRAN:= -(LGLOCA + STEAMOC + STEAMIC + SLOCA)

          STEAMIC:= SLBIC

          LGLOCA:= ELOCA + LLOCA + MLOCA

          STEAMOC:= SLBOC + MSVO

          SLOCA:=  SLOCAN + SLOCAI + SGTR + ISI

          AAFAIL:= AA=F + DA=F + OG=F * (A1=F + A2=F)

          BAFAIL:= BA=F + DB=F + OG=F * (B1=F + B2=F)

          Rule Comment
          ------------
          NO DC POWER MEANS NO 6.9 KV POWER AND NO 480V POWER MEANS NO DIESEL

          ABFAIL:= AB=F + DC=F + OG=F * (A1U2=F + A2U2=F)

          BBFAIL:= BB=F + DD=F + OG=F * (B1U2=F + B2U2=F)

          SI:= LGLOCA + SLOCA + STEAMIC + STEAMOC

          SIS:= SI * (ZA=S * ZB=S + OS=S)

          CSASUP:= AAL=S * A1L=S * DA=S * CE=S * GE=S * AC=S

          CSBSUP:= BAL=S * B1L=S * DB=S * DE=S * HE=S * BC=S

ZAF       DAAC=F + (LGLOCA + SLBIC) * DBAC=F * DCAC=F * DDAC=F

ZA7       LGLOCA * (DBAC=F*DCAC=F + DBAC=F*DDAC=F + DCAC=F*DDAC=F)

ZA6       LGLOCA * (DBAC=F + DCAC=F + DDAC=F)

ZA9       SLBIC * (DBAC=F*DCAC=F + DBAC=F*DDAC=F + DCAC=F*DDAC=F)

ZA8       SLBIC * (DBAC=F + DCAC=F + DDAC=F)
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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Page 2

SF..... Split Fraction Logic.....

ZA2	LGLOCA
ZA3	SLBIC
ZA4	STEAMOC
ZA5	SLOCA
ZA1	GTRAN
ZBF	DBAC=F + (LGLOCA + SLBIC) * DAAC=F * DCAC=F * DDAC=F
ZB21	SLBIC * DAAC=F * (DCAC=F + DDAC=F)
ZB22	LGLOCA * DAAC=F * (DCAC=F + DDAC=F)
ZB19	SLBIC * DAAC=F
ZB20	LGLOCA * DAAC=F
ZB16	SLBIC * DCAC=F * DDAC=F * ZA=F
ZB15	SLBIC * DCAC=F * DDAC=F
ZB18	LGLOCA * DCAC=F * DDAC=F * ZA=F
ZB17	LGLOCA * DCAC=F * DDAC=F
ZB12	SLBIC * (DCAC=F + DDAC=F) * ZA=F
ZB11	SLBIC * (DCAC=F + DDAC=F)
ZB14	LGLOCA * (DCAC=F + DDAC=F) * ZA=F
ZB13	LGLOCA * (DCAC=F + DDAC=F)
ZB8	SLBIC * ZA=F
ZB3	SLBIC
ZB7	LGLOCA * ZA=F
ZB2	LGLOCA
ZB10	SLOCA * ZA=F
ZB5	SLOCA
ZB9	STEAMOC * ZA=F
ZB4	STEAMOC
ZB6	GTRAN * ZA=F

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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Page 3

```
SF........ Split Fraction Logic.............................................

ZB1       GTRAN

OSS       ZA=S * ZB=S

OS1       LGLOCA

OS2       STEAMIC + STEAMOC + SLOCA

OS3       GTRAN

AEF       OG=S * AA=F * AB=F + OG=F * ((DA=F + AA=F) * (AB=F + DC=F)) +
          SI * (ZA=F*OS=F + DA=F*DC=F) * (AA=F + AB=F) +
          OG=S * AA=F * DC=F + OG=S * AB=F * DA=F +
          ERCWA + ERCWTL + FLPH1A

AE6       OG=F * (AAFAIL + ABFAIL)

AE10      OG=F*OGR1=S

AE5       OG=F * OGR1=F

AE4       DA=F * DC=F + SI * ZA=F * OS=F

AE9       SI * (ZA=S + OS=S) * (DA=F + DC=F)

AE8       SI * (ZA=S + OS=S) * (AB=F + AA=F)

AE7       SI * (ZA=S + OS=S)

AE3       DA=F + DC=F

AE2       AA=F + AB=F

AE1       -(SI + OG=F + AAFAIL + ABFAIL)

BEF       OG=S * BA=F * BB=F + OG=F * ((DB=F + BA=F) * (DD=F + BB=F)) +
          SI * (ZB=F*OS=F + DB=F*DD=F) * (BA=F + BB=F) +
          OG=S * BA=F * DD=F + OG=S * BB=F * DB=F +
          ERCWB + ERCWTL + FLPH1B

BE86      OG=F * AAFAIL * ABFAIL * (BAFAIL + BBFAIL)

BE85      OG=F * AAFAIL * ABFAIL

BE44      OG=F * (AAFAIL + ABFAIL) * (BAFAIL + BBFAIL) * AE=F *
          -(INIT=ERCWA + FLPH1A)

BE43      OG=F * (AAFAIL + ABFAIL) * (BAFAIL + BBFAIL)

BE42      OG=F * (AAFAIL + ABFAIL) * AE=F * -(ERCWA + FLPH1A)

BE41      OG=F * (AAFAIL + ABFAIL)

BE91      OG=F * OGR1=S * AE=F * -(ERCWA + FLPH1A)
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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Page 4

SF..... Split Fraction Logic.....

BE34	OG=F * AE=F * -(ERCWA + FLPH1A)
BE90	OG=F * OGR1=S
BE33	OG=F * OGR1=F
BE84	AA=F * AB=F * DB=F * DD=F
BE89	SIS * AA=F * AB=F * (DB=F + DD=F)
BE88	SIS * AA=F * AB=F * (BA=F + BB=F)
BE87	SIS * AA=F * AB=F
BE80	SIS * DA=F * DC=F * DB=F * DD=F * AE=F
BE79	SIS * DA=F * DC=F * DB=F * DD=F
BE78	SIS * DA=F * DC=F * (DB=F + DD=F) * AE=F
BE77	SIS * DA=F * DC=F * (DB=F + DD=F)
BE76	SIS * DA=F * DC=F * (BA=F + BB=F) * AE=F
BE75	SIS * DA=F * DC=F * (BA=F + BB=F)
BE74	SIS * DA=F * DC=F * AE=F
BE73	SIS * DA=F * DC=F
BE72	SIS * (DA=F + DC=F) * DB=F * DD=F * AE=F
BE71	SIS * (DA=F + DC=F) * DB=F * DD=F
BE70	SIS * (DA=F + DC=F) * (DB=F + DD=F) * AE=F
BE69	SIS * (DA=F + DC=F) * (DB=F + DD=F)
BE68	SIS * (DA=F + DC=F) * (BA=F + BB=F) * AE=F
BE67	SIS * (DA=F + DC=F) * (BA=F + BB=F)
BE66	SIS * (DA=F + DC=F) * AE=F
BE65	SIS * (DA=F + DC=F)
BE64	SIS * (AA=F + AB=F) * DB=F * DD=F * AE=F
BE63	SIS * (AA=F + AB=F) * DB=F * DD=F
BE62	SIS * (AA=F + AB=F) * (DB=F + DD=F) * AE=F
BE61	SIS * (AA=F + AB=F) * (DB=F + DD=F)
BE60	SIS * (AA=F + AB=F) * (BA=F + BB=F) * AE=F

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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Page 5

SF..... Split Fraction Logic.....

BE59	SIS * (AA=F + AB=F) * (BA=F + BB=F)
BE58	SIS * (AA=F + AB=F) * AE=F
BE57	SIS * (AA=F + AB=F)
BE56	SIS * DB=F * DD=F * AE=F
BE55	SIS * DB=F * DD=F
BE54	SIS * (DB=F + DD=F) * AE=F
BE53	SIS * (DB=F + DD=F)
BE52	SIS * (BA=F + BB=F) * AE=F
BE51	SIS * (BA=F + BB=F)
BE50	SIS * AE=F
BE49	SIS
BE83	(AA=F * AB=F + AA=F * DC=F + AB=F * DA=F) * (DB=F + DD=F)
BE82	(AA=F * AB=F + AA=F * DC=F + AB=F * DA=F) * (BA=F + BB=F)
BE81	AA=F * AB=F + AA=F * DC=F + AB=F * DA=F
BE32	DA=F * DC=F * DB=F * DD=F * AE=F * -(ERCWA + FLPH1A)
BE31	DA=F * DC=F * DB=F * DD=F
BE30	DA=F * DC=F * (DB=F + DD=F) * AE=F * -(ERCWA + FLPH1A)
BE29	DA=F * DC=F * (DB=F + DD=F)
BE28	DA=F * DC=F * (BA=F + BB=F) * AE=F * -(ERCWA + FLPH1A)
BE27	DA=F * DC=F * (BA=F + BB=F)
BE26	DA=F * DC=F * AE=F * -(ERCWA + FLPH1A)
BE25	DA=F * DC=F
BE24	(DA=F + DC=F) * DB=F * DD=F * AE=F * -(ERCWA + FLPH1A)
BE23	(DA=F + DC=F) * DB=F * DD=F
BE22	(DA=F + DC=F) * (DB=F + DD=F) * AE=F * -(ERCWA + FLPH1A)
BE21	(DA=F + DC=F) * (DB=F + DD=F)
BE20	(DA=F + DC=F) * (BA=F + BB=F) * AE=F * -(ERCWA + FLPH1A)

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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SF..... Split Fraction Logic.....

BE19	(DA=F + DC=F) * (BA=F + BB=F)
BE18	(DA=F + DC=F) * AE=F * -(ERCWA + FLPH1A)
BE17	DA=F + DC=F
BE16	(AA=F + AB=F) * DB=F * DD=F * AE=F * -(ERCWA + FLPH1A)
BE15	(AA=F + AB=F) * DB=F * DD=F
BE14	(AA=F + AB=F) * (DB=F + DD=F) * AE=F * -(ERCWA + FLPH1A)
BE13	(AA=F + AB=F) * (DB=F + DD=F)
BE12	(AA=F + AB=F) * (BA=F + BB=F) * AE=F * -(ERCWA + FLPH1A)
BE11	(AA=F + AB=F) * (BA=F + BB=F)
BE10	(AA=F + AB=F) * AE=F * -(ERCWA + FLPH1A)
BE9	AA=F + AB=F
BE8	DB=F * DD=F * AE=F * -(ERCWA + FLPH1A)
BE7	DB=F * DD=F
BE6	(DB=F + DD=F) * AE=F * -(ERCWA + FLPH1A)
BE5	DB=F + DD=F
BE4	(BA=F + BB=F) * AE=F * -(ERCWA + FLPH1A)
BE3	BA=F + BB=F
BE2	AE=F * -(ERCWA + FLPH1A)
BE1	-(BAFAIL + BBFAIL + OG=F + SIS)
MDE1	1
CEF	AE=F + FLAB2
CE2	BE=F
CE1	1
DEF	BE=F + MDE=F * EE=F
	Rule Comment

	ALL SUPPORT SYSTEMS AVAILABLE FOR ERCW HEADER 1B
DE2	AE=F
	Rule Comment

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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SF..... Split Fraction Logic.....

ALTERNATE SUPPLY FROM ERCW HEADER 2A UNAVAILABLE

DE1	1
EEF	AE=F
EE2	BE=F
EE1	1
FEF	BE=F
FE2	AE=F
FE1	1
DSLRS	OG=S + OGR1=S + CE=S * DE=S
DSLR1	OG=F * (CE=F * FE=S + DE=F * EE=S)
DSLRF	OG=F * (CE=F * FE=F + DE=F * EE=F)
GE1	1
HE1	1
AALF	AALOSS + OG=F * -OGR1=S * (AE=F * BE=F + AE=F * FE=F + AE=F * DE=F + BE=F * CE=F + CE=F * FE=F + CE=F * DE=F * EE=F + GE=F * HE=F)
AALS	1
A1LF	A1=F + AAL=F + VT1A=F * VT1AR=F
A1LS	1
A2LF	A2=F + AAL=F + VT1A=F * VT1AR=F
A2LS	1
ABLF	ABLOSS + OG=F * -OGR1=S * (AE=F * BE=F + AE=F * FE=F + AE=F * DE=F + BE=F * CE=F + CE=F * FE=F + CE=F * DE=F * EE=F + GE=F * HE=F)
ABLS	1
A1U2LF	A1U2=F + ABL=F + VT2A=F * VT2AR=F
A1U2LS	1
A2U2LF	A2U2=F + ABL=F + VT2A=F * VT2AR=F
A2U2LS	1
BALF	BALOSS + OG=F * -OGR1=S* (AE=F * BE=F + AE=F * DE=F + BE=F * EE=F + DE=F * EE=F + BE=F * CE=F + CE=F * DE=F * FE=F + GE=F * HE=F)

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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SF..... Split Fraction Logic.....

```
BALS      1

B1LF      B1=F + BAL=F + VT1B=F * VT1BR=F

B1LS      1

B2LF      B2=F + BAL=F + VT1B=F * VT1BR=F

B2LS      1

BBLF      BBLOSS + OG=F * -OGR1=S * (AE=F * BE=F + AE=F * DE=F + BE=F * EE=F
          + DE=F * EE=F + BE=F * CE=F + CE=F * DE=F * FE=F + GE=F * HE=F)

BBLS      1

B1U2LF    B1U2=F + BBL=F + VT2B=F * VT2BR=F

B1U2LS    1

B2U2LF    B2U2=F + BBL=F + VT2B=F * VT2BR=F

B2U2LS    1

          CLR1AA:= A1L=F + CE=F + GE=F

          CLR1BB:= B1L=F + DE=F + HE=F

          CLR2AA:= A1U2L=F + EE=F + GE=F

          CLR2BB:= B1U2L=F + FE=F + HE=F

V3F       (B3=F + PD=F)*(CLR1AA*CLR1BB*CLR2AA + CLR1AA*CLR1BB*CLR2BB
          + CLR1AA*CLR2AA*CLR2BB + CLR1BB*CLR2AA*CLR2BB)

V34       CLR1AA*CLR1BB*CLR2AA + CLR1AA*CLR1BB*CLR2BB +
          CLR1AA*CLR2AA*CLR2BB + CLR1BB*CLR2AA*CLR2BB

V37       (B3=F + PD=F)*(CLR1AA*CLR1BB + CLR1AA*CLR2BB +
          CLR1AA*CLR2AA + CLR1BB*CLR2AA + CLR1BB*CLR2BB + CLR2AA*CLR2BB)

V33       CLR1AA*CLR1BB + CLR1AA*CLR2BB + CLR1AA*CLR2AA +
          CLR1BB*CLR2AA + CLR1BB*CLR2BB + CLR2AA*CLR2BB

V36       (B3=F + PD=F)*(CLR1AA + CLR1BB + CLR2AA + CLR2BB)

V35       B3=F + PD=F

V32       CLR1AA + CLR1BB + CLR2AA + CLR2BB

V31       -(CLR1AA + CLR1BB + CLR2AA + CLR2BB + B3=F + PD=F)

          ACFAIL:= A1L=F * B1L=F + OG=F * DA=F * DB=F + HE=F + DE=F * MDE=S *
          (BAL=S + BBL=S) * CCSR=F + EE=F * (BAL=F * BBL=F + MDE=F) + DE=F *
          CCSR=F + CCSA
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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SF..... Split Fraction Logic.....

ACF	ACFAIL + CCSTL + V3=F
AC5	OG=F *BAL=F*BBL=F*(A1L=F + B1L=F + DA=F + DB=F)
AC4	BAL=F * BBL=F * (A1L=F + B1L=F)
AC10	OG=F * BAL=F * BBL=F
AC9	BAL=F*BBL=F
AC3	OG=F * (A1L=F + B1L=F + DA=F + DB=F)
AC2	A1L=F + B1L=F
AC8	OG=F
AC1	-(OG=F + BAL=F * BBL=F + A1L=F + B1L=F)
	Rule Comment ---------- LOSP AND PUMP B FAILS AND SUCCESSES. NOTE: SINCE PUMP A IS RUNNIN IT ALONE IS ASSOCIATED WITH LOSP.
	BCFAIL:= B2U2L=F + OG=F * (DD=F + GE=F) + OG=S * HE=F + CCSB
BCF	BCFAIL + CCSTL + V3=F
BC34	OG=F*ACFAIL
BC33	ACFAIL
BC25	OG=F*BAL=F*BBL=F*(A1L=F + B1L=F + DA=F + DB=F)*AC=F
BC5	OG=F*BAL=F*BBL=F*(A1L=F + B1L=F + DA=F + DB=F)
BC30	OG=F*BAL=F*BBL=F*AC=F
BC10	OG=F*BAL=F*BBL=F
BC23	OG=F*(A1L=F + B1L=F + DA=F + DB=F)*AC=F
BC3	OG=F*(A1L=F + B1L=F + DA=F + DB=F)
BC28	OG=F*AC=F
BC8	OG=F
BC24	BAL=F*BBL=F*(A1L=F + B1L=F)*AC=F
BC4	BAL=F*BBL=F*(A1L=F + B1L=F)
BC29	BAL=F*BBL=F*AC=F
BC9	BAL=F*BBL=F

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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SF..... Split Fraction Logic.....

BC22	(A1L=F + B1L=F)*AC=F
BC2	A1L=F + B1L=F
BC21	-(A1L=F + B1L=F + OG=F + BAL=F*BBL=F)*AC=F
BC1	-(A1L=F + B1L=F + OG=F + BAL=F*BBL=F)
CCSRS	DE=S * FE=S
CCSR3	DE=F * BAL=S * B1L=S * BBL=S * B1U2=S * EE=S * A2L=S
CCSRF	1
CCPRS	AC=S
CCPR1	AC=F * CE=S * -SI
CCPRF	1
PDF	PE=F + A3=F * (DB=F + B1L=F + A2L=F) + IMSIV + FLTB

Rule Comment

Failure of one compressor after LOSP or failure of more than two pumps for any other initiator

PD5	DB=F + A2L=F * B1L=F

Rule Comment

LOSP AND SUCCESSFUL RELOADING OF COMPRESSORS A & B. COMPRESSORS C DO NOT RESTART FOLLOWING LOSP.

PD4	B1L=F
PD3	A3=F
PD3	A2L=S * B1L=S * (A3=F + B3=F) * PE=S * OG=S
PD2	A2L=F
PD1	1
PEF	CE=F * DE=F

Rule Comment

Compressor A-A is supplied by ERCW header 1A and compressor B-B is supplied by ERCW header 1B.

PE2	CE=F + DE=F
PE1	1

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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SF..... Split Fraction Logic.....

PAF	(DAAC=F + PD=F) * (A1U2L=F + CE=F + GE=F)
PA3	A1U2L=F + CE=F * PD=S * DAAC=S + GE=F
PA2	(DAAC=F+ PD=F) * A1U2L=S * CE=S
PA1	DAAC=S * PD=S * A1U2L=S * CE=S
PBF	(DBAC=F + PD=F) * (B1U2L=F + FE=F + HE=F)
PB13	(FE=F + HE=F + B1U2L=F) * (CE=F + GE=F + A1U2L=F) * PA=F
PB12	(FE=F + HE=F + B1U2L=F) * (CE=F + GE=F + A1U2L=F)
PB11	(FE=F + HE=F + B1U2L=F) * DAAC=F
PB10	PD=F * DAAC=F
PB8	(FE=F + HE=F + B1U2L=F) * PA=F
PB7	FE=F + HE=F + B1U2L=F
PB6	(CE=F + GE=F + A1U2L=F) * PA=F
PB5	CE=F + GE=F + A1U2L=F
PB4	PD=F * PA=F
PB3	PD=F
PB9	DAAC=F
PB2	PA=F
PB1	1
RWF	FLAB3R
RW1	1
	Rule Comment ---------- THE RWST RECEIVES NO SUPPORT.
MUF	RW=F + (-SLOCAI * -SLOCAN) * (PD=F + DA=F + A1L=F + A1U2=F * B1U2=F (SLOCAI + SLOCAN) * (-CSASUP * -CSBSUP)
MU1	(SLOCAI + SLOCAN) * (CSASUP * -CSBSUP + -CSASUP * CSBSUP)
MU2	(SLOCAI + SLOCAN) * CSASUP * CSBSUP
MU3	SGTR * PD=S * DA=S * A1L=S * A1U2=S * B1U2=S * DAAC=S * DBAC=S * B1L=S

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MECH2

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SF..... Split Fraction Logic.....

MU4	PD=S * DA=S * A1L=S * A1U2=S * B1U2=S * DAAC=S * DBAC=S * B1L=S
MU7	SGTR * PD=S * DA=S * A1L=S * ((A1U2=F + B1U2=F) * (DAAC=F + DBAC=F + B1L=F))
MU5	SGTR * PD=S * DA=S * A1L=S * (A1U2=F + B1U2=F + DAAC=F + DBAC=F + B1L=F)
MU8	PD=S * DA=S * A1L=S * ((A1U2=F + B1U2=F) * (DAAC=F + DBAC=F + B1L=F))
MU6	PD=S * DA=S * A1L=S * (A1U2=F + B1U2=F + DAAC=F + DBAC=F + B1L=F)
CT1	1
CTMUF	OG=F
CTMU1	1

MODEL Name: WBNNEW
Event Tree: MEDLOC2

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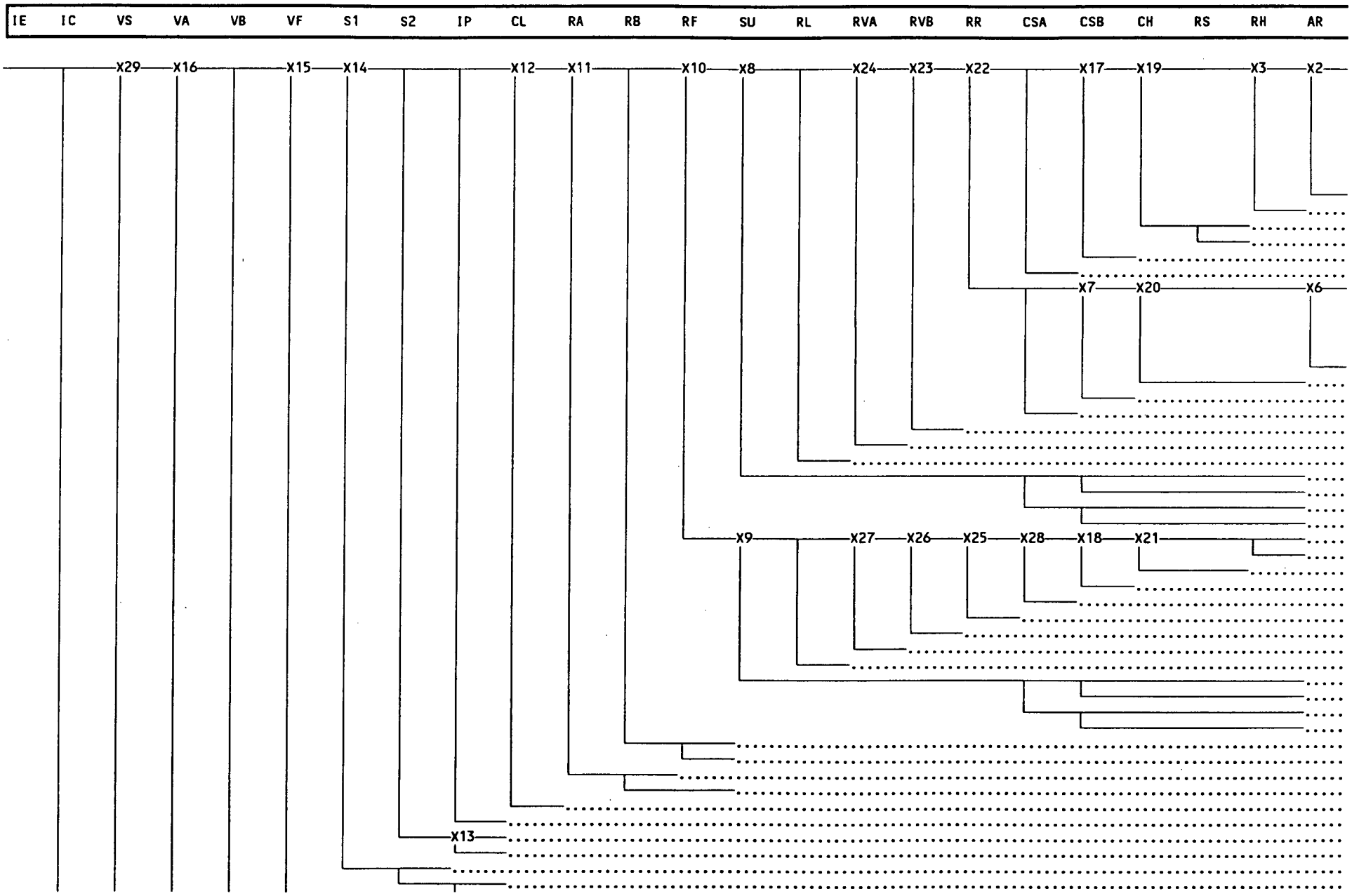

MODEL Name: WBNNEW
Event Tree: MEDLOC2

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IE	IC	VS	VA	VB	VF	S1	S2	IP	CL	RA	RB	RF	SU	RL	RVA	RVB	RR	CSA	CSB	CH	RS	RH	AR

MODEL Name: WBNNEW
Event Tree: MEDLOC2

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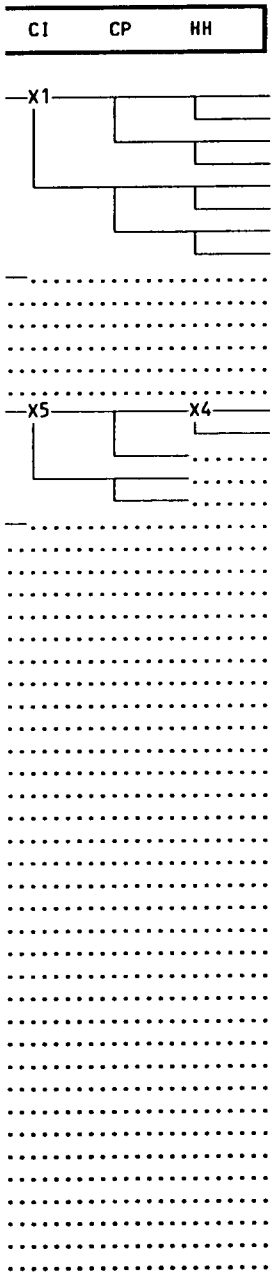

1		1
2		2
3		3
4		4
5		5
6		6
7		7
8		8
9	X1	9-16
10	X2	17-32
11	X3	33-64
12	X3	65-96
13	X19	97-192
14	X17	193-384
15		385
16		386
17	X4	387-388
18	X4	389-390
19	X4	391-392
20	X5	393-400
21	X6	401-416
22	X20	417-448
23	X7	449-512
24	X22	513-1024
25	X23	1025-2048
26	X24	2049-4096
27	X6	4097-4112
28	X6	4113-4128
29	X6	4129-4144
30	X6	4145-4160
31	X2	4161-4176
32	X2	4177-4192
33	X3	4193-4224
34	X21	4225-4288
35	X18	4289-4416
36	X28	4417-4672
37	X25	4673-5184
38	X26	5185-6208
39	X27	6209-8256
40	X6	8257-8272
41	X6	8273-8288
42	X6	8289-8304
43	X6	8305-8320
44	X8	8321-12480
45	X9	12481-16640
46	X10	16641-24960
47	X9	24961-29120
48	X11	29121-58240
49	X12	58241-116480
50	X12	116481-174720
51	X12	174721-232960
52	X13	232961-349440
53	X12	349441-407680

.....	54	X12	407681-465920
.....	55	X14	465921-931840

CI	CP	HH
.....	56	X15	931841-1863680
.....	57	X14	1863681-2329600
.....	58	X14	2329601-2795520
.....	59	X14	2795521-3261440
.....	60	X16	3261441-6522880
.....	61	X29	6522881-13045760

MODEL Name: WBNNEW

Top Event Legend for Tree: MEDLOC2

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Page 1

Top Event Designator.....	Top Event Description.....
IE	INITIATING EVENT
IC	FAILURE OF ICE CONDENSER
VS	FAILURE OF SUPPLY TO CVCS
VA	LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A
VB	LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B
VF	FAILURE OF 2/3 CVCS COLD LEG INJECTION PATHS
S1	LOSS OF SAFETY INJECTION PUMP 1A-A
S2	LOSS OF SAFETY INJECTION PUMP 1B-B
IP	FAILURE OF 2/3 SIS COLD LEG INJECTION PATHS
CL	FAILURE OF 2/3 COLD LEG ACCUMULATORS
RA	LOSS OF RHR PUMP 1A-A
RB	LOSS OF RHR PUMP 1B-B
RF	FAILURE OF 2/3 RHR COLD LEG INJECTION PATHS
SU	LOSS OF CONTAINMENT SUMP
RL	FAILURE OF SWAP SWAPOVER INSTRUMENTS
RVA	FAILURE OF SUMP SWAPOVER VALVE, 1-FCV-63-72
RVB	FAILURE OF SUMP SWAPOVER VALVE 1-FCV-63-73
RR	FAILURE OF AUTOMATIC/MANUAL SWAPOVER FROM THE RWST TO THE CONTAINMENT SUMP
CSA	LOSS OF TRAIN A CONTAINMENT SPRAY
CSB	LOSS OF TRAIN B CONTAINMENT SPRAY
CH	FAILURE OF CONTAINMENT SPRAY HEAT EXCHANGERS
RS	FAILURE OF RHR SPRAY
RH	FAILURE OF RHR & SIS HOT LEG RECIRCULATION
AR	FAILURE OF AIR RETURN FANS
CI	FAILURE OF CONTAINMENT ISOLATION
CP	CONTAINMENT PURGE FAILS TO CLOSE
HH	FAILURE OF HYDROGEN IGNITORS

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MEDLOC2

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Page 1

SF..... Split Fraction Logic.....

```
VASUC:= AAL=S * A1L=S * AC=S * CE=S * GE=S

VAFAI:= AAL=F + A1L=F + AC=F + CE=F + GE=F

VBSUC:= BAL=S * B1L=S * DB=S * BC=S * DE=S * HE=S * (ZB=S + OS=S)

VBFAI:= BAL=F + B1L=F + DB=F + BC=F + DE=F + HE=F + (ZB=F * OS=F)

S1SUC:= AAL=S * A1L=S * DA=S * CE=S * GE=S * AC=S * (ZA=S + OS=S)

S1FAI:= AAL=F + A1L=F + DA=F + CE=F + GE=F + AC=F + (ZA=F * OS=F)

S2SUC:= BAL=S * B1L=S * DB=S * DE=S * HE=S * BC=S * (ZB=S + OS=S)

S2FAI:= BAL=F + B1L=F + DB=F + DE=F + HE=F + BC=F + (ZB=F * OS=F)

RASUC:= AAL=S * A1L=S * DA=S * CE=S * GE=S * AC=S * (ZA=S + OS=S)

RAFAI:= AAL=F + A1L=F + DA=F + CE=F + GE=F + AC=F + (ZA=F * OS=F) +
FLAB2 + FLAB3C + FLAB3R

RBSUC:= BAL=S * B1L=S * DB=S * DE=S * HE=S * BC=S * (ZB=S + OS=S)

RBFAI:= BAL=F + B1L=F + DB=F + DE=F + HE=F + BC=F + (ZB=F * OS=F) +
FLAB2 + FLAB3C + FLAB3R

CSASUC:= AAL=S * A1L=S * DA=S * CE=S * GE=S * AC=S * (ZA=S + OS=S)

CSAFAI:= AAL=F + A1L=F + DA=F + CE=F + GE=F + AC=F + (ZA=F * OS=F)
+ FLAB2 + FLAB3C + FLAB3R

CSBSUC:= BAL=S * B1L=S * DB=S * BC=S * DE=S * HE=S * (ZB=S + OS=S)

CSBFAI:= BAL=F + B1L=F + DB=F + BC=F + DE=F + HE=F + (ZB=F * OS=F)
+ FLAB2 + FLAB3C + FLAB3R

RRTRAF:= RA=F + RVA=F + A2L=F + AC=F + (OG=F * (AAFAIL + ABFAIL))

RRTRBF:= RB=F + RVB=F + B2L=F + BC=F + (OG=F * (BAFAIL + BBFAIL))

CMLOCA:= (VS=F + VF=F) * IP=F + (VS=F + VF=F) * (S1=F + S2=F) +
IP=F * (VA=F + VB=F) + VA=F * VB=F * (S1=F + S2=F) + S1=F * S2=F *
(VA=F + VB=F)

RRLO:= CMLOCA + LLOCA + ELOCA

MSISOL:= MLOCA

MLCIB:= MLOCA

MLCIA:=  MLOCA

RRACT1:= ((DA=F * DB=S * DC=S * DD=S) + (DA=S * DB=F *
DC=S * DD=S) + (DA=S * DB=S * DC=F * DD=S) + (DA=S * DB=S
* DC=S * DD=F))
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MEDLOC2

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Page 2

SF..... Split Fraction Logic.....

```
          RRACT2:= ((DA=F * DB=F * DC=S * DD=S) + (DA=F * DB=S *
          DC=F * DD=S) + (DA=F * DB=S * DC=S * DD=F) + (DA=S * DB=F
          * DC=F * DD=S) + (DA=S * DB=F * DC=S * DD=F) + (DA=S * DB=S * DC=F

          ARSUPA:= A1L=S * DA=S * ZA=S

          ARSUPB:= B2L=S * DB=S * ZB=S

CP1       (ZA=S * ZB=S) + OS=S

CP3       ZA=F * ZB=F * OS=F

CP2       (ZA=F + ZB=F) * OS=F

CSA1      RW=S * CSASUC

CSAF      RW=F + CSAFAI

CSB1      CSA=S * CSBSUC

CSB2      CSA=F * CSASUC * RW=S * CSBSUC

CSB3      CSAFAI * RW=S * CSBSUC

CSBF      RW=F + CSBFAI

CH1       RR=S * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=S * DE=S * HE=S *
          B2L=S)

CH2       RR=S * (CSA=F + CE=F + GE=F + A2L=F) * (CSB=S * DE=S * HE=S *
          B2L=S)

CH3       RR=S * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=F + DE=F + HE=F +
          B2L=F)

CH4       RR=F * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=S * DE=S * HE=S *
          B2L=S)

CH5       RR=F * (CSA=F + CE=F + GE=F + A2L=F) * (CSB=S * DE=S * HE=S *
          B2L=S)

CH6       RR=F * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=F + DE=F + HE=F +
          B2L=F)

CHF       (CSA=F + A2L=F + CE=F + GE=F) * (CSB=F + B2L=F + DE=F + HE=F)

RVAF      A1L=F + -RL=S

RVA1      RL=S * A1L=S

RVBF      -RL=S + B1L=F

RVB1      RVA=S * B1L=S
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MEDLOC2

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Page 3

```
SF........ Split Fraction Logic.............................................

RVB2      RVA=F * A1L=S * RL=S * B1L=S

RVB3      A1L=F * RL=S * B1L=S

RLF       DAAC=F * DBAC=F * (DCAC=F + DDAC=F) + (DAAC=F + DBAC=F) * DCAC=F *
          DDAC=F

RL6       (DAAC=F + DBAC=F) * (DCAC=F + DDAC=F)

RL5       DAAC=F * DBAC=F * DCAC=S * DDAC=S

RL4       (DAAC=F + DBAC=F) *DCAC=S * DDAC=S

RL3       DCAC=F * DDAC=F

RL2       DCAC=F + DDAC=F

RL1       DAAC=S * DBAC=S * DCAC=S * DDAC=S

RRF       RL=F + A1L=F * (B1L=F + RRTRBF) + (RRTRAF * RRTRBF) +
          -RRLO * RRTRAF * B1L=F +
          -RRLO * (A1L=F + RRTRAF) * S1=F * S2=F +
          -RRLO * (B1L=F + RRTRBF) * VA=F * VB=F +
          -RRLO * S1=F * S2=F * VA=F * VB=F

RRA       RRTRAF * B1L=F

RR9       RRLO * A1L=F

RR8       RRLO * B1L=F

RR7       -RRLO * A1L=F

RR6       -RRLO * B1L=F

RR5       -RRLO * RRTRAF

RR4       -RRLO * RRTRBF

RR3       -RRLO * S1=F * S2=F

RR2       -RRLO * VA=F * VB=F

RR1       -RRLO

RRB       RRLO

RSF       -RR=S + (RA=F + RVA=F + A1L=F) + (RB=F + RVB=F + B1L=F) + (VA=F *
          VB=F) + (S1=F * S2=F)

RS2       (A1L=S * B1L=F) + (B1L=S * A1L=F)

RS1       RR=S * (RA=S * RVA=S * A1L=S) * (RB=S * RVB=S * B1L=S) * (VA=S +
          VB=S) * (S1=S + S2=S)
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MEDLOC2

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Page 4

SF..... Split Fraction Logic.....

CL1	IP=S
CL3	IP=F * RW=S * (S1=S + S2=S)
CL2	IP=F * (RW=F + S1=F * S2=F)
S2F	RW=F + S2FAI
S21	S1=S * S2SUC
S23	S1=F * S1SUC * RW=S * S2SUC
S22	S1FAI * RW=S * S2SUC
S1F	RW=F + S1FAI
S11	S1SUC * RW=S
VA1	VASUC * OG=S * VS=S
VA2	VS=S * VASUC * DA=S * OG=F * (ZA=S + OS=S)
VAF	VAFAI + VS=F + OG=F * ((ZA=F * OS=F) + DA=F)
VBF	VS=F + VBFAI + (ZB=F * OS=F)
VB1	OG=S * VA=S * VBSUC * (ZB=S + OS=S)
VB3	OG=S * VA=F * VASUC * VBSUC * (ZB=S + OS=S)
VB2	OG=S * VAFAI * VS=S * VBSUC * (ZB=S + OS=S)
VB4	OG=F * VA=S * VBSUC * (ZB=S + OS=S)
VB5	OG=F * (VAFAI + DA=F + ZA=F * OS=F) * VBSUC * (ZB=S + OS=S)
VB6	OG=F * VA=F * VASUC * DA=S * (ZA=S + OS=S) * VBSUC * (ZB=S + OS=S)
VSF	MLOCA * ((A1L=F + OS=F * ZA=F) * (B1L=F + OS=F * ZB=F) + RW=F)
VS1	MLOCA * A1L=S * B1L=S * (ZA=S * ZB=S + OS=S)
VS2	MLOCA * ((A1L=F + OS=F * ZA=F) * (B1L=S * (ZB=S + OS=S)) + (B1L=F + OS=F * ZB=F) * (A1L=S * (ZA=S + OS=S)))
VFF	(A1L=F + OS=F * ZA=F) * (B1L=F + OS=F * ZB=F)
VF1	A1L=S * B1L=S * OS=S + (ZA=S * ZB=S)
VF2	(A1L=F + OS=F * ZA=F) * (B1L=S * (ZB=S + OS=S)) + (B1L=F + OS=F * ZB=F) * (A1L=S * (ZA=S + OS=S))
AR1	ARSUPA * ARSUPB
ARF	-ARSUPA * -ARSUPB

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MEDLOC2

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Page 5

SF..... Split Fraction Logic.....

AR2	ARSUPA + ARSUPB
HH1	A1L=S * B1L=S
HH2	A1L=S * B1L=F + A1L=F * B1L=S
HHF	A1L=F * B1L=F
CI1	(-SBO * -U1BO * A1L=S * B1L=S) * (OS=S + ZA=S * ZB=S)
CIF	OS=F * ZA=F * ZB=F + -SBO * -U1BO * A1L=F * B1L=F
CI2	(-SBO * -U1BO * A1L=S * B1L=S) * OS=F * (ZA=S * ZB=F + ZA=F * ZB=S)
CI5	(SBO + U1BO) * OS=F * (ZA=S * ZB=F + ZA=F * ZB=S)
CI3	-SBO * -U1BO * (A1L=F * B1L=S + A1L=S * B1L=F)
CI4	(SBO + U1BO) * (OS=S + ZA=S * ZB=S)
SU1	1
IC1	1
RAF	RAFAI + RW=F
RA1	RASUC
RBF	RW=F + RBFAI
RB1	RA=S * RBSUC
RB3	RA=F * RASUC * RW=S * RBSUC
RB2	RAFAI * RW=S * RBSUC
RH1	RA=S * RB=S * A1L=S * B1L=S
RH2	B1L=S * RB=S * RVB=S * (A1L=F + RA=F + RVA=F) + (RB=F + RVB=F + B1L=F) * RA=S * A1L=S * RVA=S
RHF	(B1L=F + RB=F + RVB=F) * (A1L=F + RA=F + RVA=F)
RFF	RA=F * RB=F
RF1	IP=S * CL=S * (RB=S + RA=S)
RF2	IP=S * CL=S * RB=F
RF3	IP=S * CL=F * (RA=S + RB=S)
RF4	IP=S * CL=F * RB=F
RF5	IP=F * S1=F * S2=F * CL=S * (RA=S + RB=S)

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MEDLOC2

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Page 6

SF..... Split Fraction Logic.....

RF6	IP=F * S1=F * S2=F * CL=S * RB=F
RF7	IP=F * S1=F * S2=F * CL=F * (RA=S + RB=S)
RF8	IP=F * S1=F * S2=F * CL=F * RB=F
RF9	IP=F * (S1=S + S2=S) * CL=S * (RA=S + RB=S)
RFA	IP=F * (S1=S + S2=S) * CL=S * RB=F
RFB	IP=F * (S1=S + S2=S) * CL=F * (RA=S + RB=S)
RFC	IP=F * (S1=S + S2=S) * CL=F * RB=F
IPF	(S1=F * S2=F)
IP1	(S1=S + S2=S)

MODEL Name: WBNNEW
Event Tree: MLBINS

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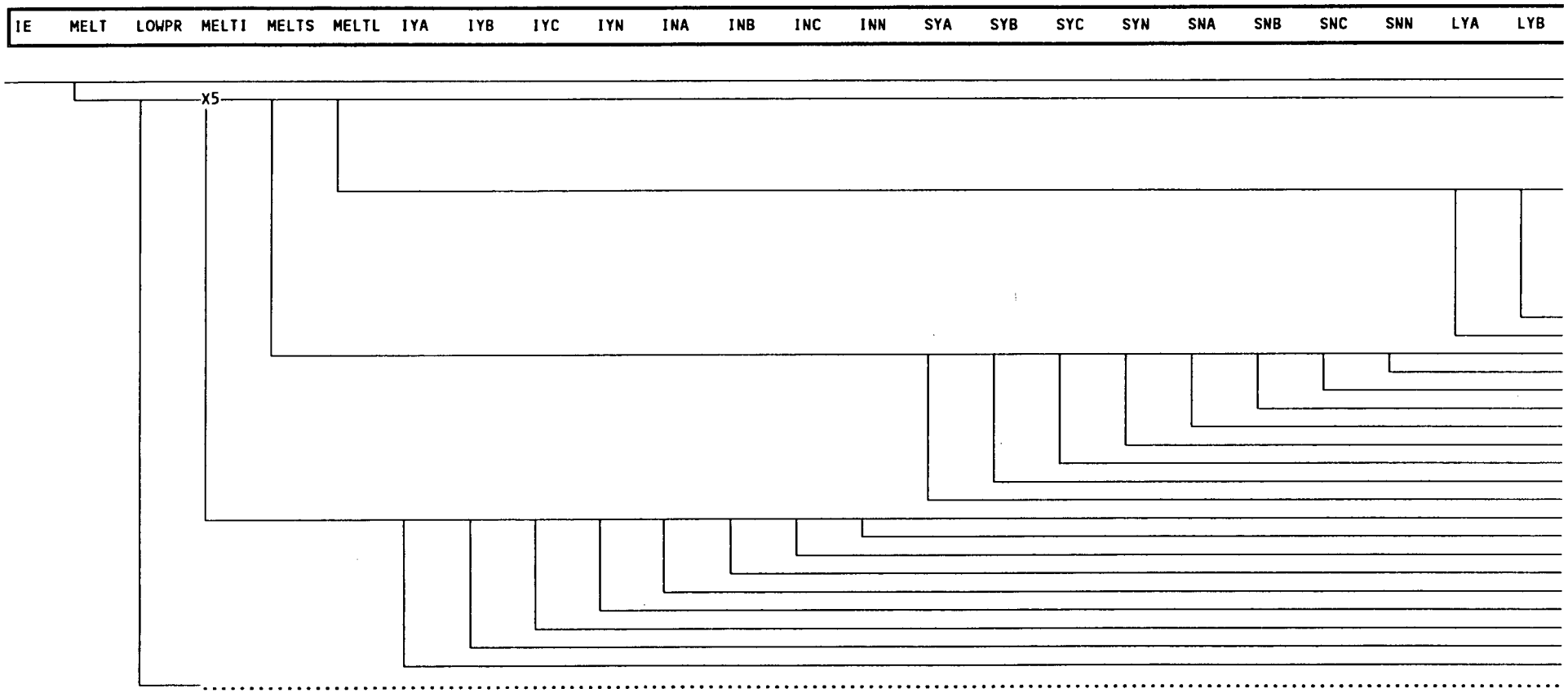

MODEL Name: WBNNEW
Event Tree: MLBINS

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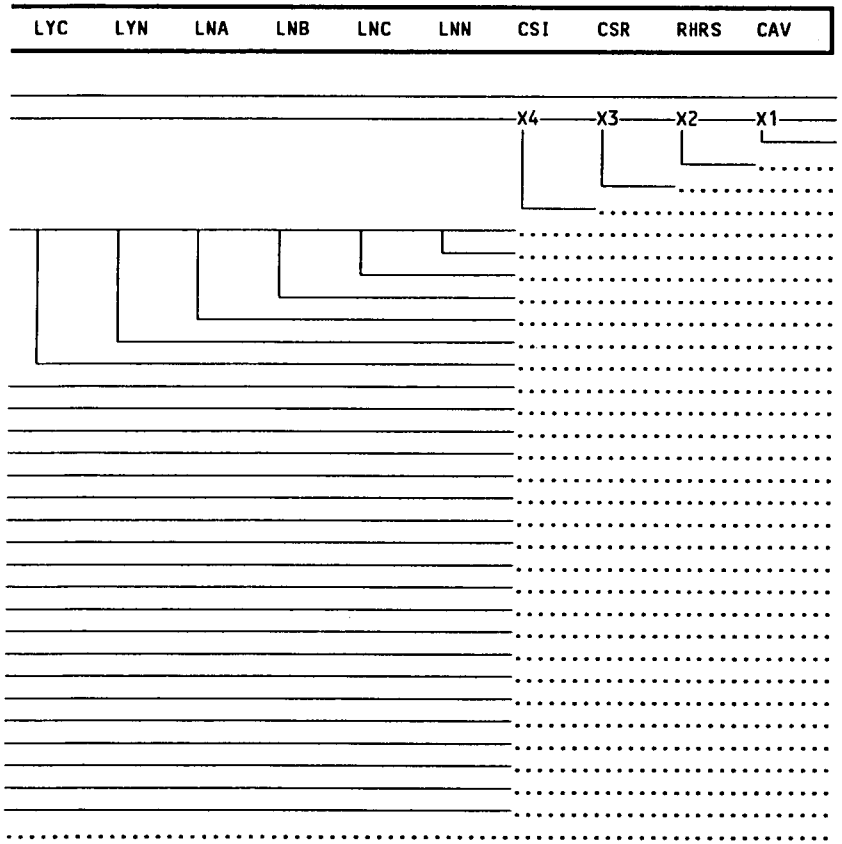

1		1
2		2
3		3
4	X1	4-5
5	X2	6-9
6	X3	10-17
7	X4	18-33
8	X4	34-49
9	X4	50-65
10	X4	66-81
11	X4	82-97
12	X4	98-113
13	X4	114-129
14	X4	130-145
15	X4	146-161
16	X4	162-177
17	X4	178-193
18	X4	194-209
19	X4	210-225
20	X4	226-241
21	X4	242-257
22	X4	258-273
23	X4	274-289
24	X4	290-305
25	X4	306-321
26	X4	322-337
27	X4	338-353
28	X4	354-369
29	X4	370-385
30	X4	386-401
31	X4	402-417
32	X4	418-433
33	X4	434-449
34	X5	450-897

MODEL Name: WBNNEW

Top Event Legend for Tree: MLBINS

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Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
MELT	NO CORE MELT FOR MEDIUM LOCA
LOWPR	NO INJECTION FOR MLOCA (200-400 PSI)
MELTI	MELT WITH SUCCESSFUL CONTAINMENT ISOLATION
MELTS	MELT WITH CI FAILURE AND CONT. PURGE SUCCESS
MELTL	MELT WITH CONT. PURGE FAILURE
IYA	MELT * CI=S * CP=S * IC=S * AR=S * HH=S
IYB	
IYC	
IYN	
INA	
INB	
INC	
INN	
SYA	
SYB	
SYC	
SYN	
SNA	
SNB	
SNC	
SNN	
LYA	
LYB	
LYC	
LYN	
LNA	
LNB	

MODEL Name: WBNNEW

Top Event Legend for Tree: MLBINS

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Page 2

Top Event Designator.....	Top Event Description.....
LNC	
LNN	
CSI	FAILURE OF CONTAINMENT SPRAY INJECTION
CSR	FAILURE OF CONTAINMENT SPRAY RECIRCULATION
RHRS	FAILURE OF RHR SPRAY RECIRCULATION
CAV	WATER IN REACTOR CAVITY

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MLBINS

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Page 1

```
SF........ Split Fraction Logic.............................................

MELTF      REC=F * (CL=F + (RA=F + RVA=F) * (RB=F + RVB=F) +-RF=S + RL=F +
           RR=F + SU=F + (VA=F * VB=F +-VF=S) * (S1=F +S2=F) + (VA=F + VB=F) *
           (S1=F * S2=F + -IP=S))

           MELT:= MELT=F

MELTS      1

LOWPRS     (VA=F * VB=F + -VF=S) * (S1=F +S2=F) + (VA=F + VB=F) * (S1=F * S2=F
           (RA=F * RB=F + -RF=S)

LOWPRF     1

           LOWPR:= LOWPR=F

MELTIF     MELT * CI=S * CP=S

           MELTI:= MELTI=F

MELTIS     1

MELTSF     MELT * CI=F * CP=S

           MELTS:= MELTS=F

MELTSS     1

MELTLF     MELT * CP=F

           MELTL:= MELTL=F

MELTLS     1

IYAF       MELTI * IC=S * AR=S * HH=S

IYAS       1

IYBF       MELTI * IC=S * AR=S * HH=F

IYBS       1

IYCF       MELTI * IC=S * AR=F * HH=S

IYCS       1

IYNF       MELTI * IC=S * AR=F * HH=F

IYNS       1

SYAF       MELTS * IC=S * AR=S * HH=S

SYAS       1

SYBF       MELTS * IC=S * AR=S * HH=F
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MLBINS

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Page 2

SF..... Split Fraction Logic.....

SYBS	1
SYCF	MELTS * IC=S * AR=F * HH=S
SYCS	1
SYNF	MELTS * IC=S * AR=F * HH=F
SYNS	1
LYAF	MELTL * IC=S * AR=S * HH=S
LYAS	1
LYBF	MELTL * IC=S * AR=S * HH=F
LYBS	1
LYCF	MELTL * IC=S * AR=F * HH=S
LYCS	1
LYNF	MELTL * IC=S * AR=F * HH=F
LYNS	1
INAF	MELTI * IC=F * AR=S * HH=S
INAS	1
INBF	MELTI * IC=F * AR=S * HH=F
INBS	1
INCF	MELTI * IC=F * AR=F * HH=S
INCS	1
INNF	MELTI * IC=F * AR=F * HH=F
INNS	1
SNAF	MELTS * IC=F * AR=S * HH=S
SNAS	1
SNBF	MELTS * IC=F * AR=S * HH=F
SNBS	1
SNCF	MELTS * IC=F * AR=F * HH=S
SNCS	1
SNNF	MELTS * IC=F * AR=F * HH=F

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MLBINS

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Page 3

SF..... Split Fraction Logic.....

```
SNNS      1

LNAF      MELTL * IC=F * AR=S * HH=S

LNAS      1

LNBF      MELTL * IC=F * AR=S * HH=F

LNBS      1

LNCF      MELTL * IC=F * AR=F * HH=S

LNCS      1

LNNF      MELTL * IC=F * AR=F * HH=F

LNNS      1

CSIS      CSA=S + CSB=S

CSIF      1

          XCSI:= CSI=F

CSRS      (CSA=S + CSB=S) * CH=S

CSRF      1

          XCSR:=CSR=F

RHRSS     RA=S * RVA=S * RB=S * RVB=S * RR=S * RF=S * RS=S

RHRSF     1

          XRHRS:= RHRS=F

CAVS      IC=S * ((S1=S + S2=S) * IP=S + (RA=S + RB=S) * RF=S + CSA=S +
          CSB=S) * SU=S

CAVF      1

          XCAV:= CAV=F

          IYA:= IYA=F

          IYB:= IYB=F

          IYC:= IYC=F

          IYN:= IYN=F

          SYA:= SYA=F

          SYB:= SYB=F
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: MLBINS

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Page 4

SF..... Split Fraction Logic.....

```
SYC:= SYC=F
SYN:= SYN=F
LYA:= LYA=F
LYB:= LYB=F
LYC:= LYC=F
LYN:= LYN=F
INA:= INA=F
INB:= INB=F
INC:= INC=F
INN:= INN=F
SNA:= SNA=F
SNB:= SNB=F
SNC:= SNC=F
SNN:= SNN=F
LNA:= LNA=F
LNB:= LNB=F
LNC:= LNC=F
LNN:= LNN=F
CSI:= CSI=S
CSR:= CSR=S
RHRS:= RHRS=S
CAV:= CAV=S
```

MODEL Name: WBNNEW

Binning Logic for Event Tree: MLBINS

16:42:27 03 AUG 1992
Page 1

Bin.....	Binning Rules.....
CCI	-LOWPR*MELTI*XCAV*CSR
DCI	-LOWPR*MELTI*CAV*CSR
CEI	-LOWPR*MELTI*XCAV*CSI*RHRS*XCSR
DEI	-LOWPR*MELTI*CAV*CSI*RHRS*XCSR
CGI	-LOWPR*MELTI*XCAV*CSI*XCSR*XRHRS
DGI	-LOWPR*MELTI*CAV*CSI*XCSR*XRHRS
CII	-LOWPR*MELTI*XCAV*XCSI*XCSR*RHRS
DII	-LOWPR*MELTI*CAV*XCSI*XCSR*RHRS
CNI	-LOWPR*MELTI*XCAV*XCSI*XCSR*XRHRS
DNI	-LOWPR*MELTI*CAV*XCSI*XCSR*XRHRS
CCS	-LOWPR*MELTS*XCAV*CSR
DCS	-LOWPR*MELTS*CAV*CSR
CES	-LOWPR*MELTS*XCAV*CSI*XCSR*RHRS
DES	-LOWPR*MELTS*CAV*CSI*XCSR*RHRS
CGS	-LOWPR*MELTS*XCAV*CSI*XCSR*XRHRS
DGS	-LOWPR*MELTS*CAV*CSI*XCSR*XRHRS
CIS	-LOWPR*MELTS*XCAV*XCSI*XCSR*RHRS
DIS	-LOWPR*MELTS*CAV*XCSI*XCSR*RHRS
CNS	-LOWPR*MELTS*XCAV*XCSI*XCSR*XRHRS
DNS	-LOWPR*MELTS*CAV*XCSI*XCSR*XRHRS
CPL	-LOWPR*MELTL*XCAV*CSR
DPL	-LOWPR*MELTL*CAV*CSR
CQL	-LOWPR*MELTL*XCAV*CSI*XCSR*RHRS
DQL	-LOWPR*MELTL*CAV*CSI*XCSR*RHRS
CRL	-LOWPR*MELTL*XCAV*CSI*XCSR*XRHRS
DRL	-LOWPR*MELTL*CAV*CSI*XCSR*XRHRS
CSL	-LOWPR*MELTL*XCAV*XCSI*XCSR*RHRS
DSL	-LOWPR*MELTL*CAV*XCSI*XCSR*RHRS
CTL	-LOWPR*MELTL*XCAV*XCSI*XCSR*XRHRS
DTL	-LOWPR*MELTL*CAV*XCSI*XCSR*XRHRS
ACI	LOWPR*MELTI*XCAV*CSI*CSR
BCI	LOWPR*MELTI*CAV*CSI*CSR
AEI	LOWPR*MELTI*XCAV*CSI*XCSR*RHRS

BEI	LOWPR*MELTI*CAV*CSI*XCSR*RHRS
AGI	LOWPR*MELTI*XCAV*CSI*XCSR*XRHRS
BGI	LOWPR*MELTI*CAV*CSI*XCSR*XRHRS
AII	LOWPR*MELTI*XCAV*XCSI*XCSR*RHRS
BII	LOWPR*MELTI*CAV*XCSI*XCSR*RHRS

MODEL Name: WBNNEW

Binning Logic for Event Tree: MLBINS

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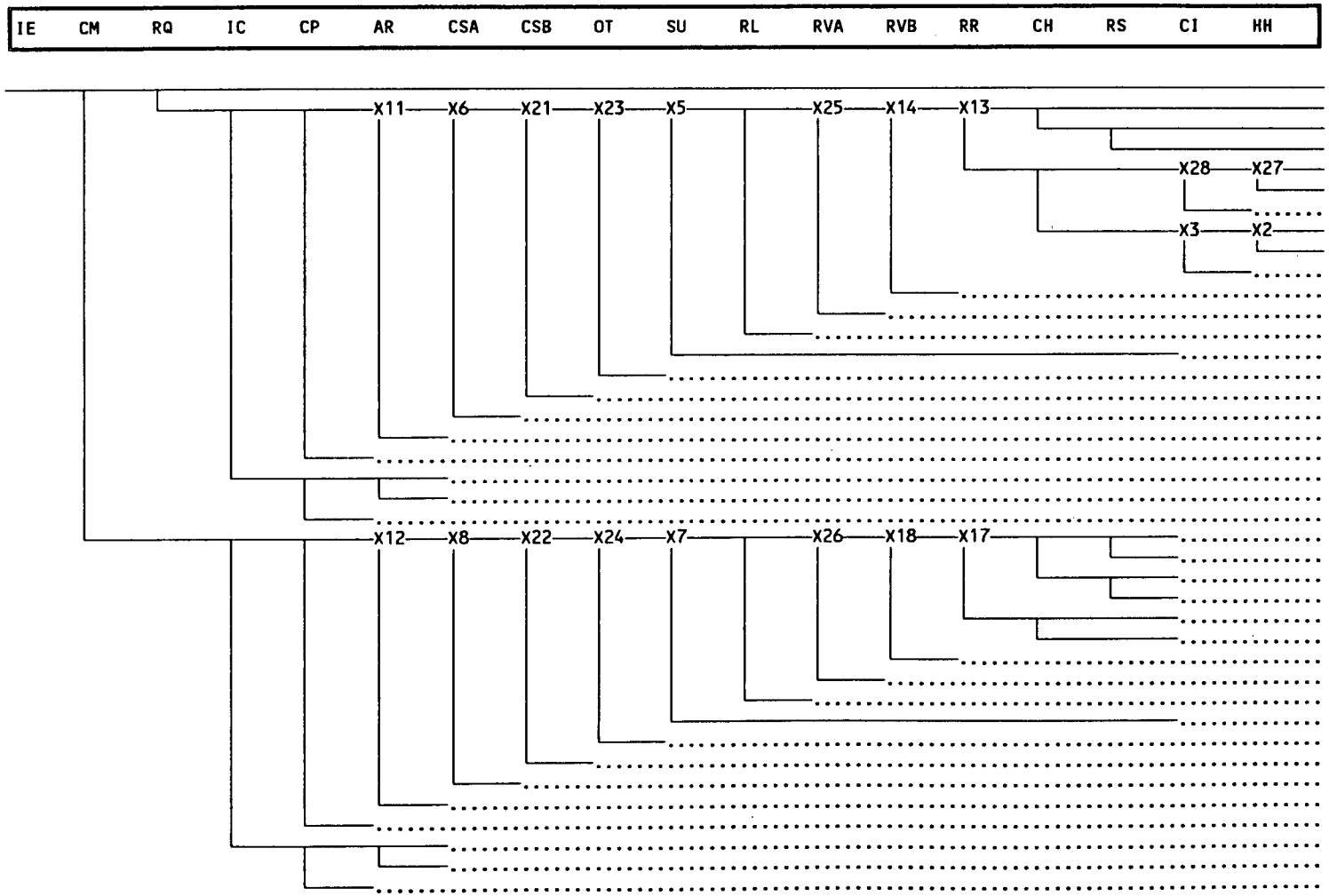
Page 2

Bin.....	Binning Rules.....
ANI	LOWPR*MELTI*XCAV*XCSI*XCSR*XRHRS
BNI	LOWPR*MELTI*CAV*XCSI*XCSR*XRHRS
ACS	LOWPR*MELTS*XCAV*CSI*CSR
BCS	LOWPR*MELTS*CAV*CSI*CSR
AES	LOWPR*MELTS*XCAV*CSI*XCSR*RHRS
BES	LOWPR*MELTS*CAV*CSI*XCSR*RHRS
AGS	LOWPR*MELTS*XCAV*CSI*XCSR*XRHRS
BGS	LOWPR*MELTS*CAV*CSI*XCSR*XRHRS
AIS	LOWPR*MELTS*XCAV*XCSI*XCSR*RHRS
BIS	LOWPR*MELTS*CAV*XCSI*XCSR*RHRS
ANS	LOWPR*MELTS*XCAV*XCSI*XCSR*XRHRS
BNS	LOWPR*MELTS*CAV*XCSI*XCSR*XRHRS
APL	LOWPR*MELTL*XCAV*CSI*CSR
BPL	LOWPR*MELTL*CAV*CSI*CSR
AQL	LOWPR*MELTL*XCAV*CSI*XCSR*RHRS
BQL	LOWPR*MELTL*CAV*CSI*XCSR*RHRS
ARL	LOWPR*MELTL*XCAV*CSI*XCSR*XRHRS
BRL	LOWPR*MELTL*CAV*CSI*XCSR*XRHRS
ASL	LOWPR*MELTL*XCAV*XCSI*XCSR*RHRS
BSL	LOWPR*MELTL*CAV*XCSI*XCSR*RHRS
ATL	LOWPR*MELTL*XCAV*XCSI*XCSR*XRHRS
BTL	LOWPR*MELTL*CAV*XCSI*XCSR*XRHRS
MELT	MELT
SUCCESS	1

MODEL Name: WBNNEW
Event Tree: RECIR2

14:14:47 03 AUG 1992



1		1
2		2
3		3
4		4
5		5
6		6
7	X27	7-8
8		9
9		10
10	X2	11-12
11	X13	13-23
12	X14	24-45
13	X25	46-89
14	X3	90-93
15	X5	94-185
16	X23	186-369
17	X21	370-737
18	X6	738-1473
19	X11	1474-2945
20	X6	2946-3681
21	X6	3682-4417
22	X11	4418-5889
23	X3	5890-5893
24	X3	5894-5897
25	X3	5898-5901
26	X3	5902-5905
27	X28	5906-5909
28	X3	5910-5913
29	X17	5914-5937
30	X18	5938-5985
31	X26	5986-6081
32	X3	6082-6085
33	X7	6086-6281
34	X24	6282-6673
35	X22	6674-7457
36	X8	7458-9025
37	X12	9026-12161
38	X8	12162-13729
39	X8	13730-15297
40	X12	15298-18433

MODEL Name: WBNNEW

Top Event Legend for Tree: RECIR2

14:14:53 03 AUG 1992
Page 1

Top Event Designator.....	Top Event Description.....
IE	INITIATING EVENT
CM	CORE IS MELTED DURING INJECTION MODE
RQ	SUMP RECIRCULATION IS REQUIRED
IC	FAILURE OF ICE CONDENSER
CP	FAILURE OF CONTAINMENT PURGE ISOLATION
AR	FAILURE OF AIR RETURN FANS
CSA	FAILURE OF TRAIN A CONTAINMENT SPRAY
CSB	FAILURE OF TRAIN B CONTAINMENT SPRAY
OT	OPERATOR FAILS TO CONTROL CONTAINMENT SPRAY
SU	CONTAINMENT SUMP IS UNAVAILABLE
RL	FAILURE OF LEVEL CONTROL SWITCHES FOR RHR SWAPOVER
RVA	FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72
RVB	FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73
RR	FAILURE OF AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI & CVCS PUMPS
CH	FAILURE OF CONTAINMENT SPRAY HEAT EXCHANGERS
RS	LOSS OF RHR SPRAY
CI	FAILURE OF CONTAINMENT ISOLATION
HH	FAILURE OF HYDROGEN IGNITORS

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: RECIR2

14:40:02 03 AUG 1992
Page 1

```
SF........ Split Fraction Logic.............................................

          CSASUC:= AAL=S * A1L=S * DA=S * CE=S * GE=S * AC=S * (ZA=S + OS=S)

          CSAFAI:= AAL=F + A1L=F + DA=F + CE=F + GE=F + AC=F + (ZA=F * OS=F)
          + FLAB3R + FLAB3C + FLAB2

          CSBSUC:= BAL=S * B1L=S * DB=S * BC=S * DE=S * HE=S * (ZB=S + OS=S)

          CSBFAI:= BAL=F + B1L=F + DB=F + BC=F + DE=F + HE=F + (ZB=F * OS=F)
          + FLAB3R + FLAB3C + FLAB2

          SGCOOL:= (AF=S * (MA=S + MB=S + TP=S + TPR=S) + OF=S * MF=S * CD=S)
          + RT=F * FW=S

          RRTRAF:= RA=F + RVA=F + A2L=F + AC=F + (OG=F * (AAFAIL + ABFAIL))

          RRTRBF:= RB=F + RVB=F + B2L=F + BC=F + (OG=F * (BAFAIL + BBFAIL))

          RRLO:= CM=F + INIT=LLOCA + INIT = ELOCA

          RRTRS:= -(RRTRAF + RRTRBF)

          MUUSE:= INIT=SGTR * (SL=F * DP=S) * (VA=S + VB=S) * -(PR=F + SE=F +
          PI=F)

          ARSUPA:= A1L=S * DA=S * ZA=S

          ARSUPB:= B2L=S * DB=S * ZB=S

          DRYSUMP:= -(PR=F + SE=F + OB=S + PI=F + IECIB + SR=F) *
          (SL=F + SGTR + DP=F) * (VC=S + SI=S)

          RRFAIL:= RL=F + A1L=F *  (B1L=F + RRTRBF) + (RRTRAF * RRTRBF) +
          -RRLO * RRTRAF * B1L=F +
          -RRLO * (A1L=F + RRTRAF) * S1=F * S2=F +
          -RRLO * (B1L=F + RRTRBF) * VA=F * VB=F +
          -RRLO * S1=F * S2=F * VA=F * VB=F

RQF       (PR=F + PI=F + SE=F) +
          -SGCOOL + RT=F * EB=F

RQS       1

CMS       -((PR=F + PI=F + SE=F + (ITR + SGTR) * (SL=F + DP=F * DS=F)) *
          ((RW=F + -VC=S * -SI=S) + (SGTR + ITR) * -SE=F * -PR=F * -PI=F * (-
          -SGCOOL * OB=F + RT=F * (SR=F + EB=F + (TT=F + AM=F) *
          FW=F * PL=F))

CMF       1

RLF       DAAC=F * DBAC=F * (DCAC=F + DDAC=F) + (DAAC=F + DBAC=F) * DCAC=F *
          DDAC=F

RL6       (DAAC=F + DBAC=F) * (DCAC=F + DDAC=F)

RL5       DAAC=F * DBAC=F * DCAC=S * DDAC=S
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: RECIR2

14:40:06 03 AUG 1992
Page 2

SF..... Split Fraction Logic.....

```
RL4      (DAAC=F + DBAC=F) * DCAC=S * DDAC=S

RL3      DCAC=F * DDAC=F

RL2      DCAC=F + DDAC=F

RL1      DAAC=S * DBAC=S * DCAC=S * DDAC=S

RVAF     A1L=F + -RL=S

RVA1     RL=S * A1L=S

RVBF     -RL=S + B1L=F

RVB1     RVA=S * B1L=S

RVB2     RVA=F * A1L=S * RL=S *B1L=S

RVB3     A1L=F * RL=S * B1L=S

RRF      RL=F + A1L=F *  (B1L=F + RRTRBF) + (RRTRAF * RRTRBF) +
         -RRLO * RRTRAF * B1L=F +
         -RRLO * (A1L=F + RRTRAF) * S1=F * S2=F +
         -RRLO * (B1L=F + RRTRBF) * VA=F * VB=F +
         -RRLO * S1=F * S2=F * VA=F * VB=F

RRA      RRTRAF * B1L=F

RR9      RRLO * A1L=F

RR8      RRLO * B1L=F

RR7      -RRLO * A1L=F

RR6      -RRLO * B1L=F

RR5      -RRLO * RRTRAF

RR4      -RRLO * RRTRBF

RR3      -RRLO * S1=F * S2=F

RR2      -RRLO * VA=F * VB=F

RR1      -RRLO

RRB      RRLO

RSF      -RR=S + (RA=F + RVA=F + A1L=F) + (RB=F + RVB=F + B1L=F) + (VA=F *
         VB=F + VC=F) + (S1=F * S2=F + SI=F)

RS2      (A1L=F * B1L=S) + (B1L=F * A1L=S)

RS1      RR=S * (RA=S * RVA=S * A1L=S) * (RB=S * RVB=S * B1L=S) * (VA=S +
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: RECIR2

14:40:11 03 AUG 1992
Page 3

```
SF........ Split Fraction Logic.............................................

          VB=S) * VC=S * (S1=S + S2=S) * SI=S

IC1       1

CP1       OS=S + (ZA=S * ZB=S)

CP3       OS=F * ZA=F * ZB=F

CP2       (ZA=F + ZB=F) * OS=F

AR1       ARSUPA * ARSUPB

ARF       -ARSUPA * -ARSUPB

AR2       -ARSUPA + -ARSUPB

CSAF      RW=F + CSAFAI + DRYSUMP

CSA1      RW=S * CSASUC

CSBF      RW=F + CSBFAI + DRYSUMP

CSB1      CSA=S * CSBSUC

CSB2      CSA=F * CSASUC * RW=S * CSBSUC

CSB3      CSAFAI * RW=S * CSBSUC

OTS       CSA=F * CSB=F

OT1       CM=S * (IECIB + PR=F + PI=F + SE=F + SR=S)

OTF       1

SU2       CM=S

SU3       CM=F

CHF       (CSA=F + A2L=F + CE=F + GE=F + (OG=F * (AAFAIL + ABFAIL))) * (CSB=F
          + B2L=F + DE=F + HE=F + (OG=F * (BAFAIL + BBFAIL)))

CH1       RR=S * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=S * DE=S * HE=S *
          B2L=S)

CH2       RR=S * (CSA=F + CE=F + GE=F + A2L=F) * (CSB=S * DE=S * HE=S *
          B2L=S)

CH3       RR=S * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=F + DE=F + HE=F +
          B2L=F)

CH4       RR=F * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=S * DE=S * HE=S *
          B2L=S)

CH5       RR=F * (CSA=F + CE=F + GE=F + A2L=F) * (CSB=S * DE=S * HE=S *
          B2L=S)
```

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: RECIR2

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Page 4

SF..... Split Fraction Logic.....

CH6	RR=F * (CSA=S * CE=S * GE=S * A2L=S) * (CSB=F + DE=F + HE=F + B2L=F)
CHF	(CSA=F + A2L=F + CE=F + GE=F) * (CSB=F + B2L=F + DE=F + HE=F)
CI1	(-SBO * -U1BO * A1L=S * B1L=S) * (OS=S + ZA=S * ZB=S)
CIF	OS=F * ZA=F * ZB=F + -SBO * -U1BO * A1L=F * B1L=F
CI2	(-SBO * -U1BO * A1L=S * B1L=S) * OS=F * (ZA=F * ZB=S + ZA=S * ZB=F)
CI5	(SBO + U1BO) * OS=F * (ZA=S * ZB=F + ZA=F * ZB=S)
CI3	-SBO * -U1BO * (A1L=F * B1L=S + A1L=S * B1L=F)
CI4	(SBO + U1BO) * (OS=S + ZA=S * ZB=S)
HH1	A1L=S * B1L=S
HHF	A1L=F * B1L=F
HH2	(A1L=F + B1L=F)

MODEL Name: WBNNEW

Binning Logic for Event Tree: RECIR2

16:42:46 03 AUG 1992
Page 1

Bin..... Binning Rules.....

EBTRAP EB=F

NOEB 1

MODEL Name: WBNNEW

Page No. 1

Event Tree: RECL

14:15:01 03 AUG 1992

IE	REC

1
2

1
2

MODEL Name: WBNNEW

Top Event Legend for Tree: RECL

14:15:05 03 AUG 1992
Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
REC	FAILURE TO RECOVER FAILED SEQUENCES (LLOCA + MLOCA + ELOCA)

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: RECL

14:40:27 03 AUG 1992
Page 1

SF..... Split Fraction Logic.....

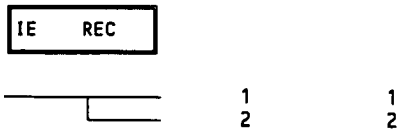
RECF 1

MODEL Name: WBNNEW

Page No. 1

Event Tree: RECOVERY

14:15:12 03 AUG 1992



MODEL Name: WBNNEW

Top Event Legend for Tree: RECOVERY

14:15:15 03 AUG 1992
Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
REC	FAILURE TO RECOVER POWER BEFORE CORE DAMAGE

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: RECOVERY

14:40:36 03 AUG 1992
Page 1

```
SF........ Split Fraction Logic.............................................

REC1      OG=F * OGR1=F * (GA=F * GB=F * GC=S * GD=S + GA=S * GB=S * GC=F *
          GD=F) * AF=S

REC4      OG=F * OGR1=F * (GA=F * GB=S + GA=S * GB=F) * (GC=F * GD=S + GC=S *
          GD=F) * AF=S

REC2      OG=F * OGR1=F * (GA=F * GB=F * (GC=F * GD=S + GC=S * GD=F) + GA=F *
          GB=S * GC=F * GD=F + GA=S * GB=F * GC=F * GD=F) * AF=S

REC3      OG=F * OGR1=F * (GA=F * GB=F * GC=S * GD=S + GA=S * GB=S * GC=F *
          GD=F) * -AF=S

REC5      OG=F * OGR1=F * GA=F * GB=F * GC=F * GD=F * AF=S

REC6      OG=F * OGR1=F * GA=F * GB=F * GC=F * GD=F * -AF=S

REC4      OG=F * OGR1=F * AF=S * ((GA=F * GB=S * GC=S * GD=S) +
          (GA=S * GB=F * GC=S * GD=S) +
          (GA=S * GB=S * GC=F * GD=S) +
          (GA=S * GB=S * GC=S * GD=F))

REC3      OG=F * OGR1=F * (GA=F * GB=S + GA=S * GB=F) * (GC=F * GD=S + GC=S *
          GD=F) * -AF=S

REC3      OG=F * OGR1=F * (GA=F * GB=F * (GC=F * GD=S + GC=S * GD=F) + GA=F *
          GB=S * GC=F * GD=F + GA=S * GB=F * GC=F * GD=F) * -AF=S

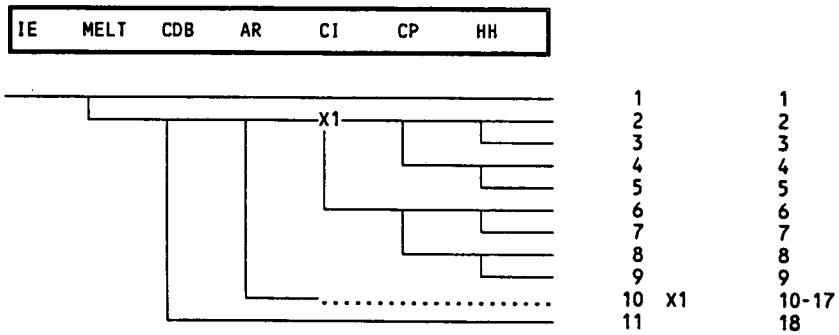
RECF      1
```

MODEL Name: WBNNEW

Page No. 1

Event Tree: VIBIN

14:15:22 03 AUG 1992



MODEL Name: WBNNEW

Top Event Legend for Tree: VIBIN

14:15:26 03 AUG 1992
Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
MELT	NO CORE DAMAGE
CDB	CONTAINMENT BYPASS - V SEQUENCE
AR	FAILURE OF CONTAINMENT AIR RETURN FANS
CI	FAILURE OF CONTAINMENT ISOLATION
CP	FAILURE OF CONTAINMENT PURGE ISOLATION
HH	FAILURE OF HYDROGEN IGNITORS

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: VIBIN

14:40:46 03 AUG 1992
Page 1

```
SF........ Split Fraction Logic.............................................
MELTF     VI9=F + VI4=F * VI9=S
          MELT:=MELT=F
MELTS     1
CDBF      VI9=F
CDBS      1
HH1       1
CI1       1
CP1       1
AR1       1
```

MODEL Name: WBNNEW

Binning Logic for Event Tree: VIBIN

16:42:56 03 AUG 1992
Page 1

```
Bin....... Binning Rules...................................................

ATV        CDB=F

BCI        MELT=F * CI=S * CP=S

BCS        MELT=F * CI=F * CP=S

BPL        MELT=F * CP=F

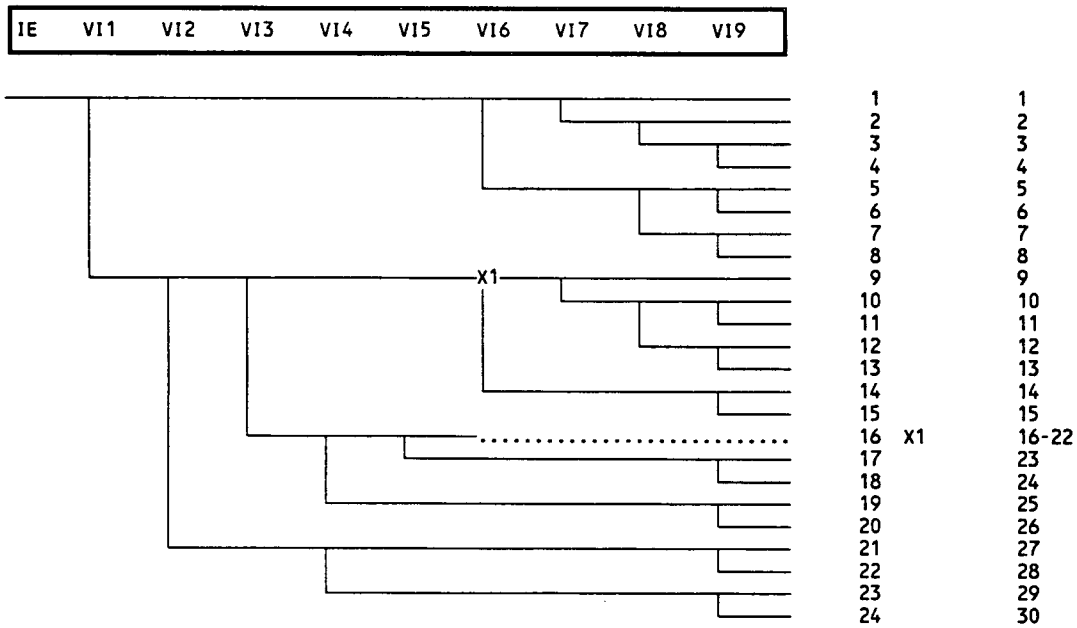
SUCCESS    1
```

MODEL Name: WBNNEW

Page No. 1

Event Tree: VILOCA

14:15:33 03 AUG 1992



MODEL Name: WBNNEW

Top Event Legend for Tree: VILOCA

14:15:38 03 AUG 1992
Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
VI1	FAILURE TO ISOLATE RHR PUMPS
VI2	MANUAL VALVE 74-34 FAILS TO CLOSE
VI3	CHECK VALVE 63-502 FAILS TO CLOSE
VI4	LEAK < RWST VENT CAPACITY
VI5	OPERATOR FAILS TO CLOSE MOV 63-1
VI6	RELIEF VALVES FAIL TO OPEN
VI7	LEAK < RELIEF CAPACITY
VI8	RHR SYSTEM NOTINTACT
VI9	OPERATOR FAILS TO ISOLATE LOCA (ECA-1.2)

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: VILOCA

14:40:55 03 AUG 1992
Page 1

SF..... Split Fraction Logic.....

VI11	1
VI21	1
VI31	1
VI41	1
VI5F	1
VI61	VI1=S
VI62	VI1=F
VI71	VI1=S
VI72	VI1=F
VI81	VI1=S * VI6=S
VI82	VI1=S * VI6=F
VI83	VI1=F * VI6=S
VI91	VI1=S * VI6=S
VI92	VI1=S * VI6=F * VI8=S
VI93	VI1=S * VI6=F * VI8=F
VI94	VI1=F * VI6=S * VI8=S
VI95	VI1=F * VI6=S
VI96	VI1=F * VI6=F
VI97	VI1=F * VI3=F * VI4=S * VI5=F
VI98	VI1=F * VI2=F * VI4=S
VI99	VI1=F * VI4=F
VI9F	1

MODEL Name: WBNNEW

Binning Logic for Event Tree: VILOCA

16:43:05 03 AUG 1992
Page 1

```
Bin....... Binning Rules...................................................

LOCA       VI7=S + VI1=S * VI7=F * VI8=S

CDB        VI9=F

CD         VI4=F * VI9=S

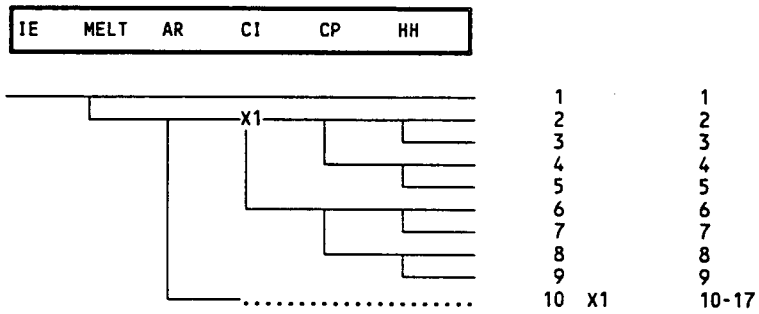
SUCCESS    1
```

MODEL Name: WBNNEW

Event Tree: VSBIN

Page No. 1

14:15:45 03 AUG 1992



MODEL Name: WBNNEW

Top Event Legend for Tree: VSBIN

14:15:49 03 AUG 1992
Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
MELT	NO CORE DAMAGE
AR	FAILURE OF CONTAINMENT AIR RETURN FANS
CI	FAILURE OF CONTAINMENT ISOLATION
CP	FAILURE OF CONTAINMENT PURGE ISOLATION
HH	FAILURE OF HYDROGEN IGNITORS

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: VSBIN

14:41:06 03 AUG 1992
Page 1

```
SF........ Split Fraction Logic.............................................

MELTF     VSA=F + VS3=F + VS4=F

          MELT:=MELT=F

MELTS     1

HH1       1

CI1       1

CP1       1

AR1       1
```

MODEL Name: WBNNEW

Binning Logic for Event Tree: VSBIN

16:43:14 03 AUG 1992
Page 1

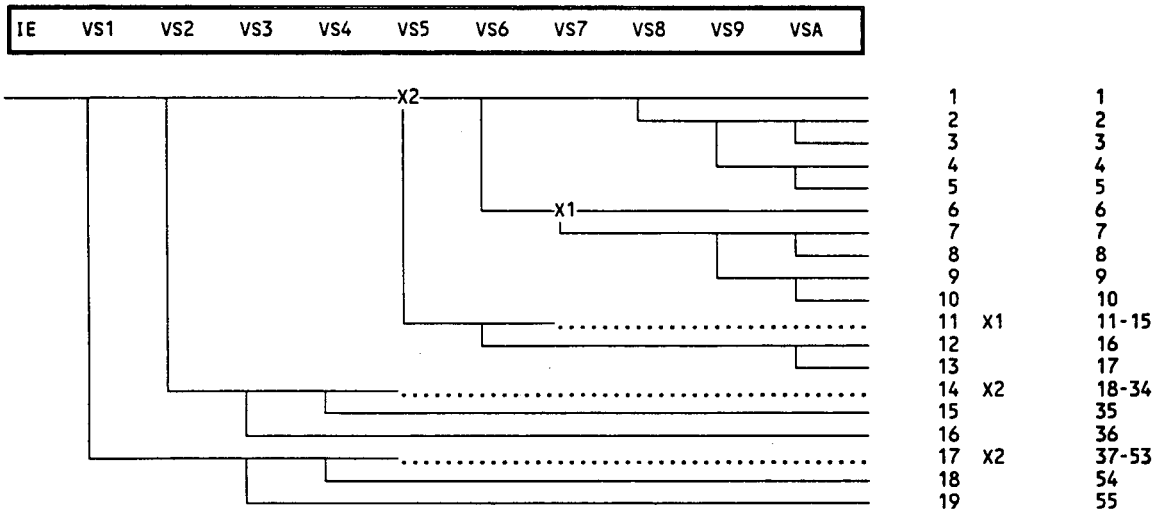
Bin.....	Binning Rules.....
ATV	MELT
BCI	MELT * CI=S * CP=S
BCS	MELT * CI=F * CP=S
BPL	MELT * CP=F
SUCCESS	1

MODEL Name: WBNNEW

Page No. 1

Event Tree: VSLOCA

14:15:56 03 AUG 1992



MODEL Name: WBNNEW

Top Event Legend for Tree: VSLOCA

14:16:00 03 AUG 1992
Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
VS1	FAILURE OF CHECK VALVE 63-502 TO CLOSE
VS2	MANUAL VALVE 74-34 FAILS TO CLOSE
VS3	LEAK < RWST VENT CAPACITY
VS4	OPERATOR FAILS TO CLOSE MOV(S) TO ISOLATE RWST
VS5	RELIEF VALVE 75-505 FAILS TO OPEN
VS6	RELIEF VALVES 63-626 & 627 FAIL TO OPEN
VS7	LEAK < 900 GPM
VS8	LEAK < 1800 GPM
VS9	RHR SYSTEM NOT INTACT
VSA	FAILURE OF OPERATOR TO ISOLATE OR USE ECA-1.1

MODEL Name: WBNNEW

Split Fraction Logic for Event Tree: VSLOCA

14:41:15 03 AUG 1992
Page 1

SF..... Split Fraction Logic.....

VS11	1
VS21	1
VS31	1
VS4F	1
VS51	1
VS61	1
VS71	1
VS81	1
VS91	VS5=S * VS6=S
VS92	VS5=S + VS6=S
VSA1	VS5=S * VS6=S * VS9=S
VSA2	(VS5=S + VS6=S) * VS9=S
VSA3	VS5=S * VS6=S * VS9=F
VSA4	(VS5=S + VS6=S) * VS9=F
VSA5	VS5=F * VS6=F

MODEL Name: WBNNEW

Binning Logic for Event Tree: VSLOCA

16:43:23 03 AUG 1992
Page 1

Bin.....	Binning Rules.....
LOCA	VS7=S + VS8=S
CDB	VSA=F + VS3=F + VS4=F
SUCCESS	VSA=S
DEFAULT	1

WATTS BAR Initiating Events and Event Trees Used For Quantification

Initiator...	Description.....	Event Tree Names....	Initiator Frequency.....
CCSA	LOSS OF COMPONENT COOLING WATER TRAIN A	MACRO1	2.7800E-02
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
CCSTL	TOTAL LOSS OF COMPONENT COOLING WATER	MACRO1	1.1100E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
CPEX	CORE POWER EXCURSION	MACRO1	2.6800E-02
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
ELOCA	EXCESSIVE LOCA INITIATOR	MACRO1	2.6600E-07
		ELECT1	
		ELECT2	
		MECH2	
		LARLOC4	
		RECL	
		LLBINS	
ERCWA	LOSS OF ERCW TRAIN A	MACRO1	7.1000E-04
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
ERCWB	LOSS OF ERCW TRAIN B	MACRO1	7.1000E-04
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
ERCWTL	TOTAL LOSS OF ERCW	MACRO1	1.5100E-05
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
EXMFW	EXCESSIVE MAIN FEEDWATER	MACRO1	1.6800E-01
		ELECT1	

WATTS BAR Initiating Events and Event Trees Used For Quantification

Initiator...	Description.....	Event Tree Names....	Initiator Frequency.....
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
FLAB2	FLOODING, ERCW TO AUX BLDG > 30 MINUTES	MACRO1	4.2000E-06
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
FLAB3C	FLOODING, CST TO AUX BLDG	MACRO1	2.8000E-05
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
FLAB3R	FLOODING, RWST TO AUX BLDG	MACRO1	3.2000E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
FLPH1A	FLOOD ERCW STAINER ROOM, TRAIN A	MACRO1	2.3000E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
FLPH1B	FLOODING, ERCW STRAINER ROOM	MACRO1	2.3000E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
FLTB	INTERNAL FLOODING IN TURBINE BLDG	MACRO1	2.0000E-02
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
IMSIV	INADVERTENT ALL MSIVS CLOSE	MACRO1	1.9300E-02
		ELECT1	
		ELECT2	
		MECH2	

WATTS BAR Initiating Events and Event Trees Used For Quantification

Initiator...	Description.....	Event Tree Names....	Initiator Frequency.....
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
ISI	INADVERTANT SAFETY INJECTION	MACRO1	2.9900E-02
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
LASD	LOSS OF 6.9 SHUTDOWN BOARD 1A-A	MACRO1	3.0380E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
LBSD	LOSS OF 6.9 SHUTDOWN BOARD 1B-B	MACRO1	3.0410E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
LDAAC	LOSS OF 120 VAC VITAL BOARD 1-I	MACRO1	1.1930E-01
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
LDBAC	LOSS OF 120 VAC VITAL BOARD 1-II	MACRO1	1.1850E-01
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
LDCAC	LOSS OF 120 VAC VITAL BOARD 1-III	MACRO1	1.1580E-01
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
LDDAC	LOSS OF 120 VAC VITAL BOARD 1-IV	MACRO1	1.1450E-01
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	

WATTS BAR Initiating Events and Event Trees Used For Quantification

Initiator...	Description.....	Event Tree Names....	Initiator Frequency.....
		GTBINS	
LLOCA	LARGE & EXCESSIVE BREAK LOCA	MACRO1	2.0300E-04
		ELECT1	
		ELECT2	
		MECH2	
		LARLOC4	
		RECL	
		LLBINS	
LOCV	LOSS OF CONDENSER VACUUM	MACRO1	1.1800E-01
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
LOSP	LOSS OF OFFSITE POWER	MACRO1	8.5600E-02
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
LRCP	LOSS OF 1 OR MORE RCPS/PRIMARY FLOW	MACRO1	1.7600E-01
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
LVBB1	LOSS OF BATTERY BOARD I	MACRO1	5.9700E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
LVBB2	LOSS OF BATTERY BOARD II	MACRO1	5.7860E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
MLOCA	MEDIUM BREAK LOCA	MACRO1	4.6500E-04
		ELECT1	
		ELECT2	
		MECH2	
		MEDLOC2	
		RECL	
		MLBINS	
MSIV	INADVERTEBT CLOSURE OF ONE MSIV	MACRO1	8.6600E-02
		ELECT1	
		ELECT2	
		MECH2	

WATTS BAR Initiating Events and Event Trees Used For Quantification

Initiator...	Description.....	Event Tree Names....	Initiator Frequency.....
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
MSVO	STEAM GENERATOR PORV/SAFETY FAILS OPEN	MACRO1	4.1900E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
PLMFW	PARTIAL LOSS OF MAIN FEEDWATER	MACRO1	1.1300E+00
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
RTIE	REACTOR TRIP INITIATING EVENT	MACRO1	1.3500E+00
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
SGTR	STEAM GENERATOR TUBE RUPTURE	MACRO1	2.8400E-02
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
SLBIC	STEAM LINE BREAK INSIDE CONTAINMENT	MACRO1	4.6500E-04
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
SLBOC	STEAM LINE BREAK OUTSIDE CONTAINMENT	MACRO1	6.0400E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
SLOCAI	SMALL LOCA ISOLABLE, PZR PORV LEAK	MACRO1	2.3000E-02
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	

WATTS BAR Initiating Events and Event Trees Used For Quantification

Initiator...	Description.....	Event Tree Names....	Initiator Frequency.....
		RECIR2	
		RECOVERY	
		GTBINS	
SLOCAN	SMALL LOCA NON-ISOLABLE, RCP SEAL LOCA	MACRO1	5.8300E-03
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
TLMFW	TOTAL LOSS OF MAIN FEEDWATER	MACRO1	1.6200E-01
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
TTIE	TURBINE TRIP INITIATING EVENT	MACRO1	1.0700E+00
		ELECT1	
		ELECT2	
		MECH2	
		GTRAN4	
		RECIR2	
		RECOVERY	
		GTBINS	
VI	RHR DISCHARGE PATH ISLOCA	MACRO1	4.0000E-06
		VILOCA	
		VIBIN	
VS	RHR SUCTION PATH ISLOCA	MACRO1	7.2000E-06
		VSLOCA	
		VSBIN	

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Split Fractions for System: No System
Description: No Description

Top Event: A1
Description: No Description

A11	8.3262E-04	ALL SUPP. AVAIL.
A1F	1.0000E+00	G.F.

Top Event: A1L
Description: No Description

A1LF	1.0000E+00	ERCW/DIESEL 1A/480V SD BD 1A1-A DEPENDENCY - G.F.
A1LS	0.0000E+00	ERCW/DIESEL 1A/480V SD BD 1A1-A DEPENDENCY - G.S.

Top Event: A1U2
Description: No Description

A1U21	6.9324E-04	ALL SUPP. AVAIL.
A1U2F	1.0000E+00	G.F.

Top Event: A1U2L
Description: No Description

A1U2LF	1.0000E+00	ERCW/DIESEL 2A/480V SD BD 2A1-A DEPENDENCY - G.F.
A1U2LS	0.0000E+00	ERCW/DIESEL 2A/480V SD BD 2A1-A DEPENDENCY - G.S.

Top Event: A2
Description: No Description

A21	6.0348E-04	ALL SUPP. AVAIL.
A2F	1.0000E+00	G.F.

Top Event: A2L
Description: No Description

A2LF	1.0000E+00	ERCW/DIESEL 1A/480V SD BD 1A2-A DEPENDENCY - G.F.
A2LS	0.0000E+00	ERCW/DIESEL 1A/480V SD BD 1A2-A DEPENDENCY - G.S.

Top Event: A2U2
Description: No Description

A2U21	5.4685E-04	ALL SUPP. AVAIL.
A2U2F	1.0000E+00	G.F.

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Top Event: A2U2L
Description: No Description

A2U2LF	1.0000E+00	ERCW/DIESEL 2A/480V SD BD 2A2-A DEPENDENCY - G.F.
A2U2LS	0.0000E+00	ERCW/DIESEL 2A/480V SD BD 2A2-A DEPENDENCY - G.S.

Top Event: A3
Description: No Description

A31	4.3770E-04	ALL SUPP. AVAIL.
A3F	1.0000E+00	G.F.

Top Event: AA
Description: No Description

AA1	2.5520E-05	ALL SUPP. AVAIL.
AA2	6.6400E-04	LOSP
AAF	1.0000E+00	G.F.

Top Event: AAL
Description: No Description

AALF	1.0000E+00	ERCW/DIESEL 1A/6.9-KV SD BD 1A-A DEPENDENCY - G.F.
AALS	0.0000E+00	ERCW/DIESEL 1A/6.9-KV SD BD 1A-A DEPENDENCY - G.S.

Top Event: AB
Description: No Description

AB1	2.5520E-05	AA AND AB SUCCESSFUL
AB2	5.5650E-04	AA AND AB SUCCESSFUL, LOSP
AB3	2.4650E-05	AA OR AB FAIL
AB4	5.5550E-02	AA OR AB FAIL, LOSP
AB5	3.9940E-05	AA AND AB FAIL
AB6	5.6700E-01	AA AND AB FAIL, LOSP
AB7	5.8890E-04	ONE BUS BY SUPPORT, OTHER SUCCESS, LOSP
AB8	1.1370E-01	ONE BUS BY SUPPORT, OTHER FAILS, LOSP
AB9	6.6400E-04	BOTH BY SUPPORT
ABF	1.0000E+00	G.F.

Top Event: ABL
Description: No Description

ABLF	1.0000E+00	ERCW/DIESEL 2A/6.9-KV SD BD 2A-A DEPENDENCY - G.F.
ABLS	0.0000E+00	ERCW/DIESEL 2A/6.9-KV SD BD 2A-A DEPENDENCY -G.S.

Top Event: AC
Description: No Description

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AC1	1.3290E-04	2 PUMP TRAINS AVAIL., ALL SUPP. AVAIL.
AC10	1.3440E-02	2 PUMP TRAINS AVAIL., BA AND BB FAIL, OG=F
AC2	1.7350E-02	1 PUMP TRAIN AVAIL., (A1 OR B1) FAILS, OTHER SUPPORTS AVAIL.
AC3	1.9330E-02	1 PUMP TRAIN AVAIL., (A1 OR B1) FAIL, OG=F, OTHER SUPPORT AVAIL.
AC4	3.0350E-02	1 PUMP TRAIN AVAIL., (A1 OR B1) FAILS, OG=S, (BA AND BB) FAIL
AC5	3.3020E-02	1 PUMP TRAIN AVAIL., (A1 OR B1) FAILS, OG=F, (BA AND BB) FAIL
AC8	3.4030E-04	2 PUMP TRAINS AVAIL., OG=F
AC9	1.2810E-02	2 PUMP TRAINS AVAIL., BA AND BB FAIL, OG=S
ACF	1.0000E+00	G.F.

Top Event: AE
Description: No Description

AE1	3.0425E-05	ALL SUPPORT AVAILABLE
AE10	1.3533E-04	LOSP, LATER RECOVERED, ALL OTHER SUPPORT AVAILABLE
AE2	1.2314E-02	LOSS OF AA OR AB
AE3	8.3513E-05	LOSS OF DA OR DC
AE4	1.5823E-03	LOSS OF DA AND DC
AE5	6.8632E-03	LOSP, ALL OTHER SUPPORT AVAILABLE
AE6	3.4107E-03	LOSP, LOSS OF AA OR AB OR DA OR DC
AE7	3.1892E-05	SI, ALL SUPPORT AVAILABLE
AE8	1.1472E-02	SI, LOSS OF AA OR AB
AE9	8.4961E-05	SI, LOSS OF DA OR DC
AEF	1.0000E+00	GF

Top Event: AEBES
Description: No Description

C1	1.0410E-06	ALL SUPP. AVAIL.
C10	9.3703E-07	LOSS OF DB AND DD
C11	9.3661E-07	LOSS OF AA AND DB
C12	9.9649E-07	LOSS OF AA AND DB AND DD
C13	9.9512E-07	LOSS OF DA AND DB AND DD
C14	9.9344E-07	LOSS OF DA AND DC AND DB AND DD
C15	1.2639E-05	LOSP, ALL OTHER SUPPORT AVAIL.
C16	1.2349E-05	LOSP, LOSS OF AA
C17	1.6108E-05	LOSP, LOSS OF AA AND BA
C18	1.3255E-05	LOSP, LOSS OF AA AND AB
C19	1.9161E-05	LOSP, LOSS OF AA AND AB AND BA
C2	9.5040E-07	LOSS OF AA
C20	8.9863E-07	SI, ALL SUPP. AVAIL.
C21	1.0830E-06	SI, LOSS OF AA
C22	8.8283E-07	SI, LOSS OF DA
C23	9.4242E-07	SI, LOSS OF DA AND DC
C24	4.1735E-06	SI, LOSS OF AA AND BA
C25	8.3780E-07	SI, LOSS OF AA AND DB

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C26	9.4551E-07	SI, LOSS OF AA AND DB AND DD
C27	8.8673E-07	SI, LOSS OF DA AND DB
C28	9.5503E-07	SI, LOSS OF DA AND DB AND DD
C29	9.3913E-07	SI, LOSS OF DA AND DC AND DB AND DD
C3	1.0420E-06	LOSS OF DA
C30	1.1324E-06	SI, LOSS OF AA AND AB
C31	7.2385E-06	SI, LOSS OF AA AND AB AND BA
C32	9.4843E-07	SI, LOSS OF AA AND AB AND DB
C33	8.6423E-07	SI, LOSS OF AA AND AB AND DB AND DD
C4	4.0620E-06	LOSS OF AA AND BA
C5	9.6853E-07	LOSS OF DA AND DB
C6	9.3389E-07	LOSS OF AA AND AB
C7	7.0887E-06	LOSS OF AA AND AB AND BA
C8	9.9821E-07	LOSS OF AA AND AB AND DB
C9	1.0260E-06	LOSS OF AA AND AB AND DB AND DD
CF	1.0000E+00	G.F.

Top Event: AEBET
Description: No Description

AE1C	5.6680E-05	ALL SUPPORT
AE2C	1.3670E-02	LOSS OF AA
AE3C	9.9490E-05	LOSS OF DA
AE4C	1.6460E-03	LOSS OF DA AND DC
AE5C	2.2210E-02	LOSP, ALL SUPPORT
AE6C	1.1830E-02	LOSP, LOSS OF AA
AE7C	5.6370E-05	SI, ALL SUPP. AVAIL.
AE8C	1.2210E-02	SI, LOSS OF AA
AE9C	9.7440E-05	SI, LOSS OF DA
AEBE1	1.1400E-06	ALL SUPP. AVAIL.
AEBE10	1.1340E-06	LOSS OF DB AND DD
AEBE11	5.2780E-06	LOSS OF AA AND DB
AEBE12	8.4240E-05	LOSS OF AA AND DB AND DD
AEBE13	1.2870E-06	LOSS OF DA AND DB AND DD
AEBE14	6.1990E-05	LOSS OF DA AND DC AND DB AND DD
AEBE15	5.1120E-04	LOSP, ALL OTHER SUPPORT AVAIL.
AEBE16	3.8810E-04	LOSP, LOSS OF AA
AEBE17	2.1820E-04	LOSP, LOSS OF AA AND BA
AEBE18	2.3110E-02	LOSP, LOSS OF AA AND AB
AEBE19	1.1700E-02	LOSP, LOSS OF AA AND AB AND BA
AEBE2	4.2520E-06	LOSS OF AA
AEBE20	9.0160E-07	SI, ALL SUPP. AVAIL.
AEBE21	1.8130E-06	SI, LOSS OF AA
AEBE22	8.8980E-07	SI, LOSS OF DA
AEBE23	1.0340E-06	SI, LOSS OF DA AND DC
AEBE24	2.5240E-04	SI, LOSS OF AA AND BA
AEBE25	2.1260E-06	SI, LOSS OF AA AND DB
AEBE26	7.9830E-05	SI, LOSS OF AA AND DB AND DD
AEBE27	8.9950E-07	SI, LOSS OF DA AND DB
AEBE28	1.2380E-06	SI, LOSS OF DA AND DB AND DD
AEBE29	5.9540E-05	SI, LOSS OF DA AND DC AND DB AND DD
AEBE3	1.1420E-06	LOSS OF DA

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AEBE30	5.8730E-05	SI, LOSS OF AA AND AB
AEBE31	1.2000E-02	SI, LOSS OF AA AND AB AND BA
AEBE32	9.4650E-05	SI, LOSS OF AA AND AB AND DB
AEBE33	1.6000E-03	SI, LOSS OF AA AND AB AND DB AND DD
AEBE4	1.7660E-03	LOSS OF AA AND BA
AEBE5	1.0920E-06	LOSS OF DA AND DB
AEBE6	5.9880E-05	LOSS OF AA AND AB
AEBE7	1.3770E-02	LOSS OF AA AND AB AND BA
AEBE8	1.0130E-04	LOSS OF AA AND AB AND DB
AEBE9	1.5700E-03	LOSS OF AA AND AB AND DB AND DD
AEBEF	1.0000E+00	G.F.
AEFC	1.0000E+00	G.F.

Top Event: AES
Description: No Description

AF	1.0000E+00	G.F.
AFC	1.0000E+00	G.F.

Top Event: AF
Description: No Description

AF1	2.6831E-06	ALL SUPP. AVAIL.
AF2	3.0331E-06	SUPPORT FOR 1 SET OF TDP LCVS UNAVAIL.
AF3	2.8698E-06	ONE MDP NOT AVAIL.
AF4	7.0914E-06	1 MDP AND ASSOCIATED TDP LCVS NOT AVAIL.
AF5	1.9616E-05	TDP OR BOTH MDPS UNAVAIL.
AF6	2.2722E-05	1 MDP AND TDP UNAVAIL.
AF7	1.5788E-01	SBO (AND LOSS OF AIR ASSUMED)
AFA1	2.3390E-03	ALL SUPP. AVAIL. (ATWS)
AFA2	3.0570E-02	SUPPORT FOR 1 SET OF TDP LCVS UNAVAIL. (ATWS)
AFA3	3.0460E-02	ONE MDP NOT AVAIL. (ATWS)
AFA4	1.0000E+00	1 MDP AND ASSOCIATED TDP LCVS NOT AVAIL. (ATWS)
AFA5	5.8530E-02	TDP OR BOTH MDPS UNAVAIL. (ATWS)
AFF	1.0000E+00	G.F.
AFR1	5.1230E-03	MANUALLY CONTROL AFW

Top Event: AFATWS
Description: No Description

AFTWS1	2.3385E-03	ALL SUPP. AVAIL.
AFTWS2	3.0559E-02	SUPPORT FOR 1 SET OF TDP LCVS UNAVAIL.
AFTWS3	3.0457E-02	ONE MDP NOT AVAIL.
AFTWS4	9.9994E-01	1 MDP AND ASSOCIATED TDP LCVS NOT AVAIL.
AFTWS5	5.8543E-02	TDP OR BOTH MDPS UNAVAIL.
AFTWSF	1.0000E+00	G.F.

Top Event: AM
Description: No Description

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AM1	1.0000E-03	ALL SUPP. AVAIL.
AMF	1.0000E+00	G.F.

Top Event: AR
Description: No Description

AR1	3.1684E-04	ALL SUPPORT FOR THE AIR RETURN FANS AVAIL.
AR2	5.6935E-03	SUPPORT FOR ONE TRAIN OF AIR RETURN FAN FAILED
ARF	1.0000E+00	G.F. OF TOP EVENT AR

Top Event: B1
Description: No Description

B11	7.0702E-04	ALL SUPP. AVAIL.
B1F	1.0000E+00	G.F.

Top Event: B1L
Description: No Description

B1LF	1.0000E+00	ERCW/DIESEL 1B/480V SD BD 1B1-B DEPENDENCY - G.F.
B1LS	0.0000E+00	ERCW/DIESEL 1B/480V SD BD 1B1-B DEPENDENCY - G.S.

Top Event: B1U2
Description: No Description

B1U21	8.4458E-04	ALL SUPP. AVAIL.
B1U2F	1.0000E+00	G.F.

Top Event: B1U2L
Description: No Description

B1U2LF	1.0000E+00	ERCW/DIESEL 2B/480V SD BD 2B1-B DEPENDENCY - G.F.
B1U2LS	0.0000E+00	ERCW/DIESEL 2B/480V SD BD 2B1-B DEPENDENCY - G.S.

Top Event: B2
Description: No Description

B21	5.9562E-04	ALL SUPP. AVAIL.
B2F	1.0000E+00	G.F.

Top Event: B2L
Description: No Description

B2LF	1.0000E+00	ERCW/DIESEL 1B/480V SD BD 1B2-B DEPENDENCY - G.F.
B2LS	0.0000E+00	ERCW/DIESEL 1B/480V SD BD 1B2-B DEPENDENCY - G.S.

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Top Event: B2U2
Description: No Description

B2U21	5.7141E-04	ALL SUPP. AVAIL.
B2U2F	1.0000E+00	G.F.

Top Event: B2U2L
Description: No Description

B2U2LF	1.0000E+00	ERCW/DIESEL 2B/480V SD BD 2B2-B DEPENDENCY - G.F.
B2U2LS	0.0000E+00	ERCW/DIESEL 2B/480V SD BD 2B2-B DEPENDENCY - G.S.

Top Event: B3
Description: No Description

B31	4.3780E-04	A3 SUCCESSFUL
B32	2.7450E-04	A3 FAILS
B3F	1.0000E+00	G.F.

Top Event: BA
Description: No Description

BA1	2.5520E-05	AA SUCCESSFUL
BA2	2.4650E-05	AA FAILS
BA3	5.8890E-04	AA SUCCESSFUL, LOSP
BA4	1.1370E-01	AA FAILS, LOSP
BA5	6.6400E-04	AA FAILS BY SUPPORT, LOSP
BAF	1.0000E+00	G.F.

Top Event: BAL
Description: No Description

BALF	1.0000E+00	ERCW/DIESEL 1B/6.9KV SD BD 1B-B DEPENDENCY - G.F.
BALS	0.0000E+00	ERCW/DIESEL 1B/6.9KV SD BD 1B-B DEPENDENCY -G.S.

Top Event: BB
Description: No Description

BB1	2.5520E-05	AA, AB AND BA SUCCESSFUL
BB10	6.6400E-04	THREE PREVIOUS TRAINS FAIL BY SUPPORT
BB11	5.5550E-02	ONE PREVIOUS FAILS BY SUPPORT, ONE INDEPENDANT, LOSP
BB12	1.1370E-01	TWO PREVIOUS TRAINS FAIL BY SUPPORT, ONE INDEPENDANT, LOSP
BB13	5.6700E-01	ONE PREVIOUS TRAIN FAILS BY SUPPORT, TWO INDEPENDANT, LOSP

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BB14	7.9320E-01	THREE PREVIOUS TRAINS FAIL, LOSP
BB2	2.4650E-05	AA OR AB OR BA FAILS
BB3	3.9940E-05	TWO PREVIOUS BUSES FAIL
BB4	4.6750E-05	AA, AB, AND BA FAIL
BB5	5.3290E-04	AA, AB AND BA SUCCESSFUL, LOSP
BB6	4.2890E-02	AA OR AB OR BA FAILS, LOSP
BB7	2.7070E-01	TWO PREVIOUS BUSES FAIL, LOSP
BB8	5.5650E-04	ONE PREVIOUS TRAIN FAILS BY SUPPORT
BB9	5.8890E-04	TWO PREVIOUS TRAIN BY SUPPORT, LOSP
BBF	1.0000E+00	G.F.

Top Event: BBL
Description: No Description

BBLF	1.0000E+00	ERCW/DIESEL 1B/6.9-KV SD BD 2B-B DEPENDENCY - G.F.
BBLS	0.0000E+00	ERCW/DIESEL 1B/6.9-KV SD BD 2B-B DEPENDENCY G.S.

Top Event: BC
Description: No Description

BC1	3.6050E-03	TRAIN A AVAIL. WITH 2 PUMP TRAINS, ALL SUPPORTS AVAIL.
BC10	5.9370E-03	TRAIN A AVAIL. WITH 2 PUMP TRAINS, BA AND BB FAIL, OG=F
BC2	3.6000E-03	TRAIN A AVAIL. WITH 1 PUMP TRAIN (A1 OR B1) FAILS, OTHER SUPPORTS AVAIL.
BC21	1.7240E-01	TRAIN A UNAVAIL. WITH 2 PUMP TRAINS, ALL SUPPORTS AVAIL.
BC22	5.1780E-03	TRAIN A UNAVAIL. WITH 1 PUMP TRAIN (A1 OR B1) FAILS, OTHER SUPPORTS AVAIL.
BC23	1.3210E-02	TRAIN A UNAVAIL. WITH 1 PUMP TRAIN (A1 OR B1) FAILS, OG=F, OTHER SUPPORTS AVAIL.
BC24	4.6660E-03	TRAIN A UNAVAIL. WITH 1 PUMP TRAIN (A1 OR B1) FAILS, OG=S, BA AND BB FAIL
BC25	1.0070E-02	TRAIN A UNAVAIL. WITH 1 PUMP TRAIN (A1 OR B1) FAILS, OG=F, BA AND BB FAIL
BC28	3.1270E-01	TRAIN A UNAVAIL. WITH 2 PUMP TRAINS, OG=F
BC29	5.1110E-03	TRAIN A UNAVAIL. WITH 2 PUMP TRAINS AVAIL., OG=S, BA AND BB FAILS
BC3	5.9050E-03	TRAIN A AVAIL. WITH 1 PUMP TRAIN (A1 OR B1) FAILS, OG=F, OTHER SUPPORTS AVAIL.
BC30	1.4030E-02	TRAIN A UNAVAIL. WITH 2 PUMP TRAINS, BA AND BB FAIL, OG=F
BC33	3.6280E-03	TRAIN A G.F., OG=S
BC34	6.0460E-03	TRAIN A G.F., OG=F
BC4	3.5950E-03	TRAIN A AVAIL. WITH 1 PUMP TRAIN (A1 OR B1) FAILS, OG=S, BA AND BB FAIL
BC5	5.9090E-03	TRAIN A AVAIL. WITH 1 PUMP TRAIN (A1 OR B1) FAILS, OG=F, BA AND BB FAIL
BC8	5.9420E-03	TRAIN A AVAIL. WITH 2 PUMP TRAINS, OG=F
BC9	3.6080E-03	TRAIN A AVAIL. WITH 2 PUMP TRAINS AVAIL., OG=S, BA

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		AND BB FAILS
BCF	1.0000E+00	GF

Top Event: BE
Description: No Description

BE1	2.9380E-05	ALL SUPPORT AVAILABLE, AE=S
BE10	3.0510E-04	LOSS OF AA OR AB, AE=F
BE11	1.0680E-02	LOSS OF (AA OR AB) AND (BA OR BB), AE=S
BE12	1.4300E-01	LOSS OF (AA OR AB) AND (BA OR BB), AE=F
BE13	8.0040E-05	LOSS OF (AA OR AB) AND (DB OR DD), AE=S
BE14	3.6250E-04	LOSS OF (AA OR AB) AND (DB OR DD), AE=F
BE15	1.5200E-03	LOSS OF (AA OR AB) AND DB AND DD), AE=S
BE16	6.5890E-03	LOSS OF (AA OR AB) AND DB AND DD), AE=F
BE17	2.9350E-05	LOSS OF DA OR DC, AE=S
BE18	1.2850E-02	LOSS OF DA OR DC, AE=F
BE19	1.2310E-02	LOSS OF (DA OR DC) AND (BA OR BB), AE=S
BE2	3.4430E-02	ALL SUPPORT AVAILABLE, AE=F
BE20	5.3440E-02	LOSS OF (DA OR DC) AND (BA OR BB), AE=F
BE21	8.2440E-05	LOSS OF (DA OR DC) AND (DB OR DD), AE=S
BE22	1.2970E-02	LOSS OF (DA OR DC) AND (DB OR DD), AE=F
BE23	1.5810E-03	LOSS OF (DA OR DC) AND DB AND DD, AE=S
BE24	1.5420E-02	LOSS OF (DA OR DC) AND DB AND DD, AE=F
BE25	2.9380E-05	LOSS OF DA AND DC, AE=S
BE26	6.8700E-04	LOSS OF DA AND DC, AE=F
BE27	1.2250E-02	LOSS OF DA AND DC AND (BA OR BB), AE=S
BE28	5.1270E-02	LOSS OF DA AND DC AND (BA OR BB), AE=F
BE29	8.2360E-05	LOSS OF DA AND DC AND (DB OR DD), AE=S
BE3	1.2310E-02	LOSS OF BA OR BB, AE=S
BE30	8.1390E-04	LOSS OF DA AND DC AND (DB OR DD), AE=F
BE31	1.5230E-03	LOSS OF DA AND DC AND DB AND DD, AE=S
BE32	3.8960E-02	LOSS OF DA AND DC AND DB AND DD, AE=F
BE33	6.8630E-03	LOSP, ALL OTHER SUPPORT AVAIL., AE=S
BE34	7.0120E-03	LOSP, ALL OTHER SUPPORT AVAIL., AE=F
BE35	3.2830E-03	LOSP, LOSS OF BA OR BB OR DB OR DD, AE=S
BE36	2.1930E-02	LOSP, LOSS OF BA OR BB OR DB OR DD, AE=F
BE4	1.2350E-01	LOSS OF BA OR BB, AE=F
BE41	6.7360E-03	LOSP, LOSS OF AA OR AB OR DA OR DC, AE=S
BE42	4.4130E-02	LOSP, LOSS OF AA OR AB OR DA OR DC, AE=F
BE43	3.3430E-03	LOSP, LOSS OF (AA OR AB OR DA OR DC) AND (BA OR BB OR DB OR DD), AE=S
BE44	2.3230E-02	LOSP, LOSS OF (AA OR AB OR DA OR DC) AND (BA OR BB OR DB OR DD), AE=F
BE49	3.0870E-05	SI, ALL SUPPORT AVAILABLE, AE=S
BE5	8.2450E-05	LOSS OF DB OR DD, AE=S
BE50	3.2090E-02	SI, ALL SUPPORT AVAILABLE, AE=F
BE51	1.1470E-02	SI, LOSS OF BA OR BB, AE=S
BE52	4.4240E-02	SI, LOSS OF BA OR BB, AE=F
BE53	8.3940E-05	SI, LOSS OF DB OR DD, AE=S
BE54	3.2090E-02	SI, LOSS OF DB OR DD, AE=F
BE55	1.5810E-03	SI, LOSS OF DB AND DD, AE=S
BE56	3.0660E-02	SI, LOSS OF DB AND DD, AE=F

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BE57	3.0840E-05	SI, LOSS OF AA OR AB, AE=S
BE58	1.2300E-04	SI, LOSS OF AA OR AB, AE=F
BE59	1.1360E-02	SI, LOSS OF (AA OR AB) AND (BA OR BB), AE=S
BE6	3.5280E-02	LOSS OF DB OR DD, AE=F
BE60	2.1150E-02	SI, LOSS OF (AA OR AB) AND (BA OR BB), AE=F
BE61	8.3950E-05	SI, LOSS OF (AA OR AB) AND (DB OR DD), AE=S
BE62	1.7200E-04	SI, LOSS OF (AA OR AB) AND (DB OR DD), AE=F
BE63	1.5220E-03	SI, LOSS OF (AA OR AB) AND DB AND DD, AE=S
BE64	6.7480E-03	SI, LOSS OF (AA OR AB) AND DB AND DD, AE=F
BE65	3.0870E-05	SI ,LOSS OF DA OR DC, AE=S
BE66	1.2050E-02	SI ,LOSS OF DA OR DC, AE=F
BE67	1.1470E-02	SI, LOSS OF (DA OR DC) AND (BA OR BB), AE=S
BE68	2.3230E-02	SI, LOSS OF (DA OR DC) AND (BA OR BB), AE=F
BE69	8.4130E-05	SI, LOSS OF (DA OR DC) AND (DB OR DD), AE=S
BE7	1.5810E-03	LOSS OF DB AND DD, AE=S
BE70	9.8190E-03	SI, LOSS OF (DA OR DC) AND (DB OR DD), AE=F
BE71	1.5810E-03	SI, LOSS OF (DA OR DC) AND DB AND DD, AE=S
BE72	1.4830E-02	SI, LOSS OF (DA OR DC) AND DB AND DD, AE=F
BE73	3.0960E-05	SI ,LOSS OF DA AND DC, AE=S
BE74	6.1800E-04	SI ,LOSS OF DA AND DC, AE=F
BE75	1.1410E-02	SI, LOSS OF DA AND DC AND (BA OR BB), AE=S
BE76	4.8930E-02	SI, LOSS OF DA AND DC AND (BA OR BB), AE=F
BE77	8.3830E-05	SI, LOSS OF DA AND DC AND (DB OR DD), AE=S
BE78	7.9610E-04	SI, LOSS OF DA AND DC AND (DB OR DD), AE=F
BE79	1.5230E-03	SI, LOSS OF DA AND DC AND DB AND DD, AE=S
BE8	3.5730E-02	LOSS OF DB AND DD, AE=F
BE80	3.8960E-02	SI, LOSS OF DA AND DC AND DB AND DD, AE=F
BE81	3.0420E-05	LOSS OF AA AND AB
BE82	1.2310E-02	LOSS OF AA AND AB AND (BA OR BB)
BE83	8.3520E-05	LOSS OF AA AND AB AND (DB OR DD)
BE84	1.5820E-03	LOSS OF AA AND AB AND DB AND DD
BE85	6.8640E-03	LOSP, LOSS OF AA AND AB
BE86	3.4110E-03	LOSP, LOSS OF AA AND AB AND (BA OR BB OR DB OR DD)
BE87	3.1890E-05	SI, LOSS OF AA AND AB
BE88	1.1470E-02	SI, LOSS OF AA AND AB AND (BA OR BB)
BE89	8.4960E-05	SI, LOSS OF AA AND AB AND (DB OR DD)
BE9	2.7000E-05	LOSS OF AA OR AB, AE=S
BE90	1.3440E-04	no description entered
BE91	7.2450E-03	no description entered
BEF	1.0000E+00	GF

Top Event: BES
Description: No Description

BF	1.0000E+00	G.F.

Top Event: BNA
Description: No Description

BNAF	1.0000E+00	G.F.
BNAS	0.0000E+00	G.S.

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Top Event: BNB
Description: No Description

BNBF	1.0000E+00	G.F.
BNBS	0.0000E+00	G.S.

Top Event: BNC
Description: No Description

BNCF	1.0000E+00	G.F.
BNCS	0.0000E+00	G.S.

Top Event: BNN
Description: No Description

BNNF	1.0000E+00	G.F.
BNNS	0.0000E+00	G.S.

Top Event: BYA
Description: No Description

BYAF	1.0000E+00	G.F.
BYAS	0.0000E+00	G.S.

Top Event: BYB
Description: No Description

BYBF	1.0000E+00	G.F.
BYBS	0.0000E+00	G.S.

Top Event: BYC
Description: No Description

BYCF	1.0000E+00	G.F.
BYCS	0.0000E+00	G.S.

Top Event: BYN
Description: No Description

BYNF	1.0000E+00	G.F.
BYNS	0.0000E+00	G.S.

Top Event: CAV
Description: No Description

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CAVF	1.0000E+00	WATER IN RX CAVITY - G.F.
CAVS	0.0000E+00	WATER IN RX CAVITY - G.S.

Top Event: CCPR
Description: No Description

CCPR1	1.6100E-02	RECOVERY OF CCP A BY ALIGNING ERCW HEADER 1A (CE)
CCPRF	1.0000E+00	RECOVERY OF CCP A FAILED
CCPRS	0.0000E+00	RECOVERY OF COOLING TO CCP A NOT REQUIRED

Top Event: CCSR
Description: No Description

CCSR1	2.0490E-01	ALIGN THE C-S PUMP TO THE A CCS HX
CCSR2	3.3830E-02	ALIGN AND INITIATE ALTERNATE COOLING TO THE CHARGING PUMP
CCSR3	1.4450E-02	ALIGN ERCW HEADER 2A TO CCS HTX A
CCSRE	5.5220E-02	SWAP TO ALTERNATE POWER SUPPLY GIVEN LOSS OF NORMAL B2U2
CCSRF	1.0000E+00	GUARANTEED FAILRUE
CCSRS	0.0000E+00	G.S.

Top Event: CD
Description: No Description

CD1	8.0366E-03	ALL SUPP. AVAIL.
CDF	1.0000E+00	G.F.

Top Event: CDB
Description: No Description

CDBF	1.0000E+00	CONTAINMENT BYPASS FAILED
CDBS	0.0000E+00	CONTAINMENT BYPASS SUCCEED

Top Event: CE
Description: No Description

CE1	1.7716E-03	ALL SUPP. AVAIL.
CE2	1.6423E-03	LOSS OF BE
CEF	1.0000E+00	G.F.

Top Event: CH
Description: No Description

CH1	2.2297E-03	ALL SUPP. AVAIL., RR=S
CH2	2.3058E-02	TRAIN A SUPPORT FAILED, RR=S

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CH3	2.3213E-02	TRAIN B SUPPORT FAILED, RR=S
CH4	9.3375E-03	ALL SUPP. AVAIL., RR=F
CH5	2.9909E-02	TRAIN A SUPPORT FAILED, RR=F
CH6	3.0232E-02	TRAIN B SUPPORT FAILED, RR=F
CHF	1.0000E+00	G.F.

Top Event: CI
Description: No Description

CI1	4.9642E-03	ALL REQUIRED SUPPORT AVAIL.
CI2	2.3442E-02	FAILURE OF SSPS TRAIN A OR B (I.E. TOP EVENT ZA OR ZB) AND TOP EVENT OS
CI3	9.0559E-03	FAILURE OF TRAIN A (OR B) 480V SHUTDOWN BOARD (I.E. TOP EVENT A1 OR B2)
CI4	1.1445E-01	STATION BLACKOUT WITH TOP EVENT OS OR ZA AND ZB SUCCESSFUL
CI5	1.2745E-01	STATION BLACKOUT WITH TOP EVENT OS AND ZA OR ZB FAILED
CIF	1.0000E+00	G.F. OF TOP EVENT

Top Event: CL
Description: No Description

CL1	9.0020E-06	GIVEN MEDIUM LOCA WITH IP SUCCEEDED AND ALL SUPP. AVAIL.
CL2	9.6670E-06	GIVEN MEDIUM LOCA WITH IP FAILED DUE TO SIS PUMP UNAVAIL.
CL3	7.4480E-04	GIVEN MEDIUM LOCA WITH IP FAILED
CLF	1.0000E+00	G.F.

Top Event: CM
Description: No Description

CMF	1.0000E+00	G.F.
CMS	0.0000E+00	G.S.

Top Event: COMMON
Description: No Description

COMA	1.2014E-07	480V COMMON SYSTEM UNAVAIL.
COMB	4.3770E-04	480V COMMON SINGLE TRAIN

Top Event: CP
Description: No Description

CP1	1.5112E-03	ALL SUPPORT FOR CVI AVAIL.
CP2	1.8292E-03	FAILURE OF ONE TRAIN OF SSPS AND TOP EVENT OS
CP3	1.1620E-01	FAILURE OF ESFAS A AND B, AND OS

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CPF	1.0000E+00	G.F. OF TOP EVENT CP

Top Event: CSA
Description: No Description

CSA1	2.0878E-02	ALL SUPPORT
CSAF	1.0000E+00	G.F.

Top Event: CSAB
Description: No Description

CSAB1	1.3609E-03	ALL SUPPORT

Top Event: CSB
Description: No Description

CSB1	1.9930E-02	CSA SUCCESS, SUPPORT AVAIL. FOR CSB
CSB2	6.5180E-02	CSA FAILED, SUPPORT AVAIL. FOR CSB
CSB3	2.0880E-02	SUPPORT UNAVAIL. FOR CSA, SUPPORT AVAIL. FOR CSB
CSBF	1.0000E+00	G.F.

Top Event: CSI
Description: No Description

CSIF	1.0000E+00	CNMT. SPRAY INJ. - G.F.
CSIS	0.0000E+00	CNMT. SPRAY INJ. - G.S.

Top Event: CSR
Description: No Description

CSRF	1.0000E+00	CNMT. SPRAY RECIRC. - G.F.
CSRS	0.0000E+00	CNMT. SPRAY RECIRC. - G.S.

Top Event: CT
Description: No Description

CT1	9.5251E-05	ALL SUPP. AVAIL.
CTF	1.0000E+00	G.F.

Top Event: CTMU
Description: No Description

CTMU1	2.5452E-02	ALL SUPPORT
CTMUF	1.0000E+00	G.F.

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Top Event: D1
Description: No Description

D11	3.1798E-03	ALL SUPP. AVAIL.
D12	2.9367E-03	LOSS OF AC TO CHARGER
D1F	1.0000E+00	G.F.

Top Event: D2
Description: No Description

D21	3.1383E-03	ALL SUPP. AVAIL.
D22	2.6488E-03	LOSS OF AC TO CHARGER
D2F	1.0000E+00	G.F.

Top Event: DA
Description: No Description

DA1	1.0250E-03	ALL SUPP. AVAIL.
DA2	5.8037E-04	LOSS OF 480V TOP A1
DAF	1.0000E+00	G.F.

Top Event: DAAC
Description: No Description

DAAC1	6.9142E-04	ALL SUPP. AVAIL.
DAAC2	7.0144E-04	LOSS OF DA
DAAC3	7.2218E-04	LOSS OF A1
DAACF	1.0000E+00	G.F.

Top Event: DB
Description: No Description

DB1	9.9437E-04	ALL SUPP. AVAIL.
DB2	5.9108E-04	LOSS OF NORMAL POWER
DBF	1.0000E+00	G.F.

Top Event: DBAC
Description: No Description

DBAC1	6.9267E-04	ALL SUPP. AVAIL.
DBAC2	6.9588E-04	LOSS OF DB
DBAC3	7.3040E-04	LOSS OF B1
DBACF	1.0000E+00	G.F.

Top Event: DC
Description: No Description

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DC1	1.0232E-03	ALL SUPP. AVAIL.
DC2	5.5948E-04	LOSS OF 480V TOP A1U2
DCF	1.0000E+00	G.F.

Top Event: DCAC
Description: No Description

DCAC1	6.9950E-04	ALL SUPP. AVAIL.
DCAC2	6.9063E-04	LOSS OF DC
DCAC3	7.2772E-04	LOSS OF A1U2
DCACF	1.0000E+00	G.F.

Top Event: DD
Description: No Description

DD1	1.0079E-03	ALL SUPP. AVAIL.
DD2	5.8880E-04	LOSS OF NORMAL POWER SUPPLY
DDF	1.0000E+00	G.F.

Top Event: DDAC
Description: No Description

DDAC1	7.0382E-04	ALL SUPP. AVAIL.
DDAC2	6.9688E-04	LOSS OF DD
DDAC3	7.2193E-04	LOSS OF B1U2
DDACF	1.0000E+00	G.F.

Top Event: DE
Description: No Description

DE1	1.7423E-04	ALL SUPP. AVAIL.
DE2	1.7784E-04	LOSS OF AE
DEF	1.0000E+00	G.F.

Top Event: DG
Description: No Description

DG1	3.4414E-04	ALL SUPP. AVAIL.
DGF	1.0000E+00	G.F.

Top Event: DH
Description: No Description

DHF	1.0000E+00	G.F.
DHS	0.0000E+00	GUARANTEED SUCCCESS

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Top Event: DP
Description: No Description

DP1	3.1384E-06	ALL SUPP. AVAIL.
DP2	1.4122E-05	ONE PORV UNAVAIL. DUE TO SUPPORT
DP3	1.5416E-04	BOTH PORVS ARE DISABLED DUE TO SUPPORT
DP4	2.5659E-05	ONE SPRAY VALVE SUPPORT FAILED
DP5	1.4557E-04	ONE SPRAY VALVE AND ONE PORV UNAVAIL DUE TO SUPPORT
DP6	1.5814E-03	BOTH PORVS AND ONE SPRAY VALVE DISABLED DUE TO SUPPORT FAILURE
DP7	1.5120E-02	BOTH SPRAY VALVES DISABLED DUE TO SUPPORT FAILURE
DP8	9.1117E-02	BOTH SPRAY VALVES AND ONE PORV DISABLED DUE TO SUPPORT FAILURE
DPF	1.0000E+00	G.F.

Top Event: DS
Description: No Description

DS1	8.1532E-03	ALL SUPPORT, COOLDOWN & DEPRESS RCS, NORMAL COOLDOWN
DS2	7.3022E-03	ALL SUPPORT, COOLDOWN & DEPRESS RCS, SGTR WITH ISOLATION
DS3	2.0877E-02	ALL SUPPORT, COOLDOWN & DEPRESS RCS, SGTR WITH ISOLATION W/O HIGH HEAD SI
DS4	2.7574E-02	ALL SUPPORT, COOLDOWN & DEPRESS RCS, WITH SGTR, S/G NOT ISOLATED
DS5	6.8065E-02	ALL SUPPORT, COOLDOWN & DEPRESS RCS, WITH SGTR, S/G NOT ISOLATED, W/O HIGH HEAD SI
DS6	1.0343E-01	ALL SUPPORT, COOLDOWN & DEPRESS RCS, LOSS OF ALL AC
DS7	4.0545E-02	ALL SUPPORT, SMALL LOCA
DS8	1.8170E-03	ALL SUPPORT, SGTR WITH SUCCESSFUL ISOLATION AND INJECTION. STEAM DUMPS AVAIL. FOR COOLDOWN
DS9	1.4270E-02	ALL SUPPORT, SGTR WITH SUCCESSFUL ISOLATION BUT FAILED INJECTION. STEAM DUMPS AVAIL. FOR COOLDOWN
DSF	1.0000E+00	G.F.
DSNN	1.0000E+00	A COOLDOWN NOT NEEDED

Top Event: DSLR
Description: No Description

DSLR1	3.0160E-02	RECOVERY OF ERCW TO DIESEL FROM OPPOSITE SIDE
DSLRF	1.0000E+00	RECOVERY OF ERCW TO DIESEL FROM OPPOSITE SIDE - G.F.
DSLRS	0.0000E+00	RECOVERY OF ERCW TO DIESEL FROM OPPOSITE SIDE - G.S.

Top Event: EB
Description: No Description

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EB1	4.2076E-02	GIVEN ALL SUPP. AVAIL., IE IS NOT A LOSP
EB2	4.3911E-02	GIVEN LOSP WITH ALL SUPP. AVAIL.
EB3	3.9589E-02	GIVEN OFFSITE POWER AVAIL. WITH DAAC (OR DBAC) OR A1U2 (OR B1U2) FAILED
EB4	4.4075E-02	GIVEN LOSP WITH DAAC (OR DBAC) OR A1U2 (OR B1U2) FAILED
EB5	4.0834E-02	GIVEN OFFSITE POWER AVAIL. WITH DAAC (OR DBAC) AND A1U2 (OR B1U2) FAILED
EB6	4.2952E-02	GIVEN LOSP WITH DAAC (OR DBAC) AND A1U2 (OR B1U2) FAILED
EB7	3.5000E-02	GIVEN OFFSITE POWER AVAIL. WITH LOSS OF SUPPORT TO HARDWARE FOR EB
EBF	1.0000E+00	G.F.

Top Event: EE
Description: No Description

EE1	1.6740E-03	ALL SUPP. AVAIL.
EE2	1.7431E-03	LOSS OF BE
EEF	1.0000E+00	G.F.

Top Event: EX
Description: No Description

EXF	1.0000E+00	G.F.
EXS	0.0000E+00	G.S.

Top Event: FA
Description: No Description

FA1	4.5300E-03	ALL SUPP. AVAIL.
FAS	0.0000E+00	G.S.

Top Event: FACC
Description: No Description

FACC	8.3388E-05	COMMON CAUSE GLOBAL TERM SWITCH AND PUMP FAILURE

Top Event: FAIV
Description: No Description

FAI	4.5300E-03	SINGLE TRAIN
FAII	1.0320E-04	TWO TRAINS
FAIII	8.3480E-05	THREE TRAINS
FAIND	4.4471E-03	SINGLE TRAIN NO GLOBAL COMMON CAUSE TERM
FAIV	8.3390E-05	FOUR TRAINS AVAIL.

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Top Event: FB
Description: No Description

FB1	4.4470E-03	FA SUCCESSFUL
FB2	2.2770E-02	FA FAILS
FBS	0.0000E+00	FUEL OIL NOT NECESSARY

Top Event: FC
Description: No Description

FC1	4.4470E-03	FA AND FB SUCCESSFUL
FC2	4.4460E-03	FA OR FB FAILS
FC3	8.0920E-01	FA AND FB FAILS
FCS	0.0000E+00	FUEL OIL NOT REQUIRED

Top Event: FD
Description: No Description

FD1	4.4470E-03	FA,FB,FC SUCCESSFUL
FD2	4.4460E-03	ONE PREVIOUS TRAINS FAIL
FD3	4.4470E-03	TWO PREVIOUS TRAINS FAIL
FD4	9.9900E-01	THREE PREVIOUS TRAINS FAIL
FDS	0.0000E+00	FUEL OIL NOT REQUIRED

Top Event: FE
Description: No Description

FE1	1.6812E-03	ALL SUPP. AVAIL.
FE2	1.6751E-03	LOSS OF BE
FEF	1.0000E+00	G.F.

Top Event: FW
Description: No Description

FW1	4.9150E-03	ALL SUPP. AVAIL.
FWF	1.0000E+00	G.F.

Top Event: GA
Description: No Description

GA1	1.3620E-01	ALL SUPP. AVAIL. DIESEL 1AA
GAF	1.0000E+00	G.F.
GAS	0.0000E+00	DIESEL NOT REQUIRED

Top Event: GAIV
Description: No Description

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DG2	2.5295E-02	TWO TRAINS UNAVAIL.
DG3	6.3665E-03	THREE TRAINS UNAVAIL.
DGA	1.3622E-01	SINGLE TRAIN UNAVAIL.
DGSYS	2.4867E-03	SYSTEM UNAVAIL.

Top Event: GB
Description: No Description

GB1	1.2840E-01	GA SUCCESSFUL
GB2	1.8570E-01	GA FAILS
GB3	1.3620E-01	GA FAILS BY SUPPORT
GBF	1.0000E+00	G.F.
GBS	0.0000E+00	NOT REQUIRED

Top Event: GC
Description: No Description

GC1	1.2220E-01	GA AND GB SUCCESSFUL
GC2	1.7060E-01	GA OR GB FAILS
GC3	2.5170E-01	GA AND GB FAIL
GC4	1.2840E-01	GA OR GB BY SUPPORT, OTHER TRAIN SUCCESS
GC5	1.8570E-01	GA OR GB BY SUPPORT, OTHER TRAIN FAILS
GC6	1.3620E-01	GA AND GB BY SUPPORT
GCF	1.0000E+00	G.F.
GCS	0.0000E+00	DIESEL NOT REQUIRED

Top Event: GD
Description: No Description

GD1	1.1640E-01	GA, GB, GC SUCCESSFUL
GD10	1.3620E-01	THREE TRAINS FAIL BY SUPPORT
GD2	1.6360E-01	GA OR GB OR GC FAILS
GD3	2.0500E-01	TWO OF GA, GB, OR GC FAIL
GD4	3.9060E-01	GA, GB, AND GC FAIL
GD5	1.2220E-01	SINGLE TRAIN BY SUPPORT ALL OTHERS SUCCESS
GD6	1.7060E-01	SINGLE TRAIN BY SUPPORT, ONE TRAIN FAILS
GD7	2.5170E-01	SINGLE TRAIN BY SUPPORT, OTHER TRAINS FAIL
GD8	1.2840E-01	TWO TRAINS BY SUPPORT OTHER SUCCESS
GD9	1.8570E-01	TWO TRAINS BY SUPPORT OTHER TRAIN FAILS
GDF	1.0000E+00	GUARANTEED FAILED
GDS	0.0000E+00	DIESEL NOT REQUIRED

Top Event: GE
Description: No Description

GE1	0.0000E+00	NO SUPPORTS REQ'D
GEF	1.0000E+00	G.F.

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Top Event: HE
Description: No Description

HE1	0.0000E+00	NO SUPPORTS REQ'D
HEF	1.0000E+00	G.F.

Top Event: HH
Description: No Description

HH1	5.0005E-03	ALL REQUIRED SUPPORT AVAIL.
HH2	5.2706E-03	SUPPORT FOR ONE TRAIN OF IGNITORS FAILED
HHF	1.0000E+00	G.F. OF TOP EVENT HH

Top Event: HIPR
Description: No Description

HIPRF	1.0000E+00	G.F.
HIPRS	0.0000E+00	G.S.

Top Event: HPI
Description: No Description

HPIF	1.0000E+00	G.F.
HPIS	0.0000E+00	G.S.

Top Event: HPL
Description: No Description

HPLF	1.0000E+00	G.F.
HPLS	0.0000E+00	G.S.

Top Event: IC
Description: No Description

IC1	9.9040E-07	ICE CONDENSER UNAVAIL.

Top Event: ICRYY
Description: No Description

CLRFX1	6.2249E-07	GIVEN MEDIUM LOCA, IP FAILED, AND ALL SUPP. AVAIL.
CLRFX2	1.9690E-06	GIVEN MEDIUM LOCA WITH IP AND RB FAILED
CLRFX3	4.5161E-06	GIVEN LARGE LOCA, IP FAILED, AND ALL SUPP. AVAIL.
CLRFX4	5.4005E-04	GIVEN LARGE LOCA WITH IP AND RB FAILED
CLX1	9.6683E-06	GIVEN MEDIUM LOCA WITH IP AND RF FAILED DUE TO SUPPORT UNAVAIL.
ICRX1	5.7035E-07	GIVEN MEDIUM LOCA WITH ALL SUPP. AVAIL.

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ICRX2	5.7063E-07	GIVEN MEDIUM LOCA WITH RB FAILED
ICRX3	5.9967E-07	GIVEN LARGE LOCA WITH ALL SUPP. AVAIL.
ICRX4	2.1956E-06	GIVEN LARGE LOCA WITH RB FAILED
IPCLX1	6.7324E-07	GIVEN MEDIUM LOCA WITH RF FAILED DUE TO SUPPORT UNAVAIL.
IPCLX2	1.0390E-05	GIVEN LARGE LOCA WITH RF FAILED DUE TO SUPPORT UNAVAIL.
IPRFX1	1.2103E-06	GIVEN CL FAILED WITH ALL SUPP. AVAIL.
IPRFX2	4.1662E-06	GIVEN CL AND RB FAILED
LCLX1	3.9624E-03	GIVEN LARGE LOCA WITH IP AND RF FAILED DUE TO SUPPORT UNAVAIL.
RFX1	5.1094E-04	GIVEN IP AND CL FAILED WITH ALL SUPP. AVAIL.
RFX2	1.6414E-03	GIVEN IP, CL, AND RB FAILED

Top Event: IEVI
Description: No Description

VI1	4.0074E-06	RHR INJECTION INITIATING EVENT

Top Event: IEVS
Description: No Description

VSIE	7.2120E-06	RHR SUCTION INITIATING EVENT

Top Event: INA
Description: No Description

INAF	1.0000E+00	G.F.
INAS	0.0000E+00	G.S.

Top Event: INB
Description: No Description

INBF	1.0000E+00	G.F.
INBS	0.0000E+00	G.S.

Top Event: INC
Description: No Description

INCF	1.0000E+00	G.F.
INCS	0.0000E+00	G.S.

Top Event: INN
Description: No Description

INNF	1.0000E+00	G.F.
INNS	0.0000E+00	G.S.

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Top Event: INTPR
Description: No Description

INTPRF	1.0000E+00	RCS PRESSURE > 2000 PSIA - G.F.
INTPRS	0.0000E+00	RCS PRESSURE > 2000 PSIA - G.S.

Top Event: IP
Description: No Description

IP1	9.0383E-04	ALL SUPP. AVAIL.
IPF	1.0000E+00	G.F.

Top Event: IYA
Description: No Description

IYAF	1.0000E+00	G.F.
IYAS	0.0000E+00	G.S.

Top Event: IYB
Description: No Description

IYBF	1.0000E+00	G.F.
IYBS	0.0000E+00	G.S.

Top Event: IYC
Description: No Description

IYCF	1.0000E+00	G.F.
IYCS	0.0000E+00	G.S.

Top Event: IYN
Description: No Description

IYNF	1.0000E+00	G.F.
IYNS	0.0000E+00	G.S.

Top Event: KVIV
Description: No Description

BUS1	2.5524E-05	THREE BUSES UNAVAIL.
BUS2	6.2896E-10	TWO BUSES UNAVAIL.
BUS3	2.5126E-14	ONE BUS UNAVAIL.
BUS4	1.1745E-18	SYSTEM UNAVAIL.
BUSA	6.6403E-04	LOSP, THREE BUSES UNAVAIL.
BUSB	7.5495E-05	LOSP, TWO BUSES UNAVAIL.

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BUSC	4.2809E-05	LOSP, ONE BUS UNAVAIL.
BUSD	3.3951E-05	LOSP, SYSTEM

Top Event: LCL
Description: No Description

LCL1	3.9540E-03	GIVEN LARGE LOCA WITH IP SUCCEEDED AND ALL SUPP. AVAIL.
LCL2	3.9610E-03	GIVEN LARGE LOCA WITH IP FAILED DUE TO SIS PUMP UNAVAIL.
LCL3	1.1500E-02	GIVEN LARGE LOCA WITH IP FAILED
LCLF	1.0000E+00	G.F.

Top Event: LNA
Description: No Description

LNAF	1.0000E+00	G.F.
LNAS	0.0000E+00	G.S.

Top Event: LNB
Description: No Description

LNBF	1.0000E+00	G.F.
LNBS	0.0000E+00	G.S.

Top Event: LNC
Description: No Description

LNCF	1.0000E+00	G.F.
LNCS	0.0000E+00	G.S.

Top Event: LNN
Description: No Description

LNNF	1.0000E+00	G.F.
LNNS	0.0000E+00	G.S.

Top Event: LOWPR
Description: No Description

LOWPRF	1.0000E+00	RCS PRESSURE NOT LOW (>200 PSIA) - G.F.
LOWPRS	0.0000E+00	RCS PRESSURE NOT LOW (>200 PSIA) - G.S.

Top Event: LYA
Description: No Description

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LYAF	1.0000E+00	G.F.
LYAS	0.0000E+00	G.S.

Top Event: LYB
Description: No Description

LYBF	1.0000E+00	G.F.
LYBS	0.0000E+00	G.S.

Top Event: LYC
Description: No Description

LYCF	1.0000E+00	G.F.
LYCS	0.0000E+00	G.S.

Top Event: LYN
Description: No Description

LYNF	1.0000E+00	G.F.
LYNS	0.0000E+00	G.S.

Top Event: MA
Description: No Description

MA1	7.5990E-03	TP FAILED DUE TO SUPPORT FAILURES, CST AVAIL. AND ALL SUPPORT
MA10	8.5790E-02	TP FAILED, DEGRADED HVAC, ALTERNATE SUCTION REQUIRED AND ALL SUPPORT
MA11	1.0350E-01	TP SUCCESSFUL, ALTERNATE SUCTION REQUIRED WITH 1 ERCW TRAIN AVAIL. AND ALL SUPPORT
MA12	8.0440E-02	TP FAILED, ALTERNATE SUCTION REQUIRED WITH 1 ERCW TRAIN AVAIL. AND ALL SUPPORT
MA13	1.0460E-01	TP SUCCESSFUL, DEGRADED HVAC, ALTERNATE SUCTION REQUIRED WITH 1 ERCW TRAIN AVAIL.
MA14	7.1280E-02	TP FAILED, DEGRADED HVAC, ALTERNATE SUCTION REQUIRED WITH 1 ERCW TRAIN AVAIL.
MA2	1.0160E-01	TP FAILED DUE TO SUPPORT FAILURES, CST FAILED AND ALL SUPP. AVAIL.
MA3	7.6220E-03	TP SUCCESSFUL, CST AVAIL. AND ALL SUPP. AVAIL.
MA4	7.2670E-03	TP FAILED, CST AVAIL. AND ALL SUPPORT
MA5	7.6720E-03	TP SUCCESFUL, DEGRADED HVAC, CST AVAIL. AND ALL SUPP. AVAIL.
MA6	6.6650E-03	TP FAILED, DEGRADED HVAC, CST AVAIL. AND ALL SUPP. AVAIL.
MA7	1.0210E-01	TP SUCCESSFUL, ALTERNATE SUCTION REQUIRED AND ALL SUPPORT
MA8	9.3780E-02	TP FAILED, ALTERNATE SUCTION REQUIRED AND ALL SUPPORT
MA9	1.0280E-01	TP SUCCESSFUL, DEGRADED HVAC, ALTERNATE SUCTION

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		REQUIRED AND ALL SUPPORT
MAF	1.0000E+00	G.F.

Top Event: MACRO
Description: No Description

MACROS	0.0000E+00	G.S.

Top Event: MB
Description: No Description

MB1	7.5990E-03	TP BYPASS, MA BYPASS, ALL SUPPORT
MB10	7.4250E-02	TP SUCCESSFUL, MA FAILED, CST AVAIL.
MB11	6.7230E-03	TP FAILED, MA SUCCESSFUL, CST AVAIL.
MB12	8.1540E-02	TP FAILED, MA FAILED, CST AVAIL.
MB13	7.1530E-03	TP SUCCESSFUL, MA SUCCESSFUL, CST AVAIL., DEGRADED HVAC
MB14	7.4790E-02	TP SUCCESSFUL, MA FAILED, CST AVAIL., DEGRADED HVAC
MB15	6.2180E-03	TP FAILED, MA SUCCESSFUL, CST AVAIL., DEGRADED HVAC
MB16	7.3290E-02	TP FAILED, MA FAILED, CST AVAIL., DEGRADED HVAC
MB17	1.0210E-01	TP SUCESSFUL, MA BYPASS, CST UNAVAIL.
MB18	9.3780E-02	TP FAILED, MA BYPASS, CST UNAVAIL.
MB19	1.0350E-01	TP SUCESSFUL, MA BYPASS, CST UNAVAIL., ONLY 1 ERCW TRAIN AVAIL.
MB2	1.0160E-01	TP BYPASS, MA BYPASS, CST UNAVAIL.
MB20	8.0440E-02	TP FAILED, MA BYPASS, CST UNAVAIL., ONLY 1 ERCW TRAIN AVAIL.
MB21	1.0280E-01	TP SUCESSFUL, MA BYPASS, CST UNAVAIL., DEGRADED HVAC
MB22	8.5790E-02	TP FAILED, MA BYPASS, CST UNAVAIL., DEGRADED HVAC
MB23	1.0460E-01	TP SUCESSFUL, MA BYPASS, CST UNAVAIL., ONLY 1 ERCW TRAIN AVAIL., DEGRADED HVAC
MB24	7.1280E-02	TP FAIL, MA BYPASS, CST UNAVAIL., ONLY 1 ERCW TRAIN AVAIL., DEGRADED HVAC
MB25	1.1150E-01	TP BYPASS, MA SUCCESSFUL, CST UNAVAIL.
MB26	1.3690E-02	TP BYPASS, MA FAILED, CST UNAVAIL.
MB27	1.1230E-01	TP SUCCESSFUL, MA SUCCESSFUL, CST UNAVAIL.
MB28	1.2920E-02	TP SUCCESSFUL, MA FAILED, CST UNAVAIL.
MB29	1.0080E-01	TP FAILED, MA SUCCESSFUL, CST UNAVAIL.
MB3	7.6220E-03	TP SUCCESSFUL, MA BYPASS, ALL SUPPORT
MB30	2.6080E-02	TP FAILED, MA FAILED, CST UNAVAIL.
MB31	1.1310E-01	TP SUCCESSFUL, MA SUCCESSFUL, CST UNAVAIL., DEGRADED HVAC
MB32	1.2960E-02	TP SUCCESSFUL, MA FAILED, CST UNAVAIL., DEGRADED HVAC
MB33	9.1500E-02	TP FAILED, MA SUCCESSFUL, CST UNAVAIL., DEGRADED HVAC
MB34	2.4950E-02	TP FAILED, MA FAILED, CST UNAVAIL., DEGRADED HVAC
MB4	7.2670E-03	TP FAIL, MA BYPASS, ALL SUPPORT

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MB5	7.6720E-03	TP SUCESSFUL,DEGRADED HVAC, MA BYPASS, CST AVAIL.
MB6	6.6650E-03	TP FAILED,DEGRADED HVAC, MA BYPASS, CST AVAIL.
MB7	7.0850E-03	TP BYPASS, MA SUCCESSFUL, CST AVAIL.
MB8	7.4700E-02	TP BYPASS, MA FAILED, CST AVAIL.
MB9	7.1100E-03	TP SUCCESSFUL, MA SUCCESSFUL, CST AVAIL.
MBF	1.0000E+00	G.F.

Top Event: MDE
Description: No Description

MDE1	1.0650E-03	MAINTENANCE ALIGNMENT ON STRAINER FOR DE HEADER
MDEF	1.0000E+00	G.F.

Top Event: MELT
Description: No Description

MELTF	1.0000E+00	NO CORE MELT FOR MEDIUM LOCA - G.F.
MELTS	0.0000E+00	NO CORE MELT FOR MEDIUM LOCA - G.S.

Top Event: MELTB
Description: No Description

MELTBF	1.0000E+00	MELT WITH CNMT BYPASSED - G.F.
MELTBS	0.0000E+00	MELT WITH CNMT BYPASSED - G.S.

Top Event: MELTI
Description: No Description

MELTIF	1.0000E+00	MELT WITHOUT CNMT ISOLATED - G.F.
MELTIS	0.0000E+00	MELT WITHOUT CNMT ISOLATED - G.S.

Top Event: MELTL
Description: No Description

MELTLF	1.0000E+00	G.F.
MELTLS	0.0000E+00	G.S.

Top Event: MELTS
Description: No Description

MELTSF	1.0000E+00	MELT WITH LARGE PENETRATION ISOLATION FAILURE - G.F.
MELTSS	0.0000E+00	MELT WITH LARGE PENETRATION ISOLATION FAILURE - G.S.

Top Event: MF

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Description: No Description

MF1	2.3885E-02	ALL SUPP. AVAIL.
MFF	1.0000E+00	G.F.

Top Event: MR
Description: No Description

MR1	8.7710E-03	OPERATOR INITIATES MANUAL ROD INSERTION
MRF	1.0000E+00	G.F. OF MR

Top Event: MS
Description: No Description

MS1	2.2688E-04	ALL SUPP. AVAIL.
MSF	1.0000E+00	GUARNTEED FAILURE
MSS	0.0000E+00	GUARANTEED SUCCESS

Top Event: MU
Description: No Description

MU1	4.2160E-01	GIVEN SLOCA WITH CNMT SPRAY TRAIN A (OR B) FAILED
MU2	4.3170E-01	GIVEN SLOCA AND ALL SUPP. AVAIL.
MU3	3.3861E-02	GIVEN SGTR WITH ALL SUPP. AVAIL.
MU4	4.6724E-01	GIVEN INDUCED SGTR AND LOCA
MU5	3.2572E-02	GIVEN SGTR WITH DAAC (OR DBAC, OR B1) OR A1U2 (OR B1U2) FAILED
MU6	4.8403E-01	GIVEN INDUCED SGTR AND SLOCA WITH DAAC (OR DBAC, OR B1) OR A1U2 (OR B1U2) FAILED
MU7	3.2537E-02	GIVEN SGTR WITH DAAC (OR DBAC, OR B1) AND A1U2 (OR B1U2) FAILED
MU8	4.8404E-01	GIVEN INDUCED SGTR AND SLOCA WITH DAAC (OR DBAC, OR B1) AND A1U2 (OR B1U2) FAILED
MUF	1.0000E+00	G.F.

Top Event: OB
Description: No Description

OB1	4.4179E-02	ALL SUPP. AVAIL.
OBF	1.0000E+00	G.F.

Top Event: OF
Description: No Description

OF1	3.8010E-02	GIVEN GENERAL TRANSIENT NOT REQUIRING SI WITH AFW FAILED
OF2	4.8920E-02	GIVEN TRANSIENT REQUIRING SI WITH AFW FAILED
OFF	1.0000E+00	G.F.

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Top Event: OG
Description: No Description

OG1	4.8853E-04	ALL SUPP. AVAIL.
OGF	1.0000E+00	G.F.

Top Event: OGR1
Description: No Description

OGR11	2.5500E-01	FAILURE TO RECOVERY OFFSITE GRID IN ONE HOUR
OGR1S	0.0000E+00	OFFSITE GRID SUCCESSFUL

Top Event: OS
Description: No Description

OS1	3.5650E-02	OPERATOR FAILED TO ALIGN ECCS, GIVEN ESFAS FAILED FOLLOWING A MLOCA OR LLOCA
OS2	3.2500E-02	OPERATOR FAILED TO ALIGN ECCS, GIVEN ESFAS FAILED (MSLBOC,SGTR,SLOCA)
OS3	2.0850E-03	OPERATOR FAILED TO START AFW, GIVEN RX TRIP WITH NO SI REQUIRED
OS4	1.2140E-02	OPERATOR FAILED TO START AFW, GIVEN ATWS WITH AMSAC FAILURE
OS5	1.2700E-01	BACKUP RESTART TIMERS, GIVEN LOSP AND D/G STARTUP
OSF	1.0000E+00	G.F.
OSS	0.0000E+00	G.S.

Top Event: OT
Description: No Description

OT1	1.6490E-03	OPERATORS TERMINATE CNMT SPRAY
OTF	1.0000E+00	GUARANTEED FAILRUE
OTS	0.0000E+00	G.S.

Top Event: PA
Description: No Description

PA1	3.2562E-03	ALL SUPP. AVAIL.
PA2	2.0688E-02	LOSS OF PD (CONTROL AIR)
PA3	4.0285E-03	LOSS OF A1U2 OR CE OR GE
PAF	1.0000E+00	G.F.

Top Event: PAB
Description: No Description

PAB1	4.4760E-05	ALL SUPP. AVAIL.

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PAB2	7.8314E-04	LOSS OF PD
PAB3	5.5098E-05	LOSS OF A1U2
PAB4	3.2550E-03	LOSS OF DAAC
PAB5	2.1042E-02	LOSS OF PD AND DAAC
PAB6	6.0252E-05	LOSS OF A1U2 AND B1U2
PAB7	4.0481E-03	LOSS OF B1U2 AND DAAC
PABF	1.0000E+00	G.F.

Top Event: PB
Description: No Description

PB1	3.2200E-03	ALL SUPP. AVAIL., PA = S
PB10	2.1040E-02	LOSS OF PD AND DAAC
PB11	4.0480E-03	LOSS OF (FE OR B1U2 OR HE) AND DAAC
PB12	4.0040E-03	LOSS OF (FE OR B1U2 OR HE) AND (CE OR A1U2 OR GE), PA = S
PB13	1.4960E-02	LOSS OF (FE OR B1U2 OR HE) AND (CE OR A1U2 OR GE), PA = F
PB2	1.3750E-02	ALL SUPP. AVAIL., PA = F
PB3	2.0690E-02	LOSS OF PD, PA = S
PB4	3.7850E-02	LOSS OF PD, PA = F
PB5	3.2120E-03	LOSS OF A1U2 OR CE OR GE, PA = S
PB6	1.3680E-02	LOSS OF A1U2 OR CE OR GE, PA = F
PB7	4.0060E-03	LOSS OF B1U2 OR FE OR HE, PA = S
PB8	1.6920E-02	LOSS OF B1U2 OR FE OR HE, PA = F
PB9	3.2550E-03	LOSS OF DAAC
PBF	1.0000E+00	G.F.

Top Event: PD
Description: No Description

PD1	1.1200E-03	ALL SUPP. AVAIL.
PD2	3.5332E-03	LOSS OF A2 OR B1
PD3	1.3808E-03	LOSS OF A3 OR B3
PD4	4.0113E-02	LOSS OF A2 AND B1
PD5	3.2458E-02	LOSS OF (A2 OR B1) AND (A3 OR B3)
PD6	7.6925E-03	LOSS OF A3 AND B3
PDF	1.0000E+00	G.F.

Top Event: PE
Description: No Description

PE1	9.9705E-07	ALL SUPP. AVAIL.
PE2	1.1338E-04	LOSS OF CE OR DE
PEF	1.0000E+00	G.F.

Top Event: PI
Description: No Description

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PI1	1.4208E-04	ALL SUPPORT
PI2	1.2622E-02	A1 FAILED
PI3	2.4500E-02	BOTH BLOCK VALVE SUPPORT FAILED
PIF	1.0000E+00	G.F.
PIS	0.0000E+00	G.S.

Top Event: PL
Description: No Description

PL1	6.6200E-01	PROBABILITY POWER LEVEL > 40%

Top Event: PR
Description: No Description

PR1	4.1449E-04	STEAM CHALLENGE, ALL SUPPORT
PR2	9.2581E-04	STEAM CHALLENGE, ONE PORV SUPPORT FAILED
PR3	8.1814E-03	STEAM CHALLENGE, BOTH PORV SUPPORTS FAILED
PR4	2.3152E-02	STEAM CHALLENGE, ONE BLOCK VALVE SUPPORT FAILED
PR5	2.3853E-02	STEAM CHALLENGE, ONE PORV SUPPORT FAILED, BLOCK VALVE SUPPORT IN THE OTHER TRAIN FAILED
PR6	4.6109E-02	STEAM CHALLENGE, BOTH BLOCK VALVE SUPPORT FAILED
PRA	5.6447E-03	WATER CHALLENGE, ALL SUPP. AVAIL.
PRB	2.7350E-02	WATER CHALLENGE, ONE PORV SUPPORT FAILED
PRC	2.9913E-01	WATER CHALLENGE, BOTH PORV SUPPORT FAILED
PRD	2.8169E-02	WATER CHALLENGE, ONE BLOCK VALVE SUPPORT FAILED
PRE	4.9787E-02	WATER CHALLENGE, ONE PORV SUPPORT FAILED, ONE BLOCK VALVE SUPPORT IN THE OTHER TRAIN FAILED
PRF	1.0000E+00	G.F.
PRG	5.1983E-02	WATER CHALLENGE, BOTH BLOCK VALVE SUPPORT FAILED
PRH	9.7320E-03	OPERATORS ISOLATE STUCK OPEN PORV
PRS	0.0000E+00	G.S.

Top Event: RA
Description: No Description

RA1	1.9068E-02	GIVEN MEDIUM OR LARGE LOCA WITH ALL SUPP. AVAIL.
RA2	2.2860E-02	GIVEN IE IS NOT A MEDIUM OR LARGE LOCA WITH ALL SUPP. AVAIL.
RAF	1.0000E+00	G.F.

Top Event: RABX
Description: No Description

RABX1	1.2461E-03	GIVEN MEDIUM OR LARGE LOCA WITH ALL SUPP. AVAIL.
RABX2	1.7812E-03	GIVEN IE IS NOT A MEDIUM OR LARGE LOCA WITH ALL SUPP. AVAIL.

Top Event: RB

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Description: No Description

RB1	1.8170E-02	GIVEN MEDIUM OR LARGE LOCA WITH ALL SUPP. AVAIL. AND RA SUCCEEDED
RB2	1.9070E-02	GIVEN MEDIUM OR LARGE LOCA WITH RA FAILED DUE TO SUPPORT UNAVAIL. AND ALL SUPPORT TO RB AVAIL.
RB3	6.5340E-02	GIVEN MEDIUM OR LARGE LOCA WITH RA FAILED AND ALL SUPPORT TO RB AVAIL.
RB4	2.1570E-02	GIVEN IE IS NOT A MEDIUM OR LARGE LOCA WITH RA SUCCEEDED AND ALL SUPP. AVAIL. TO RB
RB5	2.2860E-02	GIVEN IE IS NOT A MEDIUM OR LARGE LOCA WITH RA FAILED DUE TO SUPPORT FAILURE AND ALL SUPP. AVAIL. TO RB
RB6	7.7910E-02	GIVEN IE IS NOT A MEDIUM OR LARGE LOCA WITH RA FAILED AND ALL SUPP. AVAIL. TO RB
RBF	1.0000E+00	G.F.

Top Event: RD
Description: No Description

RD1	1.1486E-02	GIVEN ALL SUPP. AVAIL.
RD2	1.5082E-02	GIVEN LOSS OF ONE RHR HEAT EXCHANGER TRAIN
RD3	1.9294E-02	GIVEN LOSS OF 480V POWER TRAIN 1B1-B (TOP EVENT B1)
RD4	2.3573E-02	GIVEN LOSS OF ONE RHR HEAT EXCHANGER TRAIN AND 480V POWER TRAIN 1B1-B (TOP EVENT B1)
RDF	1.0000E+00	G.F.

Top Event: REC
Description: No Description

REC1	3.7600E-02	TWO DIESELS FAIL, TD SUCCESS
REC2	3.7600E-02	TWO DIESELS FAIL, TD SUCCESS
REC3	9.0320E-02	TWO DIESELS FAIL, TD FAILS
REC4	3.7600E-02	TWO DIESELS FAIL, TD SUCCESS
REC5	6.4720E-02	ONE DIESEL FAILS, TD SUCCESS
REC6	4.6900E-02	ONE DIESE FAILS, TD SUCCESS, 6.9KV SD BD VENT. FAILS
RECF	1.0000E+00	G.F.

Top Event: RF
Description: No Description

RF1	5.1020E-04	GIVEN MEDIUM LOCA WITH IP AND CL SUCCEEDED AND ALL SUPP. AVAIL.
RF2	1.6370E-03	GIVEN MEDIUM LOCA WITH IP AND CL SUCCEEDED AND RB FAILED
RF3	5.7840E-03	GIVEN MEDIUM LOCA, IP SUCCEEDED, CL FAILED, AND ALL SUPP. AVAIL.
RF4	1.5550E-01	GIVEN MEDIUM LOCA WITH IP SUCCEEDED AND CL AND RB

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		FAILED
RF5	5.1030E-04	GIVEN MEDIUM LOCA, IP FAILED DUE TO SI PMP UNAVAIL., CL SUCCEEDED, AND ALL SUPP. AVAIL.
RF6	1.6400E-03	GIVEN MEDIUM LOCA, IP FAILED DUE TO SI PMP UNAVAIL., CL SUCCEEDED, AND RB FAILED
RF7	6.4390E-02	GIVEN MEDIUM LOCA, IP FAILED DUE TO SI PMP UNAVAIL., CL FAILED, AND ALL SUPP. AVAIL.
RF8	2.0370E-01	GIVEN MEDIUM LOCA WITH IP FAILED DUE TO SI PMP UNAVAIL. AND CL AND RB FAILED
RF9	7.0870E-04	GIVEN MEDIUM LOCA, IP FAILED, CL SUCCEEDED, AND ALL SUPP. AVAIL.
RFA	3.9810E-03	GIVEN MEDIUM LOCA WITH IP AND RB FAILED AND CL SUCCEEDED
RFB	8.4730E-01	GIVEN MEDIUM LOCA WITH IP AND CL FAILED AND ALL SUPP. AVAIL.
RFC	8.4780E-01	GIVEN MEDIUM LOCA, IP, CL, AND RB FAILED
RFD	5.0830E-04	GIVEN LARGE LOCA WITH IP AND CL SUCCEEDED AND ALL SUPP. AVAIL.
RFE	1.1050E-03	GIVEN LARGE LOCA WITH IP AND CL SUCCEEDED AND RB FAILED
RFF	1.0000E+00	G.F.
RFG	9.9140E-04	GIVEN LARGE LOCA, IP SUCCEEDED, CL FAILED, AND ALL SUPP. AVAIL.
RFH	1.3610E-01	GIVEN LARGE LOCA WITH IP SUCCEEDED AND CL AND RB FAILED
RFI	5.0850E-04	GIVEN LARGE LOCA, IP FAILED DUE TO SI PMP UNAVAIL., CL SUCCEEDED, AND ALL SUPP. AVAIL.
RFJ	1.1060E-03	GIVEN LARGE LOCA, IP FAILED DUE TO SI PMP UNAVAIL., CL SUCCEEDED, AND RB FAILED
RFK	1.1400E-03	GIVEN LARGE LOCA, IP FAILED DUE TO SI PMP UNAVAIL., CL FAILED, AND ALL SUPP. AVAIL.
RFL	1.3630E-01	GIVEN LARGE LOCA WITH IP FAILED DUE TO SI PMP UNAVAIL. AND CL AND RB FAILED
RFM	6.8370E-04	GIVEN LARGE LOCA, IP FAILED, CL SUCCEEDED, AND ALL SUPP. AVAIL.
RFN	2.2060E-03	GIVEN LARGE LOCA WITH IP AND RB FAILED AND CL SUCCEEDED
RFO	5.7700E-02	GIVEN LARGE LOCA WITH IP AND CL FAILED AND ALL SUPP. AVAIL.
RFP	2.1130E-01	GIVEN LARGE LOCA, IP, CL, AND RB FAILED

Top Event: RH
Description: No Description

RH1	6.6651E-03	GIVEN ALL SUPP. AVAIL.
RH2	1.5014E-02	GIVEN ONE RHR PUMP TRAIN (RA OR RB) OR 480V TRAIN A (A1) FAILED
RHF	1.0000E+00	G.F.

Top Event: RHRS
Description: No Description

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RHRSF	1.0000E+00	RHR SPRAY RECIRCULATION - G.F.
RHRSS	0.0000E+00	RHR SPRAY RECIRCULATION - G.S.

Top Event: RI
Description: No Description

RI1	3.2090E-04	GIVEN ALL SUPPORT AVAILABEL AND SI SUCCEEDED
RI2	5.0320E-04	GIVEN SI SUCCEEDED AND RA (OR RB) FAILED
RI3	3.2110E-04	GIVEN SI FAILED DUE TO SI PMP UNAVAIL. AND ALL SUPP. AVAIL.
RI4	5.0350E-04	GIVEN SI FAILED DUE TO SI PUMPS UNAVAIL. AND RA (OR RB) FAILED
RI5	5.3080E-04	GIVEN SI FAILED AND ALL SUPP. AVAIL.
RI6	8.2330E-04	GIVEN SI FAILED AND RA (OR RB) FAILED
RIF	1.0000E+00	G.F.

Top Event: RL
Description: No Description

RL1	1.7189E-05	GIVEN ALL SUPP. AVAIL.
RL2	1.7877E-05	GIVEN TOP EVENT DCAC (OR DDAC) FAILED
RL3	3.3109E-04	GIVEN TOP EVENTS DCAC AND DDAC FAILED
RL4	4.2971E-03	GIVEN TOP EVENT DAAC (OR DBAC) FAILED
RL5	4.2921E-03	GIVEN TOP EVENTS DAAC AND DBAC FAILED
RL6	4.2819E-03	GIVEN TOP EVENTS DAAC (OR DBAC) AND DCAC (OR DDAC) FAILED
RLF	1.0000E+00	G.F.

Top Event: RQ
Description: No Description

RQF	1.0000E+00	G.F.
RQS	0.0000E+00	G.S.

Top Event: RR
Description: No Description

RR1	2.9371E-03	GIVEN HIGH HEAD RECIRC IS REQD WITH ALL SUPP. AVAIL.
RR2	1.0922E-02	GIVEN HIGH HEAD RECIRC IS REQD WITH BOTH CCP TRAINS FAILED
RR3	1.0914E-02	GIVEN HIGH HEAD RECIRC IS REQD WITH BOTH SIS TRAIN FAILED
RR4	1.1327E-02	GIVEN HIGH HEAD RECIRC IS REQD AND LOSS OF SUPPORT TO TRAIN B EQUIPMENT
RR5	1.0815E-02	GIVEN HIGH HEAD RECIRC IS REQD AND LOSS OF SUPPORT TO TRAIN A EQUIPMENT
RR6	1.9750E-02	GIVEN HIGH HEAD RECIRC IS REQD AND TOP EVENT B1

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		FAILED
RR7	2.4236E-02	GIVEN HIGH HEAD RECIRC IS REQD AND TOP EVENT A1 FAILED
RR8	4.6390E-03	GIVEN HIGH HEAD RECIRC IS NOT REQD AND TOP EVENT B1 FAILED
RR9	4.7274E-03	GIVEN HIGH HEAD RECIRC IS NOT REQD AND TOP EVENT A1 FAILED
RRA	8.4906E-03	GIVEN HIGH HEAD RECIRC IS NOT REQD, TOP EVENT B1 FAILED AND LOSS OF SUPPORT TO TRAIN A EQUIPMENT
RRB	4.6064E-04	GIVEN HIGH HEAD RECIRC IS NOT REQD AND ALL SUPP. AVAIL.
RRF	1.0000E+00	G.F.

Top Event: RS
Description: No Description

RS1	5.2243E-03	GIVEN ALL SUPP. AVAIL.
RS2	1.4269E-02	GIVEN ONE RHR PUMP TRAIN (RA OR RB) FAILED
RSF	1.0000E+00	G.F.

Top Event: RT
Description: No Description

RT1	1.6159E-04	ALL SUPPORT - NO TRIP OR LOSP
RT2	1.7472E-04	1 DC TRAIN FAILED - NO RX TRIP OR LOSP
RT3	6.1438E-04	BOTH DC TRAINS FAILED - NO RX TRIP OR LOSP
RT4	1.6879E-04	FAILURE OF 1 SSPS TRAIN - NO RX TRIP OR LOSP
RT5	1.7351E-04	FAILURE OF DC POWER & SSPS IN SAME TRAIN - NO RX TRIP OR LOSP
RT6	1.8024E-04	FAILURE OF 1 DC TRAIN & OPPOSITE SSPS TRAIN - NO RX TRIP OR LOSP
RT7	6.2895E-04	FAILURE OF 1 SSPS TRAIN & BOTH DC TRAINS - NO RX TRIP OR LOSP
RT8	1.6708E-03	FAILURE OF BOTH SSPS TRAINS - NO RX TRIP OR LOSP
RT9	1.6824E-03	FAILURE OF BOTH SSPS TRAINS & 1 DC TRAIN
RTA	2.1393E-03	FAILURE OF BOTH SSPS TRAINS & BOTH DC TRAINS - NO RX TRIP OR LOSP
RTB	6.4446E-06	LOSP INITIATING EVENT
RTS	0.0000E+00	RX TRIP INITIATING EVENT

Top Event: RVA
Description: No Description

RVA1	8.9290E-03	GIVEN ALL SUPP. AVAIL.
RVAF	1.0000E+00	G.F.

Top Event: RVABX
Description: No Description

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RVABX1	5.2425E-04	GIVEN ALL SUPP. AVAIL.

Top Event: RVB
Description: No Description

RVB1	8.4810E-03	GIVEN ALL SUPP. AVAIL. AND RVA SUCCEEDED
RVB2	8.9300E-03	GIVEN ALL SUPP. AVAIL. AND RVA FAILED DUE TO SUPPORT UNVAILABLE
RVB3	5.8710E-02	GIVEN ALL SUPP. AVAIL. AND RVA FAILED
RVBF	1.0000E+00	G.F.

Top Event: RW
Description: No Description

RW1	6.5900E-07	FAILURE OF RWST
RWF	1.0000E+00	G.F.

Top Event: S1
Description: No Description

S11	1.2333E-02	GIVEN ALL SUPP. AVAIL.
S1F	1.0000E+00	G.F.

Top Event: S2
Description: No Description

S21	1.1550E-02	GIVEN ALL SUPP. AVAIL. AND TOP S1 SUCCEEDED
S22	1.2330E-02	GIVEN ALL SUPP. AVAIL. TO S2 AND TOP S1 FAILED DUE TO SUPPORT UNAVAIL.
S23	7.4780E-02	GIVEN ALL SUPP. AVAIL. AND S1 FAILED
S2F	1.0000E+00	G.F.

Top Event: SE
Description: No Description

SE1	5.7463E-07	ALL SUPP. AVAIL. WITH RCP MOTOR BEARING FAILURE
SE2	2.6847E-02	AC FAILS
SE5	3.3397E-02	PHASE B PRESENT
SE9	5.3569E-07	VA AND VB FAILS WITH RCP MOTOR BEARING FAILURE
SEA	3.3980E-02	VA AND VB FAIL AND PHASE B PRESENT
SEC	1.8531E-04	TB FAILS WITH RCP MOTOR BEARING FAILURE
SED	2.7368E-02	TB AND AC FAIL
SEF	1.0000E+00	G.F.
SEH	3.3625E-02	TB FAILS AND PHASE B PRESENT
SEI	2.2730E-03	TB FAILS AND LOSP
SES	0.0000E+00	G.S.

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Top Event: SGCLG
Description: No Description

SGCLGF	1.0000E+00	S.G. COOLING - G.F.
SGCLGS	0.0000E+00	S.G. COOLING G.S.

Top Event: SI
Description: No Description

SI1	1.0315E-03	GIVEN ALL SUPP. AVAIL.
SIF	1.0000E+00	G.F.

Top Event: SIRIX
Description: No Description

RIX1	3.2112E-04	GIVEN SI FAILED
RIX2	5.0349E-04	GIVEN SI AND RA (OR RB) FAILED
SIRIX1	5.4755E-07	GIVEN ALL SUPP. AVAIL.
SIRIX2	8.4929E-07	GIVEN RA (OR RB) FAILED

Top Event: SL
Description: No Description

SL1	5.1699E-02	ALL SUPP. AVAIL.
SL2	3.4001E-02	MSLBOC FAILS
SL3	1.6995E-02	ATWS FAILS
SLF	1.0000E+00	G.F.
SLS	0.0000E+00	G.S.

Top Event: SNA
Description: No Description

SNAF	1.0000E+00	G.F.
SNAS	0.0000E+00	G.S.

Top Event: SNB
Description: No Description

SNBF	1.0000E+00	G.F.
SNBS	0.0000E+00	G.S.

Top Event: SNC
Description: No Description

SNCF	1.0000E+00	G.F.
SNCS	0.0000E+00	G.S.

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Top Event: SNN
Description: No Description

SNNF	1.0000E+00	G.F.
SNNS	0.0000E+00	G.S.

Top Event: SP
Description: No Description

SP1	9.2231E-04	GIVEN ALL SUPP. AVAIL.

Top Event: SR
Description: No Description

SR1	3.5428E-02	50% AFW FLOW, MR=S, ALL SUPP. AVAIL.
SR2	2.0191E-01	50% AFW FLOW, MR=S, DA (OR DB) FAILED
SR3	4.0787E-01	50% AFW FLOW, MR=S, DA AND DB FAILED
SR4	5.0114E-01	50% AFW FLOW, MR=F, ALL SUPP. AVAIL.
SR5	5.9262E-01	50% AFW FLOW, MR=F, DA (OR DB) FAILED
SR6	7.0104E-01	50% AFW FLOW, MR=F, DA AND DB FAILED
SRF	1.0000E+00	G.F.
SRS	0.0000E+00	G.S.

Top Event: SU
Description: No Description

SU1	2.3091E-04	CNMT SUMP UNAVAIL. - LARGE OR MEDIUM LOCA EVENTS
SU2	2.9429E-04	CNMT SUMP UNAVAIL. - NOT LARGE OR MEDIUM LOCA EVENTS
SU3	8.8285E-03	CNMT SUMP UNAVAIL. - CORE DAMAGE SCENARIOS

Top Event: SYA
Description: No Description

SYAF	1.0000E+00	G.F.
SYAS	0.0000E+00	G.S.

Top Event: SYB
Description: No Description

SYBF	1.0000E+00	G.F.
SYBS	0.0000E+00	G.S.

Top Event: SYC
Description: No Description

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SYCF	1.0000E+00	G.F.
SYCS	0.0000E+00	G.S.

Top Event: SYN
Description: No Description

SYNF	1.0000E+00	G.F.
SYNS	0.0000E+00	G.S.

Top Event: TB
Description: No Description

TB1	3.1053E-04	ALL SUPP. AVAIL.
TB2	4.8679E-02	LOSS OF SUPPORT TO ONE BOOSTER PUMP
TB3	1.2852E-03	ALL SUPP. AVAIL. WITH LOSP
TB4	6.0956E-02	LOSS OF SUPPORT TO ONE BOOSTER PUMP WITH LOSP
TBF	1.0000E+00	G.F.

Top Event: TD
Description: No Description

TD1	1.3288E-04	TRAIN A, 2 PUMP TRAINS AVAIL., ALL SUPPORTS AVAIL.
TD10	1.3436E-02	TRAIN A, 2 PUMP TRAINS, BA=F, BB=F, OG=F, OTHER SUPPORTS AVAIL.
TD2	1.7352E-02	TRAIN A, 1 PUMP TRAIN FAILS, ALL SUPPORTS AVAIL.
TD21	3.6281E-03	TRAIN B, ALL SUPPORTS AVAIL.
TD22	6.0469E-03	TRAIN B, OG=F
TD3	1.9326E-02	TRAIN A, 1 PUMP TRAIN, OG FAILS, OTHER SUPPORTS AVAIL.
TD31	2.2909E-05	TRAINS A AND B, 2 PUMP TRAINS AVAIL., ALL SUPPORTS AVAIL.
TD32	8.9839E-05	TRAINS A AND B, 1 PUMP TRAIN FAILS, ALL SUPPORTS AVAIL.
TD33	2.5535E-04	TRAINS A AND B, 1 PUMP TRAIN, OG FAILS, OTHER SUPPORTS AVAIL.
TD34	1.4162E-04	TRAINS A AND B, 1 PUMP TRAIN, 6.9KV BDS BA AND BB FAIL, OG=S, OTHER SUPPORT AVAIL.
TD35	3.3262E-04	TRAINS A AND B, 1 PUMP TRAIN, 6.9KV BDS BA AND BB FAIL, DE=F, OG=F, OTHER SUPPORT AVAIL.
TD38	1.0642E-04	TRAINS A AND B, 2 PUMP TRAINS, OG=F, OTHER SUPPORTS AVAIL.
TD39	6.5500E-05	TRAINS A AND B, 2 PUMP TRAINS, BA=F, BB=F, OG=S, OTHER SUPPORTS AVAIL.
TD4	3.0348E-02	TRAIN A, 1 PUMP TRAIN, 6.9KV BDS BA AND BB FAIL, OG=S, OTHER SUPPORT AVAIL.
TD40	1.8849E-04	TRAINS A AND B, 2 PUMP TRAINS, BA=F, BB=F, OG=F, OTHER SUPPORTS AVAIL.
TD5	3.3013E-02	TRAIN A, 1 PUMP TRAIN, 6.9KV BDS BA AND BB FAIL, DE=F, OG=F, OTHER SUPPORT AVAIL.
TD8	3.4031E-04	TRAIN A, 2 PUMP TRAINS, OG=F, OTHER SUPPORTS

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		AVAIL.
TD9	1.2814E-02	TRAIN A, 2 PUMP TRAINS, BA=F, BB=F, OG=S, OTHER SUPPORTS AVAIL.

Top Event: TOT
Description: No Description

MA1C	7.5992E-03	TP FAILED DUE TO SUPPORT FAILURES, CST AVAIL. AND ALL SUPPORT
MA2C	1.0159E-01	TP FAILED DUE TO SUPPORT FAILURES, CST FAILED AND ALL SUPP. AVAIL.
MAMB1	5.6759E-04	ALL SUPP. AVAIL.
MAMB2	1.3906E-03	CST UNAVAIL.
TOT1	3.7638E-05	ALL SUPPORT
TOT2	1.5434E-04	CST UNAVAIL.
TOT3	3.5464E-05	DEGRADED VENTILATION
TOT4	1.5449E-04	DEGRADED VENTILATION AND CST UNAVAIL.
TOT5	2.1250E-03	CST UNAVAIL. AND ONLY 1 ERCW TRAIN AVAIL.
TOT6	2.1303E-03	DEGRADED VENTILATION, CST UNAVAIL. AND ONLY 1 ERCW TRAIN AVAIL.
TP1C	6.3529E-02	ALL SUPPORT
TP2C	6.3102E-02	CST UNAVAIL.
TP3C	7.2597E-02	DEGRADED VENTILATION
TP4C	7.2157E-02	DEGRADED VENTILATION AND CST UNAVAIL.
TP5C	8.1866E-02	CST UNAVAIL. AND ONLY 1 ERCW TRAIN AVAIL.
TP6C	9.0263E-02	DEGRADED VENTILATION, CST UNAVAIL. AND ONLY 1 ERCW TRAIN AVAIL.
TP7C	5.8602E-04	SGTR INITIATING EVENT, SUPPORT AVAIALBLE FOR SWAPOVER
TPMA1	4.6157E-04	ALL SUPPORT
TPMA2	5.9182E-03	CST UNAVAIL.
TPMA3	4.8388E-04	DEGRADED VENTILATION
TPMA4	6.1915E-03	DEGRADED VENTILATION AND CST UNAVAIL.
TPMA5	6.5847E-03	CST UNAVAIL. AND ONLY 1 ERCW TRAIN UNAVAIL.
TPMA6	6.4329E-03	DEGRADED VENTILATION, CST UNAVAIL. AND ONLY 1 ERCW TRAIN AVAIL.

Top Event: TP
Description: No Description

TP1	6.3520E-02	ALL SUPPORT
TP2	6.3100E-02	CST UNAVAIL.
TP3	7.2600E-02	DEGRADED VENTILATION
TP4	7.2160E-02	DEGRADED VENTILATION AND CST UNAVAIL.
TP5	8.1870E-02	CST UNAVAIL. AND ONLY 1 ERCW TRAIN AVAIL.
TP6	9.0260E-02	DEGRADED VENTILATION, CST UNAVAIL. AND ONLY 1 ERCW TRAIN AVAIL.
TP7	1.4650E-04	STGR INITIATING EVENT WITH SUPPORT FOR SWAPOVER AVAIL.
TP8	2.5000E-01	STGR INITIATING EVENT WITH NO SUPPORT AVAIL. FOR SWAPOVER

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TPF	1.0000E+00	G.F.

Top Event: TPR
Description: No Description

TPR1	8.0860E-01	MANUAL LOCAL START TDAFW PUMP AFTER LOSP
TPRF	1.0000E+00	MANUAL LOCAL START TDAFW PUMP AFTER LOSP - G.F.
TPRS	0.0000E+00	MANUAL LOCAL START TDAFW PUMP AFTER LOSP - G.S.

Top Event: TT
Description: No Description

TT1	1.0797E-05	ALL SUPP. AVAIL.
TT2	9.4482E-05	GIVEN ONE TRAIN OF SUPPORT FAILED
TTF	1.0000E+00	G.F.
TTS	0.0000E+00	G.S.

Top Event: UB
Description: No Description

UB1	2.7547E-03	SINGLE TRAIN
UB2	3.1102E-04	TWO TRAINS
UB3	1.8379E-04	THREE TRAINS
UBSYS	1.5697E-04	SYSTEM UNAVAIL.

Top Event: UB1A
Description: No Description

UB1A1	2.7550E-03	ALL SUPP. AVAIL.
UB1AF	1.0000E+00	G.F.

Top Event: UB1B
Description: No Description

UB1B1	2.4510E-03	UNIT BOARD 1A SUCCESSFUL
UB1B2	1.1290E-01	UNIT BOARD 1A FAILS
UB1B3	2.7550E-03	UNIT BOARD 1A FAILS BY SUPPORT
UB1BF	1.0000E+00	G.F.

Top Event: UB1C
Description: No Description

UB1C1	2.3290E-03	UNIT BOARDS 1A AND 1B SUCCESSFUL
UB1C2	5.2060E-02	ONE PREVIOUS UNIT BOARD FAILS
UB1C3	5.9090E-01	ALL PREVIOUS TRAINS FAIL
UB1C4	2.4510E-03	ONE UNIT BOARD FAILS BY SUPPORT, OTHER SUCCESSFUL
UB1C5	1.1290E-01	ONE UNIT BOARD FAILS BY SUPPORT, OTHER FAILS

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UB1CF	1.0000E+00	G.F.

Top Event: UB1D
Description: No Description

UB1D1	2.2330E-03	ALL SUPPORT
UB1D2	4.3340E-02	ONE PREVIOUS TRAIN FAILS
UB1D3	2.1080E-01	TWO PREVIOUS TRAINS FAIL
UB1D4	8.5410E-01	ALL PREVIOUS TRAINS FAIL
UB1D5	2.4510E-03	TWO PREVIOUS TRAINS BY SUPPORT
UB1D6	1.1290E-01	TWO PREVIOUS TRAINS BY SUPPORT, THIRD FAILS INDEPENDENTLY
UB1DF	1.0000E+00	G.F.

Top Event: V1
Description: No Description

V11	7.9970E-06	ALL SUPPORT
V12	3.7900E-03	A2 FAILS
V13	3.2660E-03	B2 FAILS
V14	1.4330E-05	LOSP
V15	3.7870E-03	LOSP AND A2 OR B2 FAILS
V1F	1.0000E+00	G.F.

Top Event: V1R
Description: No Description

V1R1	3.8210E-04	RESTORE VENTILATION - BOTH SHUTDOWN BOARDS AVAIL.
V1RF	1.0000E+00	RECOVERY OF UNIT 1 SHUTDOWN BOARD ROOM VENTILATION - G.F.
V1RS	0.0000E+00	RECOVERY OF UNIT 1 SHUTDOWN BOARD ROOM VENTILATION - G.S.

Top Event: V2
Description: No Description

V21	7.7860E-06	V1 SUCCESS
V210	9.6240E-05	V1 FAILS, A2 FAILS
V211	1.0820E-04	V1 FAILS, B2 FAILS
V212	4.5610E-02	V1 FAILS, A2U2 FAILS
V213	4.4170E-02	V1 FAILS, B2U2 FAILS
V214	3.1460E-03	V1 FAILS, A2 AND A2U2 FAIL
V215	1.5770E-03	V1 FAILS, A2 AND B2U2 FAIL
V216	7.9970E-06	V1 BY SUPPORT
V217	3.7900E-03	V1 BY SUPPORT, A2U2 FAILS
V218	3.2660E-03	V1 BY SUPPORT, B2U2 FAILS
V219	1.3880E-05	V1 SUCCESS, LOSP
V22	2.6420E-02	V1 FAILS
V220	1.3430E-05	V1 SUCCESS, LOSP, A2 OR B2 FAILS

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V221	3.7860E-03	V1 SUCCESS, LOSP, A2U2 OR B2U2 FAILS
V222	3.7890E-03	V1 SUCCESS, LOSP, LOSS OF 1 POWER SUPPLY TO EACH TRAIN
V223	3.1260E-02	V1 FAILS, LOSP
V224	2.5060E-04	V1 FAILS, LOSP, A2 OR B2 FAILS
V225	6.6250E-02	V1 FAILS, LOSP, A2U2 OR B2U2 FAIL
V226	8.2410E-04	V1 FAILS, LOSP, LOSS OF 1 POWER SUPLY TO EACH TRAIN
V227	1.4330E-05	V1 BY SUPPORT, LOSP
V228	3.7870E-03	V1 BY SUPPORT, LOSP, A2U2 OR B2U2 FAIL
V23	7.9970E-06	V1 BY SUPPORT
V24	7.6610E-06	V1 SUCCESS, A2 FAILS
V25	7.6690E-06	V1 SUCCESS, B2 FAILS
V26	3.7890E-03	V1 SUCCESS, A2U2 FAILS
V27	3.2650E-03	V1 SUCCESS, B2U2 FAILS
V28	3.7920E-03	V1 SUCCESS, A2 AND A2U2 FAIL
V29	3.2720E-03	V1 SUCCESS, A2 AND B2U2 FAIL
V2F	1.0000E+00	G.F.

Top Event: V2R
Description: No Description

V2R1	3.5340E-04	RESTORE VENTILATION - BOTH SHUTDOWN BOARDS AVAIL.
V2RF	1.0000E+00	RECOVERY OF UNIT 2 SHUTDOWN BOARD ROOM VENTILATION - G.F.
V2RS	0.0000E+00	RECOVERY OF UNIT 2 SHUTDOWN BOARD ROOM VENTILATION - G.S.

Top Event: V3
Description: No Description

V31	5.5440E-07	ALL SUPP. AVAIL.
V32	6.0280E-06	LOSS OF A1,B1,CE,DE,GE,OR HE
V33	2.7003E-04	LOSS OF (A1,CE,OR GE)AND(B1,DE,OR HE)
V34	1.4488E-02	LOSS OF OG,B3 OR PD
V35	4.5854E-05	LOSS OF (OG,B3,OR PD)&(A1,CE,GE,B1,DE,OR HE)
V36	5.1728E-04	no description entered
V37	3.7074E-02	no description entered
V3F	1.0000E+00	G.F.: FAILURE OF (OG, A1 AND B1) OR {(A2, B2 OR OG) AND (CE, GE, OR A1) AND (HE, DE, OR B1)}

Top Event: VA
Description: No Description

VA1	7.3280E-03	GIVEN ALL SUPP. AVAIL.
VA2	8.8330E-03	GIVEN LOSP AND ALL SUPP. AVAIL.
VAF	1.0000E+00	G.F.

Top Event: VB

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Description: No Description

VB1	7.3530E-03	GIVEN ALL SUPP. AVAIL. WITH VA SUCCEEDED
VB2	7.3280E-03	GIVEN LOSS OF SUPPORT TO VA AND SUPPORT TO VB AVAIL.
VB3	3.8680E-03	GIVEN VA FAILED
VB4	8.8110E-03	GIVEN LOSP AND VA SUCCEEDED WITH ALL SUPP. AVAIL.
VB5	8.8330E-03	GIVEN LOSP AND VA FAILED DUE TO SUPPORT UNAVAIL.
VB6	1.1270E-02	GIVEN LOSP AND VA FAILED
VBF	1.0000E+00	G.F.

Top Event: VC
Description: No Description

VC1	7.0947E-04	GIVEN ALL SUPP. AVAIL.
VC2	8.9203E-03	GIVEN LOSS OF SUPPORT TRAIN A OR B
VCF	1.0000E+00	G.F.

Top Event: VF
Description: No Description

VF1	7.3823E-04	GIVEN ALL SUPP. AVAIL.
VF2	9.0872E-03	GIVEN LOSS OF ONE SUPPORT TRAIN (A OR B)
VFF	1.0000E+00	G.F.

Top Event: VI1
Description: No Description

VI11	2.7803E-03	RHR PUMPS FAIL TO BE ISOLATED

Top Event: VI2
Description: No Description

VI21	5.6100E-03	MANUAL VALVE 74-34 NOT CLOSED

Top Event: VI3
Description: No Description

VI31	8.0690E-04	CHECK VALVE 63-502 NOT CLOSED

Top Event: VI4
Description: No Description

VI41	1.6040E-01	CONDITIONAL FREQUENCY OF LEAK > 800 GPM

Top Event: VI4D

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Description: No Description

VI4D1	6.4450E-07	LEAK > RWST VENT CAPACITY (800 GPM)

Top Event: VI5
Description: No Description

VI5F	1.0000E+00	OPERATOR FAILS TO CLOSES MOV 63-1

Top Event: VI6
Description: No Description

VI61	4.9560E-05	1 OF 2 RELIEF VALVES FAIL TO OPEN
VI62	7.4640E-05	1 OF 3 RELIEF VALVES FAIL TO OPEN

Top Event: VI7
Description: No Description

VI71	1.6040E-01	CONDITIONAL FREQUENCY OF LEAK > 800 GPM
VI72	7.4990E-02	CONDITIONAL FREQUENCY OF LEAK > 1700 GPM

Top Event: VI7D
Description: No Description

VI7D1	5.0140E-07	LEAK > 800 GPM
VI7D2	3.0276E-07	LEAK > 1700 GPM

Top Event: VI8
Description: No Description

VI81	5.0000E-02	PIPING DOWNSTREAM FAIL W/ 800 GPM RELIEF
VI82	1.0000E-01	PIPING DOWNSTREAM FAIL WITH NO RELIEF
VI83	7.0000E-01	RHR FAILURE WITH 1700 GPM RELIEF

Top Event: VI9
Description: No Description

VI91	1.0000E-01	OPERATOR FAILURE - 900 GPM TO PRT & LARGE LOCA OUTSIDE
VI92	1.0000E-01	OPERATOR FAILURE - NO FLOW TO PRT AND SMALL LOCA OUTSIDE
VI93	1.0000E-01	OPERATOR FAILURE - NO FLOW TO PRT AND LARGE LOCA OUTSIDE
VI94	1.0000E-01	OPERATOR FAILURE - 1700 GPM TO PRT AND SMALL LOCA THROUGH RHR PUMP SEAL
VI95	1.0000E-01	OPERATOR FAILURE - 1700 GPM TO PRT AND LARGE LOCA OUTSIDE

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VI96	1.0000E-01	OPERATOR FAILURE - NO FLOW TO PRT AND LARGE LOCA OUTSIDE
VI97	1.0000E-01	OPERATOR FAILURE - < 900 GPM TO RWST, ISOLATION, VI13 = F
VI98	1.0000E-01	OPERATOR FAILURE - < 900 GPM TO RWST, ISOLATION VI12 = F
VI99	1.0000E-01	OPERATOR FAILURE - > 900 RWST RUPTURE, CORE DAMAGE WITHOUT BYPASS
VI9F	1.0000E+00	G.F.

Top Event: VINV
Description: No Description

VIN1	1.9252E-04	SINGLE TRAIN
VIN1A	6.6039E-04	SINGLE TRAIN LOSP
VIN2	2.0593E-06	SYSTEM
VIN2A	1.2377E-05	SYSTEM LOSP

Top Event: VINV1
Description: No Description

VINV11	1.9250E-04	ALL SUPP. AVAIL.
VINV12	6.6040E-04	LOSP
VINV1F	1.0000E+00	G.F.

Top Event: VINV2
Description: No Description

VINV21	1.9050E-04	1B ROOM SUCCESS; ALL SUPPORT
VINV22	1.0700E-02	1B ROOM FAILS
VINV23	6.4840E-04	1B ROOM SUCCESS; LOSP
VINV24	1.8740E-02	1B ROOM FAILS; LOSP
VINV2F	1.0000E+00	G.F.

Top Event: VIV
Description: No Description

VIV1	7.9972E-06	SINGLE TRAIN
VIV1A	3.7900E-03	SINGLE TRAIN, A2 FAILS
VIV1B	3.2659E-03	SINGLE TRAIN, B2 FAILS
VIV1C	1.4328E-05	SINGLE TRAIN, LOSP
VIV1D	3.7864E-03	SINGLE TRAIN, LOSP, A2 OR B2 FAILS
VIV2	2.1125E-07	SYSTEM, ALL SUPPORT
VIV2A	3.6471E-07	SYSTEM, A2 FAILS
VIV2B	1.1923E-05	SYSTEM, A2 AND A2U2 FAILS
VIV2C	5.9763E-06	SYSTEM, A2 AND B2U2 FAILS
VIV2D	3.5324E-07	SYSTEM, B2 FAILS
VIV2E	5.3337E-06	SYSTEM, B2 AND A2U2 FAIL
VIV2F	3.1207E-06	SYSTEM, B2 AND B2U2 FAIL

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VIV2G	4.4786E-07	SYSTEM, LOSP
VIV2H	9.4916E-07	SYSTEM, LOSP, A2 FAILS
VIV2I	1.2546E-05	SYSTEM, LOSP, A2 AND A2U2 FAIL

Top Event: VNV1R
Description: No Description

VNV1R1	2.0100E-03	RESTORE VENTILATION
VNV1RF	1.0000E+00	RECOVERY OF UNIT 1 480V BOARD ROOM B VENTILATION - G.F.
VNV1RS	0.0000E+00	RECOVERY OF UNIT 1 480V BOARD ROOM B VENTILATION - G.S.

Top Event: VNV2R
Description: No Description

VNV2R1	2.0630E-03	RESTORE VENTILATION
VNV2RF	1.0000E+00	RECOVERY OF UNIT 2 480V BOARD ROOM B VENTILATION - G.F.
VNV2RS	0.0000E+00	RECOVERY OF UNIT 2 480V BOARD ROOM B VENTILATION - G.S.

Top Event: VP
Description: No Description

VP1	2.8343E-05	GIVEN ALL SUPP. AVAIL.
VP2	9.9517E-05	GIVEN LOSP AND ALL SUPP. AVAIL.
VPA1	7.3272E-03	FAILURE OF CCP TRAIN A GIVEN ALL SUPP. AVAIL.
VPA2	8.8339E-03	FAILURE OF CCP TRAIN A GIVEN LOSP

Top Event: VS
Description: No Description

VS1	7.3465E-04	GIVEN SI REQUIRED IE AND ALL SUPP. AVAIL.
VS2	9.1389E-03	GIVEN SI REQUIRED IE AND LOSS OF ONE SUPPORT TRAIN (A OR B)
VS3	4.5700E-06	GIVEN IE IS NON-SI TRANSIENT
VSF	1.0000E+00	G.F.

Top Event: VS1
Description: No Description

VS11	8.6510E-04	CHECK VALVE 63-502 NOT CLOSED

Top Event: VS2
Description: No Description

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VS21 7.5940E-06 MANUAL VALVE 74-34 NOT CLOSED

Top Event: VS3
Description: No Description

VS31 3.5490E-02 CONDITIONAL FREQUENCY OF LEAK > RWST VENT CAPACITY

Top Event: VS3D
Description: No Description

VS3D1 2.5664E-07 LEAK > RWST VENT CAPACITY (900 GPM)

Top Event: VS4
Description: No Description

VS4F 1.0000E+00 OPERATOR FAILS TO CLOSE MOV 63-1

Top Event: VS5
Description: No Description

VS51 2.2860E-05 RELIEF VALVE 74-505 OPENS

Top Event: VS6
Description: No Description

VS61 5.3400E-05 1 OF 2 RELIEF VALVES FAIL TO OPEN

Top Event: VS7
Description: No Description

VS71 3.5490E-02 CONDITIONAL FREQUENCY OF LEAK > 900 GPM

Top Event: VS7D
Description: No Description

VS7D1 2.4924E-07 LEAK > 900 GPM

Top Event: VS8
Description: No Description

VS81 4.3320E-02 CONDITIONAL FREQUENCY OF LEAK > 1700 GPM

Top Event: VS8D
Description: No Description

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VS8D1	3.1272E-07	LEAK > 1700 GPM

Top Event: VS9
Description: No Description

VS91	7.0000E-01	RCS DEPRESSURIZING AT 1700 GPM
VS92	8.0000E-01	RCS DEPRESSURIZING AT 900 GPM

Top Event: VSA
Description: No Description

VSA1	1.0000E-01	OPERATOR FAILURE - 1700 GPM TO PRT & SMALL LOCA THROUGH RHR PUMP SEAL
VSA2	1.0000E-01	OPERATOR FAILURE - 900 GPM TO PRT AND SMALL LOCA THROUGH RHR PUMP SEAL
VSA3	1.0000E-01	OPERATOR FAILURE - 1700 GPM TO PRT AND LARGE LOCA OUTSIDE
VSA4	1.0000E-01	OPERATOR FAILURE - 900 GPM TO PRT AND LARGE LOCA OUTSIDE
VSA5	1.0000E-01	OPERATOR FAILURE - NO FLOW TO PRT AND LARGE LOCA OUTSIDE
VSAF	1.0000E+00	G.F.

Top Event: VT
Description: No Description

V1A	3.4724E-04	SINGLE TRAIN ALL SUPPORT
V1C	3.3920E-04	SINGLE TRAIN 3 FAN ROOM

Top Event: VT1A
Description: No Description

VT1A1	3.4730E-04	ALL SUPP. AVAIL.
VT1A2	3.3920E-04	LOSS OF COMMON BOARD POWER TRAIN A
VT1AF	1.0000E+00	G.F.

Top Event: VT1AR
Description: No Description

VT1AR1	2.0940E-03	ESTABLISH PORTABLE VENTILATION
VT1ARF	1.0000E+00	RECOVERY OF TRANSFORMER ROOMS 1A VENTILATION - G.F.
VT1ARS	0.0000E+00	RECOVERY OF TRANSFORMER ROOMS 1A VENTILATION - G.S.

Top Event: VT1B

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Description: No Description

VT1B1	3.3920E-04	ALL SUPP. AVAIL.
VT1BF	1.0000E+00	G.F.

Top Event: VT1BR
Description: No Description

VT1BR1	2.1820E-03	ESTABLISH PORTABLE VENTILATION
VT1BRF	1.0000E+00	RECOVERY OF TRANSFORMER ROOM 1B VENTILATION - G.F.
VT1BRS	0.0000E+00	RECOVERY OF TRANSFORMER ROOM 1B VENTILATION - G.S.

Top Event: VT2A
Description: No Description

VT2A1	3.3920E-04	ALL SUPP. AVAIL.
VT2AF	1.0000E+00	G.F.

Top Event: VT2AR
Description: No Description

VT2AR1	2.1050E-03	ESTABLISH PORTABLE VENTILATION
VT2ARF	1.0000E+00	RECOVERY OF TRANSFORMER ROOMS 2A VENTILATION - G.F.
VT2ARS	0.0000E+00	RECOVERY OF TRANSFORMER ROOMS 2A VENTILATION - G.S.

Top Event: VT2B
Description: No Description

VT2B1	3.4730E-04	ALL SUPP. AVAIL.
VT2B2	3.3920E-04	LOSS OF COMMON BOARD POWER TRAIN A
VT2BF	1.0000E+00	G.F.

Top Event: VT2BR
Description: No Description

VT2BR1	2.0810E-03	ESTABLISH PORTABLE VENTILATION
VT2BRF	1.0000E+00	RECOVERY OF TRANSFORMER ROOMS 2B VENTILATION - G.F.
VT2BRS	0.0000E+00	RECOVERY OF TRANSFORMER ROOMS 2B VENTILATION - G.S.

Top Event: VTCC
Description: No Description

VTCC	7.7840E-07	COMMON CAUSE CONTRIBUTION TO 480V TRANSFORMER ROOM

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VENTILATION

Top Event: WC
Description: No Description

WC1	3.6640E-03	CONTROL SI TO PREVENT WATER CHALLENGE OF PORVS
WCF	1.0000E+00	NO WATER CHALLENGE
WCS	0.0000E+00	WATER CHALLENGE

Top Event: ZA
Description: No Description

ZA1	8.4627E-03	GENERAL TRANSIENT
ZA2	9.2023E-03	LARGE LOCA - ALL SUPP. AVAIL.
ZA3	1.0807E-02	STEAM LINE BREAK INSIDE CNMT (SLBIC) - ALL SUPP. AVAIL.
ZA4	8.5896E-03	STEAM LINE BREAK OUTSIDE CNMT (SLBOC) - ALL SUPP. AVAIL.
ZA5	7.8440E-03	SMALL LOCA
ZA6	9.0765E-03	LARGE LOCA - LOSS OF 120V AC II OR III OR IV
ZA7	9.9787E-03	LARGE LOCA - LOSS OF 120V AC (II AND III) OR (II AND IV) OR (III AND IV)
ZA8	1.0770E-02	SLBIC - LOSS OF 120V AC II OR III OR IV
ZA9	1.1743E-02	SLBIC - LOSS OF 120V AC (II AND III) OR (II AND IV) OR (III AND IV)
ZAF	1.0000E+00	G.F.

Top Event: ZAB
Description: No Description

ZAB1	5.8715E-04	GENERAL TRANSIENT
ZAB2	6.3607E-04	LARGE LOCA - ALL SUPP. AVAIL.
ZAB3	8.7566E-04	STEAM LINE BREAK INSIDE CNMT (SLBIC) - ALL SUPP. AVAIL.
ZAB4	6.0518E-04	STEAM LINE BREAK OUTSIDE CNMT - ALL SUPP. AVAIL.
ZAB5	5.1714E-04	SMALL LOCA
ZAB6	6.3540E-04	LARGE LOCA - LOSS OF 120V AC II OR III OR IV
ZAB7	1.5467E-03	LARGE LOCA - LOSS OF 120V AC (II AND III) OR (II AND IV) OR (III AND IV)
ZAB8	8.4879E-04	SLBIC - LOSS OF 120V AC II OR III OR IV
ZAB9	1.6849E-03	SLBIC - LOSS OF 120V AC (II AND III) OR (II AND IV) OR (III AND IV)
ZABF	1.0000E+00	G.F.

Top Event: ZB
Description: No Description

ZB1	7.9430E-03	ESFAS TRAIN B - GENERAL TRANSIENT, ZA=S
ZB10	6.5930E-02	ESFAS TRAIN B - SMALL LOCA, ZA=F

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ZB11	1.0030E-02	ESFAS TRAIN B - SLBIC, LOSS OF 120V AC III OR IV, ZA=S
ZB12	7.8820E-02	ESFAS TRAIN B - SLBIC, LOSS OF 120V AC III OR IV, ZA=F
ZB13	8.5180E-03	ESFAS TRAIN B - LLOCA, LOSS OF 120V AC III OR IV, ZA=S
ZB14	7.0000E-02	ESFAS TRAIN B - LLOCA, LOSS OF 120V AC III OR IV, ZA=F
ZB15	1.0180E-02	ESFAS TRAIN B - SLBIC, LOSS OF 120V AC III AND IV, ZA=S
ZB16	1.4350E-01	ESFAS TRAIN B - SLBIC, LOSS OF 120V AC III AND IV, ZA=F
ZB17	8.5170E-03	ESFAS TRAIN B - LLOCA, LOSS OF 120V AC III AND IV, ZA=S
ZB18	1.5500E-01	ESFAS TRAIN B - LLOCA, LOSS OF 120V AC III AND IV, ZA=F
ZB19	1.0770E-02	ESFAS TRAIN B - SLBIC, LOSS OF 120V AC I
ZB2	8.6460E-03	ESFAS TRAIN B - LARGE LOCA, ALL SUPP. AVAIL., ZA=S
ZB20	9.0770E-03	ESFAS TRAIN B - LLOCA, LOSS OF 120V AC I
ZB21	1.1740E-02	ESFAS TRAIN B - SLBIC, LOSS OF 120V AC I AND (III OR IV)
ZB22	9.9780E-03	ESFAS TRAIN B - LLOCA, LOSS OF 120V AC I AND (III OR IV)
ZB3	1.0040E-02	ESFAS TRAIN B - SLBIC, ALL SUPP. AVAIL., ZA=S
ZB4	8.0530E-03	ESFAS TRAIN B - STEAM LINE BREAK OUTSIDE CNMT, ZA=S
ZB5	7.3840E-03	ESFAS TRAIN B - SMALL LOCA, ZA=S
ZB6	6.9380E-02	ESFAS TRAIN B - GENERAL TRANSIENT, ZA=F
ZB7	6.9120E-02	ESFAS TRAIN B - LARGE LOCA, ALL SUPP. AVAIL., ZA=F
ZB8	8.1020E-02	ESFAS TRAIN B - SLBIC, ALL SUPP. AVAIL., ZA=F
ZB9	7.0460E-02	ESFAS TRAIN B - STEAM LINE BREAK OUTSIDE, ZA=F
ZBF	1.0000E+00	G.F.

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Top-Ranking Sequences Contributing to Group : MELT Frequency
MELT = ALL CORE DAMAGE SEQUENCES

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Rank No.	Sequence Description	Events: Guaranteed Events/Comments	End State	Frequency (per year)	Percent
1	TOTAL LOSS OF COMPONENT COOLING WATER - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FNI	1.28E-05	4.27
2	TOTAL LOSS OF ERCW	- LOSS OF ERCW TRAIN A PUMPS - LOSS OF ERCW TRAIN B PUMPS - FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	1.26E-05	4.17
3	TOTAL LOSS OF COMPONENT COOLING WATER - FAILURE OF MAKEUP TO RWST - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FNI	1.13E-05	3.74
4	TOTAL LOSS OF COMPONENT COOLING WATER - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A	ENI	7.68E-06	2.55

		- LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION			
5	LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A - LOSS OF UNIT 1 DIESEL GENERATOR 1B-B - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF UNIT 1 SHUTDOWN BOARD VENTILATION - FAILURE TO RECOVER UNIT 1 SHUTDOWN BD ROOM VENTILATION IN - LOSS OF 480V BOARD ROOM B VENTILATION - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 1B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF AIR RETURN FANS - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - FAILURE OF RHR SPRAY RECIRCULATION	ENI	7.20E-06	2.39
6	SMALL LOCA NON-ISOLABLE, RCP SEAL LOCA - FAILURE OF AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & S-	- RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF RHR SPRAY RECIRCULATION	FCI	6.93E-06	2.30
7	TOTAL LOSS OF COMPONENT COOLING WATER - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - FAILURE OF MAKEUP TO RWST	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	6.73E-06	2.24

8	LOSS OF COMPONENT COOLING WATER TRAIN A - FAILURE OF MAKEUP TO RWST - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS - LOSS OF RHR PUMP 1B-B	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - FAILURE OF SAFETY INJECTION PUMP 1A-A - LOSS OF RHR PUMP 1A-A - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FCI	5.97E-06	1.98
9	SMALL LOCA NON-ISOLABLE, RCP SEAL LOCA - FAILURE OF MAKEUP TO RWST - FAILURE OF AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & S	- RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF RHR SPRAY RECIRCULATION	FCI	5.26E-06	1.75
10	TOTAL LOSS OF COMPONENT COOLING WATER - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	3.44E-06	1.14
11	SMALL LOCA NON-ISOLABLE, RCP SEAL LOCA - FAILURE OF MAKEUP TO RWST - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B	- RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF RHR SPRAY RECIRCULATION	FCI	3.34E-06	1.11
12	LOSS OF COMPONENT COOLING WATER TRAIN A - FAILURE OF MAKEUP TO RWST - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS - FAILURE OF SAFETY INJECTION PUMP 1B-B	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - FAILURE OF SAFETY INJECTION PUMP 1A-A - LOSS OF RHR PUMP 1A-A - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FCI	3.19E-06	1.06
13	LOSS OF COMPONENT COOLING WATER TRAIN A - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS - FAILURE OF AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & S-	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - FAILURE OF SAFETY INJECTION PUMP 1A-A - LOSS OF RHR PUMP 1A-A - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FCI	3.14E-06	1.05
14	FLOODING, ERCW STRAINER ROOM - LOSS OF ERCW HEADER 1A	- LOSS OF ERCW TRAIN B PUMPS - FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B	ENI	3.09E-06	1.03

	- LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION			
15 TOTAL LOSS OF COMPONENT COOLING WATER - FAILURE OF MAKEUP TO RWST - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	3.02E-06	1.00
16 LOSS OF COMPONENT COOLING WATER TRAIN A - FAILURE OF MAKEUP TO RWST - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS - FAILURE OF AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & S-	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - FAILURE OF SAFETY INJECTION PUMP 1A-A - LOSS OF RHR PUMP 1A-A - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FCI	2.76E-06	.92
17 LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A - LOSS OF UNIT 2 DIESEL GENERATOR 2A-A - LOSS OF UNIT 2 DIESEL GENERATOR 2B-B - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - LOSS OF 6.9KV SD BD TRAIN A UNIT 2 - LOSS OF 480V SD TRANSFORMER ROOM 2A VENTILATION - LOSS OF UNIT 2 120V AC INSTRUMENT BOARD 2A - LOSS OF 6.9KV UNIT 2 SHUTDOWN BOARD 2B-B - LOSS OF 480V SD TRANSFORMER ROOM 2B VENTILATION - LOSS OF 480V SD BD RM 2B VENTILATION - LOSS OF ERCW TRAIN A PUMPS - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 2A-A - NO POWER AT 6.9 SHUTDOWN BD 2B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B	ENI	2.42E-06	.80

	- FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF RHR SPRAY RECIRCULATION			
18 LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A - LOSS OF UNIT 1 DIESEL GENERATOR 1B-B - LOSS OF UNIT 2 DIESEL GENERATOR 2A-A - LOSS OF UNIT 2 DIESEL GENERATOR 2B-B - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF UNIT 1 SHUTDOWN BOARD VENTILATION - FAILURE TO RECOVER UNIT 1 SHUTDOWN BD ROOM VENTILATION IN - LOSS OF 480V BOARD ROOM B VENTILATION - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - LOSS OF 6.9KV SD BD TRAIN A UNIT 2 - LOSS OF 480V SD TRANSFORMER ROOM 2A VENTILATION - LOSS OF UNIT 2 120V AC INSTRUMENT BOARD 2A - LOSS OF 6.9KV UNIT 2 SHUTDOWN BOARD 2B-B - LOSS OF 480V SD TRANSFORMER ROOM 2B VENTILATION - LOSS OF 480V SD BD RM 2B VENTILATION - LOSS OF ERCW TRAIN A PUMPS - LOSS OF ERCW TRAIN B PUMPS - FAILURE TO RECOVER ERCW TO DIESEL FROM OPPOSITE TRAIN - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 2A-A - NO POWER AT 6.9 SHUTDOWN BD 1B-B - NO POWER AT 6.9 SHUTDOWN BD 2B-B - FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF AIR RETURN FANS - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - FAILURE OF RHR SPRAY RECIRCULATION	ENI	2.30E-06	.77
19 LOSS OF COMPONENT COOLING WATER TRAIN A - FAILURE OF MAKEUP TO RWST - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - FAILURE OF SAFETY INJECTION PUMP 1A-A - LOSS OF RHR PUMP 1A-A	FCI	2.18E-06	.72

	- FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73	- FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION			
20	LOSS OF 6.9 SHUTDOWN BOARD 1B-B - LOSS OF ERCW HEADER 1A	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF 480V BOARD ROOM B VENTILATION - NO POWER AT 6.9 SHUTDOWN BD 1B-B - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	2.09E-06	.69
21	FLOOD ERCW STAINER ROOM, TRAIN A - MAINTENANCE ON ERCW HEADER 1B	- LOSS OF ERCW TRAIN A PUMPS - FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	2.02E-06	.67
22	LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A - LOSS OF UNIT 1 DIESEL GENERATOR 1B-B - LOSS OF UNIT 2 DIESEL GENERATOR 2A-A - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF UNIT 1 SHUTDOWN BOARD VENTILATION - FAILURE TO RECOVER UNIT 1 SHUTDOWN BD ROOM VENTILATION IN - LOSS OF 480V BOARD ROOM B VENTILATION - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - LOSS OF 6.9KV SD BD TRAIN A UNIT 2 - LOSS OF 480V SD TRANSFORMER ROOM 2A VENTILATION - LOSS OF UNIT 2 120V AC INSTRUMENT BOARD 2A - LOSS OF ERCW TRAIN A PUMPS - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 2A-A	ENI	1.98E-06	.66

	- NO POWER AT 6.9 SHUTDOWN BD 1B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF AIR RETURN FANS - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - FAILURE OF RHR SPRAY RECIRCULATION			
23 LOSS OF 6.9 SHUTDOWN BOARD 1B-B - LOSS OF ERCW HEADER 1A - FAILURE OF MAKEUP TO RWST	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF 480V BOARD ROOM B VENTILATION - NO POWER AT 6.9 SHUTDOWN BD 1B-B - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	1.96E-06	.65
24 LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A - LOSS OF UNIT 1 DIESEL GENERATOR 1B-B - LOSS OF UNIT 2 DIESEL GENERATOR 2B-B - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF UNIT 1 SHUTDOWN BOARD VENTILATION - FAILURE TO RECOVER UNIT 1 SHUTDOWN BD ROOM VENTILATION IN - LOSS OF 480V BOARD ROOM B VENTILATION - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - LOSS OF 6.9KV UNIT 2 SHUTDOWN BOARD 2B-B - LOSS OF 480V SD TRANSFORMER ROOM 2B VENTILATION - LOSS OF 480V SD BD RM 2B VENTILATION - LOSS OF ERCW TRAIN B PUMPS - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 1B-B	ENI	1.95E-06	.65

		- NO POWER AT 6.9 SHUTDOWN BD 2B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF AIR RETURN FANS - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - FAILURE OF RHR SPRAY RECIRCULATION			
25	TURBINE TRIP INITIATING EVENT - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - POWER LEVEL IS GREATER THAN 40% - FAILURE OF EMERGENCY BORATION (OPERATOR ACTIONS & EQUIPEMENT)	- FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS	FCI	1.93E-06	.64
26	PARTIAL LOSS OF MAIN FEEDWATER - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - POWER LEVEL IS GREATER THAN 40% - FAILURE OF EMERGENCY BORATION (OPERATOR ACTIONS & EQUIPEMENT)	- MAIN FEEDWATER FAILS TO CONTINUE DURING ATWS EVENT - FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS	FCI	1.78E-06	.59
27	LOSS OF BATTERY BOARD I - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B	- LOSS OF 125V DC BATTERY BD I - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF OPERATOR ACTION TO FEED & BLEED RCS - LOSS OF RHR PUMP 1A-A - FAILURE OF TRAIN A CONTAINMENT SPRAY - LOSS OF RHR SPRAY - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION	LCI	1.76E-06	.59
28	TURBINE TRIP INITIATING EVENT - FAILURE OF MAKEUP TO RWST - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - POWER LEVEL IS GREATER THAN 40% - FAILURE OF EMERGENCY BORATION (OPERATOR ACTIONS & EQUIPEMENT)	- FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS	FCI	1.69E-06	.56
29	PARTIAL LOSS OF MAIN FEEDWATER - FAILURE OF MAKEUP TO RWST - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - POWER LEVEL IS GREATER THAN 40% - FAILURE OF EMERGENCY BORATION (OPERATOR ACTIONS & EQUIPEMENT)	- MAIN FEEDWATER FAILS TO CONTINUE DURING ATWS EVENT - FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS	FCI	1.56E-06	.52

30	LOSS OF 6.9 SHUTDOWN BOARD 1B-B - LOSS OF 480V SHUTDOWN BOARD 1A1-A	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF 480V BOARD ROOM B VENTILATION - NO POWER AT 6.9 SHUTDOWN BD 1B-B - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF AIR RETURN FANS - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - FAILURE OF RHR SPRAY RECIRCULATION	ENI	1.48E-06	.49
31	LOSS OF OFFSITE POWER - LOSS OF 6.9KV SD BD UNIT 1 TRAIN A - LOSS OF 6.9KV SD BD UNIT 1 TRAIN B - LOSS OF 6.9KV SD BD TRAIN A UNIT 2 - LOSS OF 6.9KV UNIT 2 SHUTDOWN BOARD 2B-B	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF UNIT 1 SHUTDOWN BOARD VENTILATION - FAILURE TO RECOVER UNIT 1 SHUTDOWN BD ROOM VENTILATION IN - LOSS OF 480V BOARD ROOM B VENTILATION - LOSS OF 480V SD TRANSFORMER ROOM 2A VENTILATION - LOSS OF UNIT 2 120V AC INSTRUMENT BOARD 2A - LOSS OF 480V SD TRANSFORMER ROOM 2B VENTILATION - LOSS OF 480V SD BD RM 2B VENTILATION - LOSS OF ERCW TRAIN A PUMPS - LOSS OF ERCW TRAIN B PUMPS - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 2A-A - NO POWER AT 6.9 SHUTDOWN BD 1B-B - NO POWER AT 6.9 SHUTDOWN BD 2B-B - FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF AIR RETURN FANS	ENI	1.43E-06	.48

	- FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - FAILURE OF RHR SPRAY RECIRCULATION			
32 PARTIAL LOSS OF MAIN FEEDWATER - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - POWER LEVEL IS GREATER THAN 40% - FAILURE OF STEAM RELIEF, ATWS ONLY, REACTOR PRESSURE IS LESS THAN 32	- MAIN FEEDWATER FAILS TO CONTINUE DURING ATWS EVENT - FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS	FCI	1.42E-06	.47
33 LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF ERCW TRAIN A PUMPS - LOSS OF CCS AND MD AFW PUMPS VENTILIATION	- LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - FAILURE TO COOLDOWN USING STEAM DUMPS, CONDENSER, & HOTWEL - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	1.39E-06	.46
34 FLOODING, ERCW STRAINER ROOM - LOSS OF 480V SHUTDOWN BOARD 1A1-A	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF ERCW TRAIN B PUMPS - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	1.38E-06	.46
35 STEAM GENERATOR TUBE RUPTURE - FAILURE OF MAKEUP TO RWST - OPERATOR FAILS TO DEPRESSURIZE THE RCS USING SG PORVS	- LOSS OF RHR NORMAL DECAY HEAT REMOVAL - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - MELT WITH SGTR BYPASS	EIB	1.30E-06	.43
36 LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1A	KNI	1.29E-06	.43

	- LOSS OF UNIT 2 DIESEL GENERATOR 2B-B - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - LOSS OF 6.9KV UNIT 2 SHUTDOWN BOARD 2B-B - LOSS OF 480V SD TRANSFORMER ROOM 2B VENTILATION - LOSS OF 480V SD BD RM 2B VENTILATION - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 2B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION			
37	LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A - LOSS OF UNIT 1 DIESEL GENERATOR 1B-B - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF UNIT 1 SHUTDOWN BOARD VENTILATION - FAILURE TO RECOVER UNIT 1 SHUTDOWN BD ROOM VENTILATION IN - LOSS OF 480V BOARD ROOM B VENTILATION - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 1B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF AIR RETURN FANS - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS	GNI	1.27E-06	.42

		- LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION			
38	LOSS OF 6.9 SHUTDOWN BOARD 1A-A - LOSS OF 480V SHUTDOWN BOARD 1B1-B	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - NO POWER AT 6.9 SHUTDOWN BD 1A-A - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - FAILURE TO COOLDOWN USING STEAM DUMPS, CONDENSER, & HOTWEL - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - FAILURE OF RHR SPRAY RECIRCULATION	ENI	1.27E-06	.42
39	PARTIAL LOSS OF MAIN FEEDWATER - FAILURE OF MAKEUP TO RWST - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - POWER LEVEL IS GREATER THAN 40% - FAILURE OF STEAM RELIEF, ATWS ONLY, REACTOR PRESSURE IS LESS THAN 32	- MAIN FEEDWATER FAILS TO CONTINUE DURING ATWS EVENT - FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS	FCI	1.25E-06	.41
40	LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF ERCW TRAIN A PUMPS - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - FAILURE OF MAKEUP TO RWST	- LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - FAILURE TO COOLDOWN USING STEAM DUMPS, CONDENSER, & HOTWEL - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	1.21E-06	.40
41	LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1B-B - LOSS OF 125V DC BATTERY BD III	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF 480V BOARD ROOM B VENTILATION - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C	HGI	1.18E-06	.39

		- LOSS OF 6.9KV UNIT BOARD 1D - NO POWER AT 6.9 SHUTDOWN BD 2A-A - NO POWER AT 6.9 SHUTDOWN BD 1B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTE - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION			
42	REACTOR TRIP INITIATING EVENT - LOSS OF ERCW TRAIN A PUMPS - LOSS OF ERCW TRAIN B PUMPS	- FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	1.18E-06	.39
43	LOSS OF COMPONENT COOLING WATER TRAIN A - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FNI	1.17E-06	.39
44	STEAM GENERATOR TUBE RUPTURE - FAILURE OF MAKEUP TO RWST - OPERATOR FAILS TO IDENTIFY & ISOLATE RUPTURED STEAM GENERATOR - OPERATOR FAILS TO DEPRESSURIZE THE RCS USING SG PORVS	- LOSS OF RHR NORMAL DECAY HEAT REMOVAL - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - MELT WITH SGTR BYPASS	EIB	1.07E-06	.36
45	LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF 480V BOARD ROOM B VENTILATION	HGI	1.04E-06	.35

	- LOSS OF UNIT 1 DIESEL GENERATOR 1B-B - LOSS OF UNIT 2 DIESEL GENERATOR 2A-A - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - LOSS OF 6.9KV SD BD TRAIN A UNIT 2 - LOSS OF 480V SD TRANSFORMER ROOM 2A VENTILATION - LOSS OF UNIT 2 120V AC INSTRUMENT BOARD 2A - NO POWER AT 6.9 SHUTDOWN BD 2A-A - NO POWER AT 6.9 SHUTDOWN BD 1B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION			
46	LOSS OF COMPONENT COOLING WATER TRAIN A - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE OF MAKEUP TO RWST - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FNI	1.02E-06	.34
47	PARTIAL LOSS OF MAIN FEEDWATER - LOSS OF ERCW TRAIN A PUMPS - LOSS OF ERCW TRAIN B PUMPS	- FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	9.84E-07	.33
48	PARTIAL LOSS OF MAIN FEEDWATER - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - FAILURE OF EMERGENCY BORATION (OPERATOR ACTIONS & EQUIPEMENT)	- MAIN FEEDWATER FAILS TO CONTINUE DURING ATWS EVENT - FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS	FCI	9.63E-07	.32

49	LOSS OF ERCW TRAIN B - LOSS OF ERCW HEADER 1A	- LOSS OF ERCW TRAIN B PUMPS - FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	9.53E-07	.32
50	TURBINE TRIP INITIATING EVENT - LOSS OF ERCW TRAIN A PUMPS - LOSS OF ERCW TRAIN B PUMPS	- FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	9.31E-07	.31
51	LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A - LOSS OF UNIT 1 DIESEL GENERATOR 1B-B - FAILURE OF CONTAINMENT ISOLATION - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF UNIT 1 SHUTDOWN BOARD VENTILATION - FAILURE TO RECOVER UNIT 1 SHUTDOWN BD ROOM VENTILATION IN - LOSS OF 480V BOARD ROOM B VENTILATION - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 1B-B	ENS	9.30E-07	.31

		- FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF AIR RETURN FANS - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - MELT WITH CI FAILURE AND CONT. PURGE SUCCESS - FAILURE OF RHR SPRAY RECIRCULATION			
52	LOSS OF OFFSITE POWER - LOSS OF 6.9KV SD BD UNIT 1 TRAIN A - LOSS OF 6.9KV SD BD UNIT 1 TRAIN B	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF UNIT 1 SHUTDOWN BOARD VENTILATION - FAILURE TO RECOVER UNIT 1 SHUTDOWN BD ROOM VENTILATION IN - LOSS OF 480V BOARD ROOM B VENTILATION - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 1B-B - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - FAILURE TO COOLDOWN USING STEAM DUMPS, CONDENSER, & HOTWEL - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF AIR RETURN FANS - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - FAILURE OF RHR SPRAY RECIRCULATION	ENI	9.30E-07	.31
53	SMALL LOCA ISOLABLE, PZR PORV LEAK - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS - FAILURE OF AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & S	- FAILURE OF RHR SPRAY RECIRCULATION	FCI	9.19E-07	.31
54	TURBINE TRIP INITIATING EVENT - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - FAILURE OF EMERGENCY BORATION (OPERATOR ACTIONS & EQUIPEMENT)	- FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS	FCI	9.07E-07	.30
55	LOSS OF BATTERY BOARD II	- LOSS OF 125V DC BATTERY BD II	LCI	8.89E-07	.30

	- FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A	- LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1B-B - FAILURE OF OPERATOR ACTION TO FEED & BLEED RCS - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN B CONTAINMENT SPRAY - LOSS OF RHR SPRAY - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION			
56	LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A - LOSS OF UNIT 1 DIESEL GENERATOR 1B-B - OPERATOR FAILS TO DEPRESSURIZE THE RCS USING SG PORVS - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF UNIT 1 SHUTDOWN BOARD VENTILATION - FAILURE TO RECOVER UNIT 1 SHUTDOWN BD ROOM VENTILATION IN - LOSS OF 480V BOARD ROOM B VENTILATION - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 1B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF AIR RETURN FANS - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - FAILURE OF RHR SPRAY RECIRCULATION	ENI	8.64E-07	.29
57	TOTAL LOSS OF COMPONENT COOLING WATER - LOSS OF ERCW HEADER 1A	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	8.46E-07	.28

58	PARTIAL LOSS OF MAIN FEEDWATER - FAILURE OF MAKEUP TO RWST - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - FAILURE OF EMERGENCY BORATION (OPERATOR ACTIONS & EQUIPEMENT)	- MAIN FEEDWATER FAILS TO CONTINUE DURING ATWS EVENT - FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS	FCI	8.44E-07	.28
59	TURBINE TRIP INITIATING EVENT - FAILURE OF MAKEUP TO RWST - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - FAILURE OF EMERGENCY BORATION (OPERATOR ACTIONS & EQUIPEMENT)	- FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS	FCI	7.95E-07	.26
60	LOSS OF BATTERY BOARD I - LOSS OF TRAIN B ESSENTIAL AIR - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES	- LOSS OF 125V DC BATTERY BD I - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF OPERATOR ACTION TO FEED & BLEED RCS - LOSS OF RHR PUMP 1A-A - FAILURE OF TRAIN A CONTAINMENT SPRAY - LOSS OF RHR SPRAY - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION	LCI	7.84E-07	.26
61	LOSS OF BATTERY BOARD II - FAILURE OF MAKEUP TO RWST - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A	- LOSS OF 125V DC BATTERY BD II - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1B-B - FAILURE OF OPERATOR ACTION TO FEED & BLEED RCS - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN B CONTAINMENT SPRAY - LOSS OF RHR SPRAY - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION	LCI	7.80E-07	.26
62	TOTAL LOSS OF COMPONENT COOLING WATER - LOSS OF ERCW HEADER 1A - FAILURE OF MAKEUP TO RWST	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	7.42E-07	.25
63	LOSS OF 120 VAC VITAL BOARD 1-III - LOSS OF 125V DC BATTERY BD I - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B	- LOSS OF 120 V AC VITAL BD 1-III - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTE - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF OPERATOR ACTION TO FEED & BLEED RCS - LOSS OF RHR PUMP 1A-A	LCI	7.14E-07	.24

		- FAILURE OF TRAIN A CONTAINMENT SPRAY - LOSS OF RHR SPRAY - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION			
64	SMALL LOCA NON-ISOLABLE, RCP SEAL LOCA - CONTAINMENT SUMP IS UNAVAILABLE	- RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF RHR SPRAY RECIRCULATION	EGI	7.13E-07	.24
65	TOTAL LOSS OF COMPONENT COOLING WATER - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FNI	7.05E-07	.23
66	SMALL LOCA ISOLABLE, PZR PORV LEAK - FAILURE OF MAKEUP TO RWST - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS - FAILURE OF AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & S	- FAILURE OF RHR SPRAY RECIRCULATION	FCI	6.98E-07	.23
67	LOSS OF COMPONENT COOLING WATER TRAIN A - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	6.98E-07	.23
68	TOTAL LOSS OF ERCW - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES	- LOSS OF ERCW TRAIN A PUMPS - LOSS OF ERCW TRAIN B PUMPS - FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B	GNI	6.92E-07	.23

	- FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION			
69 TOTAL LOSS OF COMPONENT COOLING WATER - LOSS OF 480V SHUTDOWN BOARD 1A1-A	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	6.89E-07	.23
70 REACTOR TRIP INITIATING EVENT - LOSS OF 480V SHUTDOWN BOARD 1B1-B - LOSS OF ERCW HEADER 1A	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	6.64E-07	.22
71 STEAM GENERATOR TUBE RUPTURE - LOSS OF 125V DC BATTERY BD I - OPERATOR FAILS TO DEPRESSURIZE THE RCS USING SG PORVS	- LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - OPERATOR FAILS TO IDENTIFY & ISOLATE RUPTURED STEAM GENERA - FAILURE OF SAFETY INJECTION PUMP 1A-A - LOSS OF RHR PUMP 1A-A - LOSS OF RHR NORMAL DECAY HEAT REMOVAL - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - LOSS OF RHR SPRAY - MELT WITH SGTR BYPASS - FAILURE OF RHR SPRAY RECIRCULATION	ENB	6.59E-07	.22
72 FLOOD ERCW STAINER ROOM, TRAIN A - LOSS OF 480V SHUTDOWN BOARD 1B1-B	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF ERCW TRAIN A PUMPS - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY	ENI	6.31E-07	.21

		- FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION			
73	REACTOR TRIP INITIATING EVENT - LOSS OF 480V SHUTDOWN BOARD 1B1-B - LOSS OF ERCW HEADER 1A - FAILURE OF MAKEUP TO RWST	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	6.23E-07	.21
74	LOSS OF ERCW TRAIN A - MAINTENANCE ON ERCW HEADER 1B	- LOSS OF ERCW TRAIN A PUMPS - FAILURE OF ERCW COOLING TO CAS COMPRESSORS - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	6.23E-07	.21
75	TOTAL LOSS OF COMPONENT COOLING WATER - FAILURE OF MAKEUP TO RWST - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FNI	6.18E-07	.21
76	LOSS OF COMPONENT COOLING WATER TRAIN A - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - FAILURE OF MAKEUP TO RWST	- LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B	ENI	6.12E-07	.20

		- FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION			
77	FLOOD ERCW STAINER ROOM, TRAIN A - LOSS OF 480V SHUTDOWN BOARD 1B1-B - FAILURE OF MAKEUP TO RWST	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF ERCW TRAIN A PUMPS - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	5.92E-07	.20
78	SMALL LOCA NON-ISOLABLE, RCP SEAL LOCA - LOSS OF RHR PUMP 1B-B - FAILURE OF AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & S	- RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF RHR SPRAY RECIRCULATION	FCI	5.89E-07	.20
79	LARGE & EXCESSIVE BREAK LOCA - FAILURE OF RHR & SIS HOT LEG RECIRCULATION	- FAILURE OF RHR SPRAY IN RECIRCULATION	BCI	5.67E-07	.19
80	MEDIUM BREAK LOCA - FAILURE OF AUTOMATIC/MANUAL SWAPOVER FROM THE RWST TO THE CONTAINMEN-	- NO INJECTION FOR MLOCA (200-400 PSI) FAILURE OF RHR SPRAY RECIRCULATION	BCI	5.65E-07	.19
81	SMALL LOCA NON-ISOLABLE, RCP SEAL LOCA - LOSS OF RHR PUMP 1A-A - FAILURE OF AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & S	- RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF RHR SPRAY RECIRCULATION	FCI	5.62E-07	.19
82	PARTIAL LOSS OF MAIN FEEDWATER - LOSS OF 480V SHUTDOWN BOARD 1B1-B - LOSS OF ERCW HEADER 1A	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	5.56E-07	.18
83	LOSS OF 6.9 SHUTDOWN BOARD 1B-B - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF 480V BOARD ROOM B VENTILATION - NO POWER AT 6.9 SHUTDOWN BD 1B-B - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY	FNI	5.54E-07	.18

	- FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION			
84 LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A - LOSS OF UNIT 2 DIESEL GENERATOR 2B-B - FAILURE OF THERMAL BARRIERS TO THE RCPS - FAILURE TO RECOVER POWER BEFORE CORE DAMAGE	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - LOSS OF 6.9KV UNIT 2 SHUTDOWN BOARD 2B-B - LOSS OF 480V SD TRANSFORMER ROOM 2B VENTILATION - LOSS OF 480V SD BD RM 2B VENTILATION - NO POWER AT 6.9 SHUTDOWN BD 1A-A - NO POWER AT 6.9 SHUTDOWN BD 2B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	5.45E-07	.18
85 STEAM GENERATOR TUBE RUPTURE - LOSS OF 125V DC BATTERY BD I - LOSS OF RHR PUMP 1B-B	- LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - OPERATOR FAILS TO IDENTIFY & ISOLATE RUPTURED STEAM GENERA - FAILURE OF SAFETY INJECTION PUMP 1A-A - LOSS OF RHR PUMP 1A-A - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - MELT WITH SGTR BYPASS - FAILURE OF RHR SPRAY RECIRCULATION	ENB	5.44E-07	.18
86 SMALL LOCA NON-ISOLABLE, RCP SEAL LOCA - FAILURE OF MAKEUP TO RWST - CONTAINMENT SUMP IS UNAVAILABLE	- RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF RHR SPRAY RECIRCULATION	EGI	5.42E-07	.18
87 TURBINE TRIP INITIATING EVENT - LOSS OF 480V SHUTDOWN BOARD 1B1-B - LOSS OF ERCW HEADER 1A	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	5.27E-07	.17

88	LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1A-A - LOSS OF ERCW TRAIN B PUMPS - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - NO POWER AT 6.9 SHUTDOWN BD 1A-A - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN B ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION	GNI	5.24E-07	.17
89	PARTIAL LOSS OF MAIN FEEDWATER - LOSS OF 480V SHUTDOWN BOARD 1B1-B - LOSS OF ERCW HEADER 1A - FAILURE OF MAKEUP TO RWST	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION	ENI	5.22E-07	.17
90	LOSS OF 6.9 SHUTDOWN BOARD 1B-B - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - FAILURE OF MAKEUP TO RWST - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF 480V BOARD ROOM B VENTILATION - NO POWER AT 6.9 SHUTDOWN BD 1B-B - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION	FNI	5.20E-07	.17

91 LOSS OF OFFSITE POWER - FAILURE TO RECOVER OFFSITE POWER IN 1 HOUR - LOSS OF UNIT 1 DIESEL GENERATOR 1B-B - LOSS OF ERCW TRAIN A PUMPS - FAILURE OF TURBINE DRIVEN AFW PUMP - FAILURE TO RECOVER TD AFW PUMP START FAILURES IN 30 MINUTES	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF 480V BOARD ROOM B VENTILATION - LOSS OF 6.9KV UNIT BOARD 1A - LOSS OF 6.9KV UNIT BOARD 1B - LOSS OF 6.9KV UNIT BOARD 1C - LOSS OF 6.9KV UNIT BOARD 1D - NO POWER AT 6.9 SHUTDOWN BD 1B-B - FAILURE OF CONTROL AIR (NON-ESSENTIAL AIR) - LOSS OF TRAIN A ESSENTIAL AIR - LOSS OF CCS AND MD AFW PUMPS VENTILIATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM - FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - LOSS OF MOTOR DRIVEN AFW PUMP 1B-B - FAILURE OF EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - LOSS OF STEAM GENERATOR COOLING - FAILURE OF RHR SPRAY RECIRCULATION	GNI	5.01E-07	.17
92 STEAM GENERATOR TUBE RUPTURE - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF TRAIN B COMPONENT COOLING WATER SYSTEM	- FAILURE TO ALIGN CCP A TO ERCW TRAIN A ON LOSS OF CCS A - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	ENI	4.98E-07	.17
93 LARGE & EXCESSIVE BREAK LOCA - FAILURE OF MAKEUP TO RWST - FAILURE OF RHR & SIS HOT LEG RECIRCULATION	- FAILURE OF RHR SPRAY IN RECIRCULATION	BCI	4.98E-07	.17
94 MEDIUM BREAK LOCA - FAILURE OF MAKEUP TO RWST - FAILURE OF AUTOMATIC/MANUAL SWAPOVER FROM THE RWST TO THE CONTAINMEN	- NO INJECTION FOR MLOCA (200-400 PSI) - FAILURE OF RHR SPRAY RECIRCULATION	BCI	4.96E-07	.16
95 TURBINE TRIP INITIATING EVENT - LOSS OF 480V SHUTDOWN BOARD 1B1-B - LOSS OF ERCW HEADER 1A - FAILURE OF MAKEUP TO RWST	- LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A	ENI	4.94E-07	.16

		- LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF RHR SPRAY RECIRCULATION			
96	LOSS OF BATTERY BOARD I - FAILURE TO TRIP REACTOR AND INSERT CONTROL RODS INSERT - POWER LEVEL IS GREATER THAN 40%	- LOSS OF 125V DC BATTERY BD I - LOSS OF MOTOR DRIVEN AFW PUMP 1A-A - FAILURE OF STEAM RELIEF, ATWS ONLY, REACTOR PRESSURE IS LE - FAILURE OF PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOS - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF OPERATOR ACTION TO FEED & BLEED RCS - LOSS OF RHR PUMP 1A-A - FAILURE OF TRAIN A CONTAINMENT SPRAY - LOSS OF RHR SPRAY - FAILURE OF RHR SPRAY RECIRCULATION	FCI	4.82E-07	.16
97	REACTOR TRIP INITIATING EVENT - LOSS OF 480V SHUTDOWN BOARD 1A1-A - LOSS OF 480V SHUTDOWN BOARD 1B1-B	- LOSS OF 480V SD TRANSFORMER ROOM 1A VENTILATION - LOSS OF UNIT 1 120V AC INSTRUMENT BOARD 1A - LOSS OF SD TRANSFORMER ROOM 1B VENTILATION - LOSS OF TRAIN A COMPONENT COOLING WATER SYSTEM - LOSS OF CENTRIFUGAL CHARGING PUMP 1A-A - LOSS OF CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF SAFETY INJECTION PUMP 1A-A - FAILURE OF SAFETY INJECTION PUMP 1B-B - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B - FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - FAILURE OF TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - FAILURE OF TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - FAILURE OF HYDROGEN IGNITORS - FAILURE OF RHR SPRAY RECIRCULATION	ENI	4.66E-07	.15
98	SMALL LOCA NON-ISOLABLE, RCP SEAL LOCA - FAILURE OF MAKEUP TO RWST - LOSS OF RHR PUMP 1B-B - FAILURE OF AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & S	- RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOP - FAILURE OF RHR SPRAY RECIRCULATION	FCI	4.47E-07	.15
99	SMALL LOCA ISOLABLE, PZR PORV LEAK - FAILURE OF MAKEUP TO RWST - RCP SEAL COOLING FAILED OR RCPS NOT TRIPPED - LOCA DEVELOPS - LOSS OF RHR PUMP 1A-A - LOSS OF RHR PUMP 1B-B	- FAILURE OF RHR SPRAY RECIRCULATION	FCI	4.43E-07	.15
100	STEAM GENERATOR TUBE RUPTURE - FAILURE OF MAKEUP TO RWST - OPERATOR FAILS TO IDENTIFY & ISOLATE RUPTURED STEAM GENERATOR - LOSS OF RHR NORMAL DECAY HEAT REMOVAL	- FAILURE OF TRAIN A CONTAINMENT SPRAY - FAILURE OF TRAIN B CONTAINMENT SPRAY - MELT WITH SGTR BYPASS	EIB	4.35E-07	.14

MODEL Name: WBNNEW
End State Totals for Group(s) MELT
Total Frequency Without Success = 3.3316E-04
Total Unaccounted Frequency = 4.9264E-04

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End State....	Frequency.....
ENI	1.3820E-04
FCI	9.0334E-05
FNI	4.3482E-05
LCI	1.5062E-05
GNI	8.3444E-06
BCI	5.7051E-06
ENS	4.7865E-06
EIB	3.6590E-06
HGI	3.0935E-06
ENB	2.6654E-06
EGI	2.3251E-06
KNS	2.2248E-06
KNI	2.1739E-06
FGI	2.0700E-06
HNI	2.0341E-06
HCI	1.5723E-06
LNI	1.4330E-06
DCI	9.9475E-07
GNS	5.0632E-07
LGI	4.5740E-07
FCB	4.3361E-07
FCS	2.9288E-07
KTL	2.4831E-07
FNS	1.8514E-07
ETL	1.6614E-07
AGI	1.5319E-07

MODEL Name: WBNNEW
End State Totals for Group(s) MELT
Total Frequency Without Success = 3.3316E-04
Total Unaccounted Frequency = 4.9264E-04

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End State....	Frequency.....
KGI	8.9754E-08
FPL	7.1924E-08
FTL	4.0882E-08
ATV	4.0755E-08
LCS	3.9594E-08
CNI	3.3481E-08
BGI	3.0836E-08
FEI	2.9362E-08
BCS	2.1215E-08
HGS	2.0281E-08
FII	1.8674E-08
ANI	1.4198E-08
HCB	1.1924E-08
DGI	1.0176E-08
GTL	9.8122E-09
CNS	9.4765E-09
LPL	7.4641E-09
BNI	6.7733E-09
EGS	6.2599E-09
BPL	5.8346E-09
BEI	5.5245E-09
HNS	5.1753E-09
DCS	4.4891E-09
DNI	4.1954E-09
ANS	3.9579E-09

MODEL Name: WBNNEW
End State Totals for Group(s) MELT
Total Frequency Without Success = 3.3316E-04
Total Unaccounted Frequency = 4.9264E-04

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End State....	Frequency.....
LNS	3.6667E-09
HRL	3.3588E-09
FGS	2.6145E-09
BII	2.4643E-09
GGI	2.2195E-09
CTL	1.1377E-09
ERL	1.0792E-09
DPL	1.0724E-09
AGS	6.1527E-10
ATL	4.8212E-10
ARL	1.8665E-10
CGI	1.5461E-10
BGS	7.0340E-11
DGS	2.1976E-11
ACI	0.0000E+00
ACS	0.0000E+00
AEI	0.0000E+00
AES	0.0000E+00
AII	0.0000E+00
AIS	0.0000E+00
APL	0.0000E+00
AQL	0.0000E+00
ASL	0.0000E+00
BES	0.0000E+00
BIS	0.0000E+00
BNS	0.0000E+00

MODEL Name: WBNNEW
End State Totals for Group(s) MELT
Total Frequency Without Success = 3.3316E-04
Total Unaccounted Frequency = 4.9264E-04

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End State....	Frequency.....
BQL	0.0000E+00
BRL	0.0000E+00
BSL	0.0000E+00
BTL	0.0000E+00
CCI	0.0000E+00
CCS	0.0000E+00
CEI	0.0000E+00
CES	0.0000E+00
CGS	0.0000E+00
CII	0.0000E+00
CIS	0.0000E+00
CPL	0.0000E+00
CQL	0.0000E+00
CRL	0.0000E+00
CSL	0.0000E+00
DEI	0.0000E+00
DES	0.0000E+00
DII	0.0000E+00
DIS	0.0000E+00
DNS	0.0000E+00
DQL	0.0000E+00
DRL	0.0000E+00
DSL	0.0000E+00
DTL	0.0000E+00
ECB	0.0000E+00

MODEL Name: WBNNEW
End State Totals for Group(s) MELT
Total Frequency Without Success = 3.3316E-04
Total Unaccounted Frequency = 4.9264E-04

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End State....	Frequency.....
ECI	0.0000E+00
ECS	0.0000E+00
EEB	0.0000E+00
EEI	0.0000E+00
EES	0.0000E+00
EGB	0.0000E+00
EII	0.0000E+00
EIS	0.0000E+00
EPL	0.0000E+00
EQL	0.0000E+00
ESL	0.0000E+00
FEB	0.0000E+00
FES	0.0000E+00
FGB	0.0000E+00
FIB	0.0000E+00
FIS	0.0000E+00
FNB	0.0000E+00
FQL	0.0000E+00
FRL	0.0000E+00
FSL	0.0000E+00
GCB	0.0000E+00
GCI	0.0000E+00
GCS	0.0000E+00
GEB	0.0000E+00
GEI	0.0000E+00
GES	0.0000E+00

MODEL Name: WBNNEW
End State Totals for Group(s) MELT
Total Frequency Without Success = 3.3316E-04
Total Unaccounted Frequency = 4.9264E-04

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End State....	Frequency.....
GGB	0.0000E+00
GGS	0.0000E+00
GIB	0.0000E+00
GII	0.0000E+00
GIS	0.0000E+00
GNB	0.0000E+00
GPL	0.0000E+00
GQL	0.0000E+00
GRL	0.0000E+00
GSL	0.0000E+00
HCS	0.0000E+00
HEB	0.0000E+00
HEI	0.0000E+00
HES	0.0000E+00
HGB	0.0000E+00
HIB	0.0000E+00
HII	0.0000E+00
HIS	0.0000E+00
HNB	0.0000E+00
HPL	0.0000E+00
HQL	0.0000E+00
HSL	0.0000E+00
HTL	0.0000E+00
ICI	0.0000E+00
ICS	0.0000E+00

MODEL Name: WBNNEW
End State Totals for Group(s) MELT
Total Frequency Without Success = 3.3316E-04
Total Unaccounted Frequency = 4.9264E-04

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End State....	Frequency.....
IEI	0.0000E+00
IES	0.0000E+00
IGI	0.0000E+00
IGS	0.0000E+00
III	0.0000E+00
IIS	0.0000E+00
INI	0.0000E+00
INS	0.0000E+00
IPL	0.0000E+00
IQL	0.0000E+00
IRL	0.0000E+00
ISL	0.0000E+00
ITL	0.0000E+00
JCI	0.0000E+00
JCS	0.0000E+00
JEI	0.0000E+00
JES	0.0000E+00
JGI	0.0000E+00
JGS	0.0000E+00
JII	0.0000E+00
JIS	0.0000E+00
JNI	0.0000E+00
JNS	0.0000E+00
JPL	0.0000E+00
JQL	0.0000E+00
JRL	0.0000E+00

MODEL Name: WBNNEW
End State Totals for Group(s) MELT
Total Frequency Without Success = 3.3316E-04
Total Unaccounted Frequency = 4.9264E-04

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End State....	Frequency.....
JSL	0.0000E+00
JTL	0.0000E+00
KCI	0.0000E+00
KCS	0.0000E+00
KEI	0.0000E+00
KES	0.0000E+00
KGS	0.0000E+00
KII	0.0000E+00
KIS	0.0000E+00
KPL	0.0000E+00
KQL	0.0000E+00
KRL	0.0000E+00
KSL	0.0000E+00
LEI	0.0000E+00
LES	0.0000E+00
LGS	0.0000E+00
LII	0.0000E+00
LIS	0.0000E+00
LQL	0.0000E+00
LRL	0.0000E+00
LSL	0.0000E+00
LTL	0.0000E+00
MELT	0.0000E+00

Top Event Importance for Model: WBNNEW

Sorted by Probabilistic Importance

Total Sequence Frequency = 3.0092E-04

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.....	Top.....	Probabilistic..	Guar. Event....	Total.....	Frequency.....
1.	MU	3.4971E-01	3.4006E-01	6.8978E-01	2.0757E-04
2.	SE	2.2130E-01	5.5639E-01	7.7769E-01	2.3402E-04
3.	OGR1	1.4983E-01	0.0000E+00	1.4983E-01	4.5085E-05
4.	REC	1.1366E-01	8.8620E-01	9.9986E-01	3.0088E-04
5.	TP	1.1162E-01	2.5582E-02	1.3720E-01	4.1286E-05
6.	RT	1.0620E-01	0.0000E+00	1.0620E-01	3.1958E-05
7.	RR	1.0518E-01	7.1771E-01	8.2289E-01	2.4762E-04
8.	TPR	1.0504E-01	2.5582E-02	1.3063E-01	3.9308E-05
9.	GA	1.0479E-01	2.0125E-03	1.0680E-01	3.2138E-05
10.	GB	9.4282E-02	1.9650E-03	9.6247E-02	2.8962E-05
11.	PL	8.3795E-02	0.0000E+00	8.3795E-02	2.5215E-05
12.	CCPR	8.2440E-02	1.8163E-01	2.6407E-01	7.9464E-05
13.	EB	6.5686E-02	0.0000E+00	6.5686E-02	1.9766E-05
14.	CE	6.4394E-02	1.5505E-01	2.1944E-01	6.6034E-05
15.	RB	5.7732E-02	6.6125E-01	7.1898E-01	2.1635E-04
16.	B1	5.3476E-02	1.5420E-01	2.0768E-01	6.2494E-05
17.	GD	4.9785E-02	8.9896E-04	5.0684E-02	1.5252E-05
18.	BC	4.7463E-02	3.8895E-01	4.3641E-01	1.3132E-04
19.	AC	4.4632E-02	5.6933E-01	6.1396E-01	1.8475E-04
20.	GC	4.3541E-02	7.4699E-04	4.4288E-02	1.3327E-05
21.	VA	4.1045E-02	4.4129E-01	4.8233E-01	1.4514E-04
22.	AE	3.6698E-02	1.1835E-01	1.5505E-01	4.6657E-05
23.	A1	3.4926E-02	1.4027E-01	1.7519E-01	5.2718E-05
24.	BE	3.2791E-02	1.1647E-01	1.4926E-01	4.4915E-05
25.	RA	2.8355E-02	7.3376E-01	7.6212E-01	2.2933E-04
26.	MB	2.3698E-02	3.5094E-01	3.7464E-01	1.1274E-04

Top Event Importance for Model: WBNNEW

Sorted by Probabilistic Importance

Total Sequence Frequency = 3.0092E-04

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.....	Top.....	Probabilistic..	Guar. Event....	Total.....	Frequency.....
27.	DS	2.2452E-02	7.1382E-01	7.3627E-01	2.2156E-04
28.	MA	2.2182E-02	3.3291E-01	3.5509E-01	1.0685E-04
29.	DA	2.1377E-02	1.3810E-02	3.5187E-02	1.0588E-05
30.	RVB	2.0734E-02	2.1101E-01	2.3174E-01	6.9735E-05
31.	DB	2.0509E-02	1.3055E-02	3.3564E-02	1.0100E-05
32.	V3	2.0338E-02	1.6575E-01	1.8609E-01	5.5997E-05
33.	AA	1.9447E-02	1.2082E-01	1.4027E-01	4.2209E-05
34.	BA	1.8686E-02	1.3552E-01	1.5420E-01	4.6402E-05
35.	SR	1.8326E-02	1.7782E-02	3.6108E-02	1.0865E-05
36.	S2	1.6680E-02	6.6129E-01	6.7797E-01	2.0401E-04
37.	CTMU	1.5269E-02	1.6898E-01	1.8425E-01	5.5444E-05
38.	TB	1.5049E-02	7.7165E-01	7.8670E-01	2.3673E-04
39.	CI	1.3789E-02	8.1795E-03	2.1968E-02	6.6106E-06
40.	ZB	1.2974E-02	4.4040E-03	1.7378E-02	5.2293E-06
41.	MDE	1.1861E-02	0.0000E+00	1.1861E-02	3.5692E-06
42.	BB	1.1043E-02	5.0684E-02	6.1727E-02	1.8575E-05
43.	DE	1.0959E-02	1.6099E-01	1.7195E-01	5.1743E-05
44.	PA	1.0896E-02	1.6434E-01	1.7524E-01	5.2732E-05
45.	AB	1.0507E-02	4.4288E-02	5.4795E-02	1.6489E-05
46.	PB	1.0359E-02	1.4486E-01	1.5522E-01	4.6710E-05
47.	SU	9.0033E-03	0.0000E+00	9.0033E-03	2.7093E-06
48.	OS	8.3262E-03	0.0000E+00	8.3262E-03	2.5055E-06
49.	ZA	8.1407E-03	9.2556E-03	1.7396E-02	5.2348E-06
50.	CCSR	7.9888E-03	1.3034E-01	1.3833E-01	4.1625E-05
51.	RVA	7.7037E-03	1.7912E-01	1.8682E-01	5.6218E-05

Top Event Importance for Model: WBNNEW

Sorted by Probabilistic Importance

Total Sequence Frequency = 3.0092E-04

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.....	Top.....	Probabilistic..	Guar. Event....	Total.....	Frequency.....
52.	SL	6.6102E-03	7.2341E-03	1.3844E-02	4.1660E-06
53.	DC	6.5013E-03	0.0000E+00	6.5013E-03	1.9564E-06
54.	PD	5.6422E-03	2.3919E-01	2.4484E-01	7.3675E-05
55.	OB	4.9569E-03	4.8625E-02	5.3581E-02	1.6124E-05
56.	CSB	4.7183E-03	6.7911E-01	6.8383E-01	2.0578E-04
57.	CH	4.2900E-03	6.4908E-01	6.5337E-01	1.9661E-04
58.	RH	4.0017E-03	2.3233E-03	6.3250E-03	1.9033E-06
59.	OF	3.2882E-03	0.0000E+00	3.2882E-03	9.8946E-07
60.	B2U2	3.2773E-03	6.1727E-02	6.5004E-02	1.9561E-05
61.	PR	2.9725E-03	1.0840E-01	1.1137E-01	3.3514E-05
62.	RD	2.9079E-03	1.5294E-02	1.8202E-02	5.4771E-06
63.	CD	2.6485E-03	4.7980E-02	5.0629E-02	1.5235E-05
64.	CSA	2.5183E-03	7.4588E-01	7.4840E-01	2.2520E-04
65.	AF	2.5007E-03	1.8671E-04	2.6874E-03	8.0867E-07
66.	EE	2.1115E-03	1.5505E-01	1.5716E-01	4.7292E-05
67.	LCL	2.0828E-03	0.0000E+00	2.0828E-03	6.2674E-07
68.	MF	2.0598E-03	9.6909E-02	9.8969E-02	2.9781E-05
69.	FA	2.0125E-03	0.0000E+00	2.0125E-03	6.0559E-07
70.	FB	1.9650E-03	0.0000E+00	1.9650E-03	5.9129E-07
71.	VB	1.8067E-03	6.5963E-01	6.6144E-01	1.9904E-04
72.	PI	1.7743E-03	0.0000E+00	1.7743E-03	5.3392E-07
73.	HH	1.7078E-03	1.2093E-01	1.2263E-01	3.6902E-05
74.	MR	1.6620E-03	2.3836E-04	1.9003E-03	5.7184E-07
75.	S1	1.6237E-03	7.3380E-01	7.3543E-01	2.2130E-04
76.	DSLR	1.5206E-03	1.5474E-02	1.6995E-02	5.1139E-06
77.	OG	1.5004E-03	1.6748E-01	1.6898E-01	5.0850E-05

Top Event Importance for Model: WBNNEW

Sorted by Probabilistic Importance

Total Sequence Frequency = 3.0092E-04

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.....	Top.....	Probabilistic..	Guar. Event....	Total.....	Frequency.....
78.	B2	1.3556E-03	1.5420E-01	1.5556E-01	4.6810E-05
79.	D1	1.1506E-03	0.0000E+00	1.1506E-03	3.4625E-07
80.	D2	1.0355E-03	0.0000E+00	1.0355E-03	3.1161E-07
81.	FE	1.0186E-03	1.4926E-01	1.5028E-01	4.5222E-05
82.	DP	1.0179E-03	7.3627E-01	7.3729E-01	2.2186E-04
83.	DD	9.3851E-04	0.0000E+00	9.3851E-04	2.8241E-07
84.	FD	8.9896E-04	0.0000E+00	8.9896E-04	2.7051E-07
85.	RF	8.8025E-04	0.0000E+00	8.8025E-04	2.6488E-07
86.	CP	8.7961E-04	0.0000E+00	8.7961E-04	2.6469E-07
87.	FC	7.4699E-04	0.0000E+00	7.4699E-04	2.2478E-07
88.	B1U2	7.4545E-04	6.1727E-02	6.2473E-02	1.8799E-05
89.	VINV2	6.1428E-04	6.5004E-02	6.5619E-02	1.9746E-05
90.	UB1B	5.1499E-04	1.5080E-01	1.5131E-01	4.5532E-05
91.	UB1C	5.1497E-04	1.5091E-01	1.5142E-01	4.5565E-05
92.	UB1A	5.1493E-04	1.5091E-01	1.5142E-01	4.5565E-05
93.	UB1D	5.1491E-04	1.5080E-01	1.5131E-01	4.5532E-05
94.	DCAC	3.4850E-04	1.1978E-02	1.2327E-02	3.7093E-06
95.	VNV2R	3.1199E-04	0.0000E+00	3.1199E-04	9.3882E-08
96.	A2	3.0552E-04	1.4027E-01	1.4057E-01	4.2301E-05
97.	RL	2.8096E-04	0.0000E+00	2.8096E-04	8.4546E-08
98.	AM	2.5095E-04	0.0000E+00	2.5095E-04	7.5516E-08
99.	AR	1.5661E-04	1.2413E-01	1.2429E-01	3.7401E-05
100.	A1U2	1.3610E-04	5.4795E-02	5.4931E-02	1.6530E-05
101.	VS	1.1929E-04	1.6586E-03	1.7779E-03	5.3500E-07
102.	VSA	1.0355E-04	0.0000E+00	1.0355E-04	3.1161E-08

Top Event Importance for Model: WBNNEW

Sorted by Probabilistic Importance

Total Sequence Frequency = 3.0092E-04

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.....	Top.....	Probabilistic..	Guar. Event....	Total.....	Frequency.....
103.	VS8	1.0355E-04	0.0000E+00	1.0355E-04	3.1159E-08
104.	B3	1.0188E-04	1.4983E-01	1.4993E-01	4.5116E-05
105.	DAAC	8.0808E-05	9.1748E-03	9.2556E-03	2.7852E-06
106.	RI	7.9269E-05	0.0000E+00	7.9269E-05	2.3853E-08
107.	VS9	7.2488E-05	0.0000E+00	7.2488E-05	2.1813E-08
108.	VT1BR	5.2304E-05	0.0000E+00	5.2304E-05	1.5739E-08
109.	VT1AR	5.0190E-05	0.0000E+00	5.0190E-05	1.5103E-08
110.	VNV1R	4.8726E-05	0.0000E+00	4.8726E-05	1.4663E-08
111.	RW	3.9009E-05	0.0000E+00	3.9009E-05	1.1738E-08
112.	OT	3.8016E-05	1.5654E-01	1.5658E-01	4.7116E-05
113.	VC	3.5259E-05	4.8243E-01	4.8246E-01	1.4518E-04
114.	RS	3.3598E-05	5.3609E-02	5.3643E-02	1.6142E-05
115.	VS1	2.0697E-05	0.0000E+00	2.0697E-05	6.2280E-09
116.	VI9	1.0992E-05	0.0000E+00	1.0992E-05	3.3078E-09
117.	VI7	1.0906E-05	0.0000E+00	1.0906E-05	3.2818E-09
118.	VI8	1.0830E-05	0.0000E+00	1.0830E-05	3.2589E-09
119.	VS3	7.3962E-07	0.0000E+00	7.3962E-07	2.2256E-10
120.	VI1	3.2989E-07	0.0000E+00	3.2989E-07	9.9270E-11
121.	VS2	1.7941E-07	0.0000E+00	1.7941E-07	5.3988E-11
122.	VI6	6.5696E-08	0.0000E+00	6.5696E-08	1.9769E-11
123.	VI2	5.0312E-08	0.0000E+00	5.0312E-08	1.5140E-11
124.	VI4	3.7135E-08	0.0000E+00	3.7135E-08	1.1175E-11
125.	VI3	4.2305E-09	0.0000E+00	4.2305E-09	1.2730E-12
126.	VS6	3.5818E-09	0.0000E+00	3.5818E-09	1.0778E-12
127.	VS7	3.5818E-09	0.0000E+00	3.5818E-09	1.0778E-12
128.	MELTI	0.0000E+00	9.5811E-01	9.5811E-01	2.8831E-04

Top Event Importance for Model: WBNNEW

Sorted by Probabilistic Importance

Total Sequence Frequency = 3.0092E-04

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.....	Top.....	Probabilistic..	Guar. Event....	Total.....	Frequency.....
129.	VT1A	0.0000E+00	1.7519E-01	1.7519E-01	5.2718E-05
130.	SGCLG	0.0000E+00	1.0444E-01	1.0444E-01	3.1427E-05
131.	DDAC	0.0000E+00	3.9634E-03	3.9634E-03	1.1927E-06
132.	DBAC	0.0000E+00	4.4040E-03	4.4040E-03	1.3252E-06
133.	IYA	0.0000E+00	9.5811E-01	9.5811E-01	2.8831E-04
134.	CSR	0.0000E+00	6.6238E-01	6.6238E-01	1.9932E-04
135.	RHRS	0.0000E+00	8.9323E-01	8.9323E-01	2.6879E-04
136.	A3	0.0000E+00	1.4983E-01	1.4983E-01	4.5085E-05
137.	SYA	0.0000E+00	1.8949E-03	1.8949E-03	5.7020E-07
138.	SYC	0.0000E+00	7.5702E-03	7.5702E-03	2.2780E-06
139.	MELTS	0.0000E+00	2.1358E-02	2.1358E-02	6.4271E-06
140.	MELTL	0.0000E+00	8.7943E-04	8.7943E-04	2.6463E-07
141.	SYB	0.0000E+00	1.1701E-03	1.1701E-03	3.5209E-07
142.	SYN	0.0000E+00	1.0723E-02	1.0723E-02	3.2268E-06
143.	MELT	0.0000E+00	1.0000E+00	1.0000E+00	3.0092E-04
144.	DG	0.0000E+00	1.7519E-01	1.7519E-01	5.2718E-05
145.	LYC	0.0000E+00	5.5150E-04	5.5150E-04	1.6595E-07
146.	LYA	0.0000E+00	2.9173E-04	2.9173E-04	8.7786E-08
147.	LYN	0.0000E+00	3.6200E-05	3.6200E-05	1.0893E-08
148.	EX	0.0000E+00	6.9114E-04	6.9114E-04	2.0798E-07
149.	B2U2L	0.0000E+00	6.8372E-02	6.8372E-02	2.0574E-05
150.	CM	0.0000E+00	6.3030E-01	6.3030E-01	1.8967E-04
151.	BYC	0.0000E+00	1.8219E-04	1.8219E-04	5.4825E-08
152.	SI	0.0000E+00	6.3507E-01	6.3507E-01	1.9110E-04
153.	VS4	0.0000E+00	2.0137E-05	2.0137E-05	6.0595E-09

Top Event Importance for Model: WBNNEW

Sorted by Probabilistic Importance

Total Sequence Frequency = 3.0092E-04

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.....	Top.....	Probabilistic..	Guar. Event....	Total.....	Frequency.....
154.	B1L	0.0000E+00	2.1141E-01	2.1141E-01	6.3616E-05
155.	VT1B	0.0000E+00	2.0768E-01	2.0768E-01	6.2494E-05
156.	VINV1	0.0000E+00	1.5556E-01	1.5556E-01	4.6810E-05
157.	B2L	0.0000E+00	1.5929E-01	1.5929E-01	4.7932E-05
158.	AAL	0.0000E+00	1.4459E-01	1.4459E-01	4.3510E-05
159.	MS	0.0000E+00	5.7254E-01	5.7254E-01	1.7229E-04
160.	INTPR	0.0000E+00	9.2109E-01	9.2109E-01	2.7717E-04
161.	MELTB	0.0000E+00	1.9519E-02	1.9519E-02	5.8736E-06
162.	RQ	0.0000E+00	3.5379E-01	3.5379E-01	1.0646E-04
163.	FW	0.0000E+00	5.6908E-02	5.6908E-02	1.7125E-05
164.	A2L	0.0000E+00	1.4490E-01	1.4490E-01	4.3602E-05
165.	BYA	0.0000E+00	1.9337E-02	1.9337E-02	5.8187E-06
166.	CSI	0.0000E+00	6.4002E-01	6.4002E-01	1.9259E-04
167.	V2	0.0000E+00	3.4621E-04	3.4621E-04	1.0418E-07
168.	CAV	0.0000E+00	5.0116E-01	5.0116E-01	1.5081E-04
169.	DH	0.0000E+00	5.4931E-02	5.4931E-02	1.6530E-05
170.	ABL	0.0000E+00	6.4399E-02	6.4399E-02	1.9379E-05
171.	VT2A	0.0000E+00	5.4931E-02	5.4931E-02	1.6530E-05
172.	A2U2	0.0000E+00	5.4795E-02	5.4795E-02	1.6489E-05
173.	BBL	0.0000E+00	6.5095E-02	6.5095E-02	1.9588E-05
174.	A1U2L	0.0000E+00	6.4535E-02	6.4535E-02	1.9420E-05
175.	A2U2L	0.0000E+00	6.4399E-02	6.4399E-02	1.9379E-05
176.	PE	0.0000E+00	1.1961E-01	1.1961E-01	3.5992E-05
177.	VT2B	0.0000E+00	6.2473E-02	6.2473E-02	1.8799E-05
178.	A1L	0.0000E+00	1.7952E-01	1.7952E-01	5.4019E-05
179.	B1U2L	0.0000E+00	6.5840E-02	6.5840E-02	1.9812E-05

Top Event Importance for Model: WBNNEW

Sorted by Probabilistic Importance

Total Sequence Frequency = 3.0092E-04

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.....	Top.....	Probabilistic..	Guar. Event....	Total.....	Frequency.....
180.	CDB	0.0000E+00	1.0992E-05	1.0992E-05	3.3078E-09
181.	LOWPR	0.0000E+00	7.0417E-03	7.0417E-03	2.1190E-06
182.	V1R	0.0000E+00	9.5804E-02	9.5804E-02	2.8829E-05
183.	BAL	0.0000E+00	1.5793E-01	1.5793E-01	4.7524E-05
184.	V1	0.0000E+00	9.5844E-02	9.5844E-02	2.8841E-05

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 3.0092E-04

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
1.	MELTF	1.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0092E-04
2.	IYAF	9.5811E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.8831E-04
3.	MELTIF	9.5811E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.8831E-04
4.	INTPRF	9.2109E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7717E-04
5.	RHRSF	8.9323E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.6879E-04
6.	RECF	8.8620E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.6667E-04
7.	TBF	7.7165E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3220E-04
8.	CSAF	7.4588E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.2445E-04
9.	DPF	7.3627E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.2156E-04
10.	S1F	7.3380E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.2081E-04
11.	RAF	7.3376E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.2080E-04
12.	RRF	7.1771E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1597E-04
13.	DSNN	7.1349E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1470E-04
14.	CSBF	6.7911E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0436E-04
15.	CSRF	6.6238E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9932E-04
16.	S2F	6.6129E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9899E-04
17.	RBF	6.6125E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9898E-04
18.	VBF	6.5963E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9849E-04
19.	CHF	6.4908E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9532E-04
20.	CSIF	6.4002E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9259E-04
21.	SIF	6.3507E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9110E-04
22.	CMF	6.3030E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8967E-04
23.	MSF	5.7254E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7229E-04
24.	ACF	5.6933E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7132E-04
25.	SEF	5.5639E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6743E-04
26.	CAVF	5.0116E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5081E-04
27.	VCF	4.8243E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4517E-04
28.	VAF	4.4129E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3279E-04
29.	BCF	3.8895E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1704E-04
30.	RQF	3.5379E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0646E-04
31.	MBF	3.5094E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0561E-04
32.	MUF	3.4006E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0233E-04
33.	MAF	3.3291E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0018E-04
34.	MU4	2.4079E-01	1.0539E+00	9.5275E-01	3.0429E-05	4.6724E-01	7.2457E-05
35.	PDF	2.3919E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.1977E-05
36.	B1LF	2.1141E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.3616E-05
37.	SED	2.1104E-01	8.4988E+00	7.8900E-01	2.3200E-03	2.7368E-02	6.3507E-05
38.	RVBF	2.1101E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.3496E-05
39.	VT1BF	2.0768E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.2494E-05
40.	CCPRF	1.8163E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4657E-05
41.	A1LF	1.7952E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4019E-05
42.	RVAF	1.7912E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.3900E-05
43.	VT1AF	1.7519E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.2718E-05
44.	DGF	1.7519E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.2718E-05
45.	CTMUF	1.6898E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0850E-05
46.	OGF	1.6748E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0398E-05
47.	V3F	1.6575E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.9877E-05
48.	PAF	1.6434E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.9453E-05
49.	DEF	1.6099E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.8445E-05
50.	B2LF	1.5929E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7932E-05

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 3.0092E-04

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
51.	BALF	1.5793E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7524E-05
52.	OTF	1.5654E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7105E-05
53.	VINV1F	1.5556E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.6810E-05
54.	EEF	1.5505E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.6657E-05
55.	CEF	1.5505E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.6657E-05
56.	B1F	1.5420E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.6402E-05
57.	B2F	1.5420E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.6402E-05
58.	UB1CF	1.5091E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.5410E-05
59.	UB1AF	1.5091E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.5410E-05
60.	UB1DF	1.5080E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.5377E-05
61.	UB1BF	1.5080E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.5377E-05
62.	B3F	1.4983E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.5085E-05
63.	A3F	1.4983E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.5085E-05
64.	OGR11	1.4983E-01	1.4186E+00	8.5673E-01	1.6907E-04	2.5500E-01	4.5085E-05
65.	FEF	1.4926E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.4915E-05
66.	A2LF	1.4490E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.3602E-05
67.	PBF	1.4486E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.3592E-05
68.	AALF	1.4459E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.3510E-05
69.	A1F	1.4027E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.2209E-05
70.	A2F	1.4027E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.2209E-05
71.	BAF	1.3552E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0779E-05
72.	CCSRF	1.3034E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.9221E-05
73.	ARF	1.2413E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.7354E-05
74.	HHF	1.2093E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.6388E-05
75.	AAF	1.2082E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.6357E-05
76.	PEF	1.1961E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.5992E-05
77.	AEF	1.1835E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.5614E-05
78.	BEF	1.1647E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.5048E-05
79.	PRF	1.0840E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2619E-05
80.	TPR1	1.0504E-01	1.0183E+00	9.2273E-01	2.8756E-05	8.0860E-01	3.1610E-05
81.	GA1	1.0479E-01	1.6215E+00	9.0200E-01	2.1652E-04	1.3620E-01	3.1532E-05
82.	SGCLGF	1.0444E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.1427E-05
83.	MFF	9.6909E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9162E-05
84.	V1F	9.5844E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.8841E-05
85.	V1RF	9.5804E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.8829E-05
86.	RT1	9.4822E-02	5.8720E+02	9.0526E-01	1.7643E-01	1.6159E-04	2.8533E-05
87.	TP1	8.6507E-02	1.6286E+00	9.5736E-01	2.0198E-04	6.3520E-02	2.6031E-05
88.	PL1	8.3795E-02	1.0204E+00	9.6009E-01	1.8142E-05	6.6200E-01	2.5215E-05
89.	CCPR1	8.2440E-02	5.6882E+00	9.2329E-01	1.4338E-03	1.6100E-02	2.4808E-05
90.	GB2	7.5046E-02	1.3007E+00	9.3144E-01	1.1110E-04	1.8570E-01	2.2583E-05
91.	B2U2LF	6.8372E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0574E-05
92.	B1U2LF	6.5840E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9812E-05
93.	BBLF	6.5095E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9588E-05
94.	VINV2F	6.5004E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9561E-05
95.	A1U2LF	6.4535E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9420E-05
96.	ABLF	6.4399E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9379E-05
97.	A2U2LF	6.4399E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9379E-05
98.	RR1	6.4192E-02	2.2791E+01	9.3581E-01	6.5766E-03	2.9371E-03	1.9317E-05
99.	VT2BF	6.2473E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8799E-05
100.	B2U2F	6.1727E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8575E-05

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 3.0092E-04

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
101.	B1U2F	6.1727E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8575E-05
102.	EB1	6.0558E-02	2.3395E+00	9.4116E-01	4.2079E-04	4.2076E-02	1.8223E-05
103.	FWF	5.6908E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7125E-05
104.	VT2AF	5.4931E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6530E-05
105.	DHF	5.4931E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6530E-05
106.	A2U2F	5.4795E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6489E-05
107.	A1U2F	5.4795E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6489E-05
108.	RSF	5.3609E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6132E-05
109.	B11	5.3476E-02	7.5790E+01	9.4708E-01	2.2521E-02	7.0702E-04	1.6092E-05
110.	MU2	5.1784E-02	1.0247E+00	9.8122E-01	1.3090E-05	4.3170E-01	1.5583E-05
111.	BBF	5.0684E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5252E-05
112.	OBF	4.8625E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4632E-05
113.	CDF	4.7980E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4438E-05
114.	CE1	4.7819E-02	2.7210E+01	9.5348E-01	7.9009E-03	1.7716E-03	1.4390E-05
115.	ABF	4.4288E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3327E-05
116.	MU6	4.0614E-02	1.0028E+00	9.9739E-01	1.6242E-06	4.8403E-01	1.2222E-05
117.	VA1	4.0207E-02	5.9553E+00	9.6342E-01	1.5021E-03	7.3280E-03	1.2099E-05
118.	REC1	3.8825E-02	1.9938E+00	9.6117E-01	3.1072E-04	3.7600E-02	1.1683E-05
119.	A11	3.4926E-02	4.2087E+01	9.6576E-01	1.2374E-02	8.3262E-04	1.0510E-05
120.	RR5	3.1465E-02	3.8779E+00	9.6853E-01	8.7549E-04	1.0815E-02	9.4684E-06
121.	RB5	3.1009E-02	2.2422E+00	9.7094E-01	3.8254E-04	2.2860E-02	9.3312E-06
122.	REC2	2.9478E-02	1.7545E+00	9.7052E-01	2.3592E-04	3.7600E-02	8.8705E-06
123.	TPF	2.5582E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.6980E-06
124.	TPRF	2.5582E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.6980E-06
125.	RA2	2.5371E-02	1.8594E+00	9.7989E-01	2.6467E-04	2.2860E-02	7.6345E-06
126.	TP3	2.5112E-02	1.1718E+00	9.8655E-01	5.5731E-05	7.2600E-02	7.5566E-06
127.	GD3	2.3033E-02	1.0407E+00	9.8951E-01	1.5402E-05	2.0500E-01	6.9311E-06
128.	REC3	2.2400E-02	1.2256E+00	9.7760E-01	7.4631E-05	9.0320E-02	6.7406E-06
129.	AC1	2.2271E-02	1.6826E+02	9.7777E-01	5.0338E-02	1.3290E-04	6.7018E-06
130.	GC3	2.1696E-02	1.0114E+00	9.9618E-01	4.5727E-06	2.5170E-01	6.5286E-06
131.	BC21	2.1527E-02	1.1026E+00	9.7863E-01	3.7304E-05	1.7240E-01	6.4778E-06
132.	DA1	2.1377E-02	2.1044E+01	9.7943E-01	6.0379E-03	1.0250E-03	6.4326E-06
133.	MELTSF	2.1358E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.4271E-06
134.	AC2	2.0710E-02	2.1099E+00	9.8040E-01	3.3987E-04	1.7350E-02	6.2320E-06
135.	DB1	2.0509E-02	2.0794E+01	9.8030E-01	5.9622E-03	9.9437E-04	6.1715E-06
136.	AE5	1.9589E-02	3.8303E+00	9.8044E-01	8.5756E-04	6.8632E-03	5.8947E-06
137.	MELTBF	1.9519E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8736E-06
138.	BYAF	1.9337E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8187E-06
139.	GC2	1.8854E-02	1.0644E+00	9.8675E-01	2.3364E-05	1.7060E-01	5.6735E-06
140.	AA2	1.8832E-02	2.9300E+01	9.8120E-01	8.5216E-03	6.6400E-04	5.6670E-06
141.	GB1	1.7924E-02	1.0969E+00	9.8572E-01	3.3462E-05	1.2840E-01	5.3935E-06
142.	SRF	1.7782E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.3508E-06
143.	BA4	1.7130E-02	1.1318E+00	9.8309E-01	4.4758E-05	1.1370E-01	5.1546E-06
144.	RB6	1.6717E-02	1.1909E+00	9.8387E-01	6.2314E-05	7.7910E-02	5.0305E-06
145.	CE2	1.6575E-02	1.1030E+01	9.8350E-01	3.0232E-03	1.6423E-03	4.9876E-06
146.	SR1	1.6532E-02	1.4288E+00	9.8425E-01	1.3376E-04	3.5428E-02	4.9748E-06
147.	V37	1.6417E-02	1.3543E+00	9.8636E-01	1.1073E-04	3.7074E-02	4.9402E-06
148.	AE1	1.6059E-02	0.0000E+00	9.8396E-01	0.0000E+00	3.0425E-05	4.8324E-06
149.	RVB1	1.5510E-02	2.1147E+00	9.9047E-01	3.3830E-04	8.4810E-03	4.6671E-06
150.	DSLRF	1.5474E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.6563E-06

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 3.0092E-04

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
151.	BC33	1.5448E-02	5.1190E+00	9.8500E-01	1.2440E-03	3.6280E-03	4.6486E-06
152.	RDF	1.5294E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.6021E-06
153.	CTMU1	1.5269E-02	7.6904E-01	1.0060E+00	-7.1315E-05	2.5452E-02	4.5948E-06
154.	S22	1.5186E-02	2.1173E+00	9.8605E-01	3.4041E-04	1.2330E-02	4.5698E-06
155.	BE2	1.5025E-02	1.4208E+00	9.8500E-01	1.3114E-04	3.4430E-02	4.5213E-06
156.	DAF	1.3810E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.1557E-06
157.	MA4	1.3526E-02	2.8203E+00	9.8667E-01	5.5177E-04	7.2670E-03	4.0703E-06
158.	DBF	1.3055E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.9285E-06
159.	DCACF	1.1978E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.6044E-06
160.	CI4	1.1893E-02	9.8295E-01	1.0022E+00	-5.7936E-06	1.1445E-01	3.5789E-06
161.	MDE1	1.1861E-02	1.1137E+01	9.8919E-01	3.0538E-03	1.0650E-03	3.5692E-06
162.	MB4	1.1598E-02	2.5841E+00	9.8840E-01	4.8017E-04	7.2670E-03	3.4899E-06
163.	REC4	1.1499E-02	1.2943E+00	9.8850E-01	9.2028E-05	3.7600E-02	3.4602E-06
164.	GD2	1.1400E-02	1.0401E+00	9.9215E-01	1.4443E-05	1.6360E-01	3.4304E-06
165.	TB2	1.1375E-02	1.2185E+00	9.8882E-01	6.9124E-05	4.8679E-02	3.4231E-06
166.	MU3	1.1300E-02	1.3194E+00	9.8881E-01	9.9480E-05	3.3861E-02	3.4002E-06
167.	REC5	1.0994E-02	1.1589E+00	9.8901E-01	5.1116E-05	6.4720E-02	3.3082E-06
168.	GD4	1.0914E-02	1.0063E+00	9.9594E-01	3.1281E-06	3.9060E-01	3.2843E-06
169.	SYNF	1.0723E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2268E-06
170.	SEH	1.0186E-02	1.2910E+00	9.8988E-01	9.0607E-05	3.3625E-02	3.0652E-06
171.	DS6	1.0031E-02	9.8684E-01	1.0015E+00	-4.4184E-06	1.0343E-01	3.0184E-06
172.	AB6	9.9913E-03	1.0005E+00	9.9936E-01	3.4168E-07	5.6700E-01	3.0066E-06
173.	DE1	9.4337E-03	5.4364E+01	9.9070E-01	1.6061E-02	1.7423E-04	2.8388E-06
174.	ZAF	9.2556E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7852E-06
175.	DAACF	9.1748E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7609E-06
176.	BB14	8.1907E-03	1.0003E+00	9.9872E-01	4.8716E-07	7.9320E-01	2.4647E-06
177.	CIF	8.1795E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.4613E-06
178.	CCSR3	7.9888E-03	1.5102E+00	9.9252E-01	1.5579E-04	1.4450E-02	2.4040E-06
179.	PB1	7.9642E-03	2.8308E+00	9.9409E-01	5.5269E-04	3.2200E-03	2.3966E-06
180.	ZB6	7.8007E-03	1.0975E+00	9.9273E-01	3.1513E-05	6.9380E-02	2.3474E-06
181.	RVA1	7.7037E-03	1.0510E+00	9.9954E-01	1.5494E-05	8.9290E-03	2.3182E-06
182.	SYCF	7.5702E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.2780E-06
183.	PA1	7.4750E-03	2.6188E+00	9.9471E-01	4.8871E-04	3.2562E-03	2.2493E-06
184.	SLF	7.2341E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1768E-06
185.	RR4	7.2220E-03	1.6304E+00	9.9278E-01	1.9186E-04	1.1327E-02	2.1732E-06
186.	BE41	7.2042E-03	2.0608E+00	9.9281E-01	3.2136E-04	6.7360E-03	2.1679E-06
187.	RB4	7.0827E-03	1.1434E+00	9.9684E-01	4.4088E-05	2.1570E-02	2.1313E-06
188.	LOWPRF	7.0417E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1190E-06
189.	DS4	6.7461E-03	1.2319E+00	9.9342E-01	7.1772E-05	2.7574E-02	2.0300E-06
190.	OS3	6.6922E-03	4.1871E+00	9.9334E-01	9.6105E-04	2.0850E-03	2.0138E-06
191.	DC1	6.4636E-03	6.3721E+00	9.9450E-01	1.6182E-03	1.0232E-03	1.9450E-06
192.	ZA1	6.2945E-03	9.0290E-01	1.0008E+00	-2.9469E-05	8.4627E-03	1.8941E-06
193.	SL1	6.2645E-03	1.1059E+00	9.9422E-01	3.3614E-05	5.1699E-02	1.8851E-06
194.	SU2	6.1343E-03	2.1491E+01	9.9397E-01	6.1678E-03	2.9429E-04	1.8459E-06
195.	BE3	5.4626E-03	1.4049E+00	9.9495E-01	1.2336E-04	1.2310E-02	1.6438E-06
196.	MU1	5.2304E-03	1.0057E+00	9.9583E-01	2.9780E-06	4.2160E-01	1.5739E-06
197.	EB3	5.1277E-03	1.1240E+00	9.9489E-01	3.8853E-05	3.9589E-02	1.5430E-06
198.	RT2	4.9807E-03	2.9452E+01	9.9503E-01	8.5631E-03	1.7472E-04	1.4988E-06
199.	OB1	4.9569E-03	1.0604E+00	9.9721E-01	1.9012E-05	4.4179E-02	1.4916E-06
200.	DS8	4.9202E-03	3.7028E+00	9.9508E-01	8.1479E-04	1.8170E-03	1.4806E-06

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

Sorted by Importance

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
201.	MA3	4.7395E-03	1.0799E+00	9.9939E-01	2.4233E-05	7.6220E-03	1.4262E-06
202.	BC1	4.6533E-03	1.9923E+00	9.9641E-01	2.9967E-04	3.6050E-03	1.4003E-06
203.	RT4	4.5379E-03	2.7873E+01	9.9546E-01	8.0878E-03	1.6879E-04	1.3655E-06
204.	RVB3	4.5116E-03	1.0184E+00	9.9885E-01	5.8739E-06	5.8710E-02	1.3576E-06
205.	MB9	4.5003E-03	1.1357E+00	9.9903E-01	4.1124E-05	7.1100E-03	1.3542E-06
206.	DBACF	4.4040E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3252E-06
207.	ZBF	4.4040E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3252E-06
208.	DDACF	3.9634E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1927E-06
209.	RH1	3.7066E-03	1.5488E+00	9.9632E-01	1.6624E-04	6.6651E-03	1.1154E-06
210.	TB4	3.6733E-03	1.0396E+00	9.9743E-01	1.2675E-05	6.0956E-02	1.1053E-06
211.	GD1	3.6224E-03	1.0088E+00	9.9883E-01	3.0120E-06	1.1640E-01	1.0900E-06
212.	PA2	3.4215E-03	1.0761E+00	9.9839E-01	2.3397E-05	2.0688E-02	1.0296E-06
213.	BC2	3.4006E-03	1.8819E+00	9.9681E-01	2.6635E-04	3.6000E-03	1.0233E-06
214.	B2U21	3.2773E-03	5.7973E+00	9.9726E-01	1.4444E-03	5.7141E-04	9.8619E-07
215.	ZB1	3.2034E-03	5.7261E-01	1.0034E+00	-1.2964E-04	7.9430E-03	9.6396E-07
216.	OF1	3.1996E-03	1.0809E+00	9.9680E-01	2.5303E-05	3.8010E-02	9.6281E-07
217.	CH5	3.1629E-03	1.0245E+00	9.9924E-01	7.6015E-06	2.9909E-02	9.5178E-07
218.	RA1	2.9844E-03	1.1408E+00	9.9726E-01	4.3194E-05	1.9068E-02	8.9804E-07
219.	MA1	2.9648E-03	1.3854E+00	9.9705E-01	1.1685E-04	7.5990E-03	8.9215E-07
220.	MB1	2.8050E-03	1.3662E+00	9.9720E-01	1.1103E-04	7.5990E-03	8.4406E-07
221.	CD1	2.6485E-03	8.0500E-01	1.0016E+00	-5.9155E-05	8.0366E-03	7.9699E-07
222.	MB12	2.6114E-03	1.0293E+00	9.9740E-01	9.6066E-06	8.1540E-02	7.8582E-07
223.	CSA1	2.5183E-03	8.6663E-01	1.0028E+00	-4.0988E-05	2.0878E-02	7.5781E-07
224.	CSB3	2.4792E-03	1.0101E+00	9.9978E-01	3.1118E-06	2.0880E-02	7.4604E-07
225.	SU3	2.4592E-03	6.4825E-01	1.0031E+00	-1.0679E-04	8.8285E-03	7.4001E-07
226.	GC1	2.4362E-03	9.9519E-01	1.0007E+00	-1.6487E-06	1.2220E-01	7.3310E-07
227.	PD4	2.3748E-03	9.7276E-01	1.0011E+00	-8.5389E-06	4.0113E-02	7.1463E-07
228.	RHF	2.3233E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.9911E-07
229.	V33	2.3039E-03	9.4511E+00	9.9772E-01	2.5438E-03	2.7003E-04	6.9328E-07
230.	CSB1	2.2391E-03	9.0245E-01	1.0020E+00	-2.9952E-05	1.9930E-02	6.7377E-07
231.	RB3	2.2357E-03	1.0313E+00	9.9781E-01	1.0084E-05	6.5340E-02	6.7277E-07
232.	BB7	2.1628E-03	1.0004E+00	9.9984E-01	1.8327E-07	2.7070E-01	6.5081E-07
233.	LCL1	2.0828E-03	1.5185E+00	9.9794E-01	1.5664E-04	3.9540E-03	6.2674E-07
234.	MF1	2.0598E-03	1.0794E+00	9.9806E-01	2.4467E-05	2.3885E-02	6.1982E-07
235.	FA1	2.0125E-03	1.2944E+00	9.9866E-01	8.9002E-05	4.5300E-03	6.0559E-07
236.	GAF	2.0125E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.0559E-07
237.	GBF	1.9650E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.9129E-07
238.	SYAF	1.8949E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.7020E-07
239.	PD5	1.8583E-03	1.0102E+00	9.9966E-01	3.1610E-06	3.2458E-02	5.5918E-07
240.	ZA5	1.8462E-03	1.1025E+00	9.9919E-01	3.1082E-05	7.8440E-03	5.5556E-07
241.	SR4	1.7941E-03	1.0018E+00	9.9821E-01	1.0773E-06	5.0114E-01	5.3987E-07
242.	BE34	1.7908E-03	1.2360E+00	9.9833E-01	7.1516E-05	7.0120E-03	5.3889E-07
243.	PI3	1.6969E-03	9.7020E-01	1.0007E+00	-9.1917E-06	2.4500E-02	5.1061E-07
244.	FB1	1.6698E-03	1.2277E+00	9.9898E-01	6.8814E-05	4.4470E-03	5.0246E-07
245.	PB3	1.6640E-03	1.0296E+00	9.9937E-01	9.0904E-06	2.0690E-02	5.0071E-07
246.	MR1	1.6620E-03	1.0835E+00	9.9926E-01	2.5355E-05	8.7710E-03	5.0011E-07
247.	VSF	1.6586E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.9910E-07
248.	OS2	1.6341E-03	1.0479E+00	9.9839E-01	1.4900E-05	3.2500E-02	4.9171E-07
249.	S11	1.6237E-03	8.6559E-01	1.0017E+00	-4.0950E-05	1.2333E-02	4.8859E-07
250.	RD1	1.6197E-03	1.1394E+00	9.9838E-01	4.2435E-05	1.1486E-02	4.8741E-07

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
251.	HH1	1.5940E-03	5.8877E-01	1.0021E+00	-1.2437E-04	5.0005E-03	4.7965E-07
252.	RT8	1.5884E-03	1.9415E+00	9.9842E-01	2.8379E-04	1.6708E-03	4.7798E-07
253.	CI1	1.5823E-03	5.9708E-01	1.0020E+00	-1.2185E-04	4.9642E-03	4.7615E-07
254.	DE2	1.5252E-03	9.5188E+00	9.9848E-01	2.5639E-03	1.7784E-04	4.5896E-07
255.	ZB10	1.5241E-03	1.0212E+00	9.9850E-01	6.8264E-06	6.5930E-02	4.5862E-07
256.	DSLR1	1.5206E-03	9.8619E-01	1.0004E+00	-4.2855E-06	3.0160E-02	4.5758E-07
257.	OG1	1.5004E-03	3.2388E+00	9.9891E-01	6.7401E-04	4.8853E-04	4.5148E-07
258.	EE1	1.4918E-03	1.1087E+00	9.9982E-01	3.2773E-05	1.6740E-03	4.4890E-07
259.	BC22	1.4163E-03	1.2529E+00	9.9868E-01	7.6496E-05	5.1780E-03	4.2620E-07
260.	PD1	1.4091E-03	1.6558E+00	9.9926E-01	1.9758E-04	1.1200E-03	4.2404E-07
261.	B21	1.3556E-03	2.4303E+00	9.9915E-01	4.3067E-04	5.9562E-04	4.0793E-07
262.	GB3	1.3125E-03	1.0079E+00	9.9875E-01	2.7588E-06	1.3620E-01	3.9495E-07
263.	BE33	1.3006E-03	1.1863E+00	9.9871E-01	5.6433E-05	6.8630E-03	3.9137E-07
264.	RD2	1.2882E-03	1.0841E+00	9.9871E-01	2.5702E-05	1.5082E-02	3.8764E-07
265.	AFA5	1.2341E-03	1.0182E+00	9.9887E-01	5.8155E-06	5.8530E-02	3.7137E-07
266.	PR4	1.2007E-03	1.0494E+00	9.9883E-01	1.5214E-05	2.3152E-02	3.6130E-07
267.	AC3	1.1905E-03	1.0376E+00	9.9926E-01	1.1548E-05	1.9330E-02	3.5824E-07
268.	S21	1.1771E-03	8.7920E-01	1.0014E+00	-3.6776E-05	1.1550E-02	3.5422E-07
269.	SYBF	1.1701E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.5209E-07
270.	RR6	1.1002E-03	1.0546E+00	9.9890E-01	1.6763E-05	1.9750E-02	3.3107E-07
271.	D11	1.0802E-03	4.8967E-01	1.0016E+00	-1.5406E-04	3.1798E-03	3.2505E-07
272.	VB1	1.0563E-03	8.2275E-01	1.0013E+00	-5.3733E-05	7.3530E-03	3.1787E-07
273.	DP7	1.0179E-03	9.6437E-01	1.0005E+00	-1.0887E-05	1.5120E-02	3.0630E-07
274.	D21	9.7203E-04	4.5979E-01	1.0017E+00	-1.6307E-04	3.1383E-03	2.9250E-07
275.	DD1	9.3851E-04	9.9630E-01	1.0000E+00	-1.1150E-06	1.0079E-03	2.8241E-07
276.	BE1	9.1773E-04	0.0000E+00	9.9910E-01	0.0000E+00	2.9380E-05	2.7616E-07
277.	MB27	9.1366E-04	1.0063E+00	9.9920E-01	2.1406E-06	1.1230E-01	2.7494E-07
278.	MA7	9.1318E-04	1.0062E+00	9.9929E-01	2.0811E-06	1.0210E-01	2.7479E-07
279.	GDF	8.9896E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7051E-07
280.	RF1	8.8025E-04	2.7139E+00	9.9913E-01	5.1602E-04	5.1020E-04	2.6488E-07
281.	MELTLF	8.7943E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.6463E-07
282.	PR2	8.6317E-04	1.8995E+00	9.9917E-01	2.7092E-04	9.2581E-04	2.5974E-07
283.	BA1	8.4398E-04	0.0000E+00	9.9918E-01	0.0000E+00	2.5520E-05	2.5397E-07
284.	VA2	8.3828E-04	1.0779E+00	9.9931E-01	2.3636E-05	8.8330E-03	2.5225E-07
285.	RR7	8.1325E-04	1.0327E+00	9.9919E-01	1.0097E-05	2.4236E-02	2.4472E-07
286.	AFA1	7.5942E-04	1.2892E+00	9.9932E-01	8.7227E-05	2.3390E-03	2.2852E-07
287.	DS2	7.5445E-04	1.1026E+00	9.9925E-01	3.1090E-05	7.3022E-03	2.2703E-07
288.	VB2	7.5033E-04	1.0958E+00	9.9929E-01	2.9041E-05	7.3280E-03	2.2579E-07
289.	GCF	7.4699E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.2478E-07
290.	B1U21	7.4545E-04	9.4449E-01	1.0000E+00	-1.6718E-05	8.4458E-04	2.2432E-07
291.	RVB2	7.1323E-04	1.0725E+00	9.9935E-01	2.2022E-05	8.9300E-03	2.1462E-07
292.	EXF	6.9114E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0798E-07
293.	RB1	6.8695E-04	1.0251E+00	9.9954E-01	7.6880E-06	1.8170E-02	2.0671E-07
294.	V36	6.7095E-04	2.2940E+00	9.9933E-01	3.8959E-04	5.1728E-04	2.0190E-07
295.	PR1	6.5137E-04	2.4889E+00	9.9938E-01	4.4823E-04	4.1449E-04	1.9601E-07
296.	CH4	6.2392E-04	9.6935E-01	1.0003E+00	-9.3088E-06	9.3375E-03	1.8775E-07
297.	EE2	6.1970E-04	1.2931E+00	9.9949E-01	8.8360E-05	1.7431E-03	1.8648E-07
298.	AA1	6.1473E-04	0.0000E+00	9.9941E-01	0.0000E+00	2.5520E-05	1.8498E-07
299.	VINV22	6.1428E-04	9.5015E-01	1.0005E+00	-1.5162E-05	1.0700E-02	1.8485E-07
300.	FD1	6.0375E-04	9.9007E-01	1.0000E+00	-3.0000E-06	4.4470E-03	1.8168E-07

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
301.	MB6	5.9295E-04	1.0877E+00	9.9941E-01	2.6575E-05	6.6650E-03	1.7843E-07
302.	FE2	5.8944E-04	1.2837E+00	9.9952E-01	8.5515E-05	1.6751E-03	1.7737E-07
303.	LYCF	5.5150E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6595E-07
304.	CP3	5.5150E-04	9.9657E-01	1.0005E+00	-1.1690E-06	1.1620E-01	1.6595E-07
305.	V35	5.2654E-04	0.0000E+00	9.9947E-01	0.0000E+00	4.5854E-05	1.5844E-07
306.	UB1B1	5.1499E-04	3.6264E-01	1.0016E+00	-1.9226E-04	2.4510E-03	1.5497E-07
307.	UB1C1	5.1497E-04	3.7415E-01	1.0015E+00	-1.8877E-04	2.3290E-03	1.5496E-07
308.	UB1A1	5.1493E-04	3.3795E-01	1.0018E+00	-1.9977E-04	2.7550E-03	1.5495E-07
309.	UB1D1	5.1491E-04	3.8415E-01	1.0014E+00	-1.8574E-04	2.2330E-03	1.5494E-07
310.	BA3	5.1167E-04	1.8438E+00	9.9950E-01	2.5406E-04	5.8890E-04	1.5397E-07
311.	GD8	4.8908E-04	1.0010E+00	9.9985E-01	3.6081E-07	1.2840E-01	1.4717E-07
312.	AE6	4.8472E-04	1.0452E+00	9.9985E-01	1.3661E-05	3.4107E-03	1.4586E-07
313.	AFR1	4.6523E-04	9.8054E-01	1.0001E+00	-5.8857E-06	5.1230E-03	1.4000E-07
314.	REC6	4.6286E-04	1.0094E+00	9.9954E-01	2.9698E-06	4.6900E-02	1.3928E-07
315.	AC8	4.6041E-04	2.3515E+00	9.9954E-01	4.0683E-04	3.4030E-04	1.3854E-07
316.	BC28	4.6041E-04	1.0010E+00	9.9954E-01	4.4306E-07	3.1270E-01	1.3854E-07
317.	FC1	4.5177E-04	9.5545E-01	1.0002E+00	-1.3466E-05	4.4470E-03	1.3595E-07
318.	MB8	4.4794E-04	1.0055E+00	9.9955E-01	1.8044E-06	7.4700E-02	1.3479E-07
319.	ZB5	4.4571E-04	9.2932E-01	1.0005E+00	-2.1427E-05	7.3840E-03	1.3412E-07
320.	BB6	4.3030E-04	1.0085E+00	9.9962E-01	2.6633E-06	4.2890E-02	1.2948E-07
321.	FE1	4.2911E-04	4.7282E-01	1.0009E+00	-1.5891E-04	1.6812E-03	1.2913E-07
322.	SU1	4.0983E-04	2.7591E+00	9.9959E-01	5.2947E-04	2.3091E-04	1.2333E-07
323.	AB4	4.0694E-04	1.0052E+00	9.9969E-01	1.6640E-06	5.5550E-02	1.2246E-07
324.	V2F	3.4621E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0418E-07
325.	SL3	3.4568E-04	9.7374E-01	1.0005E+00	-8.0373E-06	1.6995E-02	1.0402E-07
326.	CP1	3.2811E-04	2.2546E-01	1.0012E+00	-2.3343E-04	1.5112E-03	9.8735E-08
327.	DSF	3.2369E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.7403E-08
328.	GC6	3.2350E-04	9.9975E-01	1.0000E+00	-8.7040E-08	1.3620E-01	9.7345E-08
329.	S23	3.1710E-04	1.0027E+00	9.9978E-01	8.9307E-07	7.4780E-02	9.5421E-08
330.	CI3	3.1317E-04	8.8555E-01	1.0010E+00	-3.4755E-05	9.0559E-03	9.4237E-08
331.	VNV2R1	3.1199E-04	1.0856E+00	9.9982E-01	2.5815E-05	2.0630E-03	9.3882E-08
332.	A21	3.0552E-04	6.4667E-01	1.0002E+00	-1.0639E-04	6.0348E-04	9.1936E-08
333.	DCAC1	2.9948E-04	5.0147E-01	1.0003E+00	-1.5012E-04	6.9950E-04	9.0118E-08
334.	V34	2.9779E-04	1.0006E+00	9.9999E-01	1.9595E-07	1.4488E-02	8.9611E-08
335.	FD4	2.9521E-04	1.0000E+00	9.9970E-01	8.8923E-08	9.9900E-01	8.8834E-08
336.	FB2	2.9521E-04	1.0110E+00	9.9974E-01	3.3726E-06	2.2770E-02	8.8834E-08
337.	FC3	2.9521E-04	1.0001E+00	9.9970E-01	1.0978E-07	8.0920E-01	8.8834E-08
338.	RH2	2.9506E-04	1.0194E+00	9.9970E-01	5.9138E-06	1.5014E-02	8.8789E-08
339.	CH2	2.9372E-04	9.8747E-01	1.0003E+00	-3.8600E-06	2.3058E-02	8.8385E-08
340.	LYAF	2.9173E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.7786E-08
341.	PB6	2.8551E-04	9.7430E-01	1.0004E+00	-7.8396E-06	1.3680E-02	8.5916E-08
342.	PR3	2.5732E-04	1.0286E+00	9.9976E-01	8.6694E-06	8.1814E-03	7.7433E-08
343.	AM1	2.5095E-04	1.1935E+00	9.9981E-01	5.8284E-05	1.0000E-03	7.5516E-08
344.	PB4	2.4554E-04	1.0038E+00	9.9985E-01	1.1743E-06	3.7850E-02	7.3887E-08
345.	RRB	2.4296E-04	1.3615E+00	9.9983E-01	1.0882E-04	4.6064E-04	7.3112E-08
346.	MRF	2.3836E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.1728E-08
347.	RTB	2.3836E-04	0.0000E+00	9.9976E-01	0.0000E+00	6.4446E-06	7.1728E-08
348.	BE50	2.3531E-04	1.0071E+00	9.9976E-01	2.2066E-06	3.2090E-02	7.0810E-08
349.	AE7	2.3531E-04	0.0000E+00	9.9977E-01	0.0000E+00	3.1892E-05	7.0810E-08
350.	GC4	2.3125E-04	1.0010E+00	9.9985E-01	3.5871E-07	1.2840E-01	6.9586E-08

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
351.	BA5	2.0109E-04	1.2740E+00	9.9982E-01	8.2511E-05	6.6400E-04	6.0512E-08
352.	BE9	1.9912E-04	0.0000E+00	9.9980E-01	0.0000E+00	2.7000E-05	5.9917E-08
353.	BC8	1.9212E-04	1.0314E+00	9.9981E-01	9.4967E-06	5.9420E-03	5.7813E-08
354.	AFF	1.8671E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.6186E-08
355.	BE43	1.8406E-04	9.8175E-01	1.0001E+00	-5.5100E-06	3.3430E-03	5.5386E-08
356.	BYCF	1.8219E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4825E-08
357.	BE85	1.8192E-04	1.0247E+00	9.9983E-01	7.4802E-06	6.8640E-03	5.4744E-08
358.	RL4	1.7683E-04	1.0276E+00	9.9988E-01	8.3380E-06	4.2971E-03	5.3212E-08
359.	BE91	1.7503E-04	1.0240E+00	9.9982E-01	7.2698E-06	7.2450E-03	5.2670E-08
360.	AE10	1.7503E-04	2.2915E+00	9.9983E-01	3.8867E-04	1.3533E-04	5.2670E-08
361.	GD5	1.6633E-04	1.0008E+00	9.9988E-01	2.8465E-07	1.2220E-01	5.0051E-08
362.	GD9	1.5938E-04	1.0003E+00	9.9993E-01	1.1613E-07	1.8570E-01	4.7960E-08
363.	AR2	1.5658E-04	8.2866E-01	1.0010E+00	-5.1856E-05	5.6935E-03	4.7116E-08
364.	AE2	1.5482E-04	9.9821E-01	1.0000E+00	-5.4386E-07	1.2314E-02	4.6587E-08
365.	PB2	1.5014E-04	1.0034E+00	9.9995E-01	1.0510E-06	1.3750E-02	4.5181E-08
366.	BC34	1.4549E-04	9.7217E-01	1.0002E+00	-8.4254E-06	6.0460E-03	4.3781E-08
367.	RR3	1.4232E-04	1.0129E+00	9.9986E-01	3.9239E-06	1.0914E-02	4.2825E-08
368.	A1U21	1.3610E-04	2.5125E-01	1.0005E+00	-2.2547E-04	6.9324E-04	4.0954E-08
369.	MB10	1.3588E-04	9.9719E-01	1.0002E+00	-9.1218E-07	7.4250E-02	4.0890E-08
370.	BB8	1.3480E-04	1.2244E+00	9.9988E-01	6.7549E-05	5.5650E-04	4.0564E-08
371.	CH3	1.3184E-04	9.8267E-01	1.0004E+00	-5.3400E-06	2.3213E-02	3.9672E-08
372.	BB5	1.2480E-04	1.2155E+00	9.9989E-01	6.4873E-05	5.3290E-04	3.7553E-08
373.	VS1	1.1929E-04	1.0279E+00	9.9998E-01	8.3981E-06	7.3465E-04	3.5898E-08
374.	BC23	1.1747E-04	1.0085E+00	9.9989E-01	2.5848E-06	1.3210E-02	3.5349E-08
375.	HH2	1.1383E-04	8.7252E-01	1.0007E+00	-3.8563E-05	5.2706E-03	3.4252E-08
376.	AB7	1.0896E-04	1.1576E+00	9.9991E-01	4.7462E-05	5.8890E-04	3.2788E-08
377.	RL1	1.0413E-04	0.0000E+00	9.9991E-01	0.0000E+00	1.7189E-05	3.1334E-08
378.	VS81	1.0355E-04	1.0023E+00	9.9990E-01	7.1929E-07	4.3320E-02	3.1159E-08
379.	BC3	1.0236E-04	1.0033E+00	9.9998E-01	1.0019E-06	5.9050E-03	3.0802E-08
380.	B31	1.0188E-04	3.8267E-01	1.0003E+00	-1.8585E-04	4.3780E-04	3.0657E-08
381.	MB11	9.3355E-05	9.8813E-01	1.0001E+00	-3.5949E-06	6.7230E-03	2.8092E-08
382.	OF2	8.8582E-05	1.0003E+00	9.9999E-01	9.0699E-08	4.8920E-02	2.6656E-08
383.	DAAC1	8.0808E-05	3.3610E-01	1.0005E+00	-1.9992E-04	6.9142E-04	2.4316E-08
384.	CH6	7.7644E-05	9.9154E-01	1.0003E+00	-2.6245E-06	3.0232E-02	2.3364E-08
385.	PI2	7.7462E-05	1.0049E+00	9.9994E-01	1.4865E-06	1.2622E-02	2.3310E-08
386.	V31	7.5647E-05	0.0000E+00	9.9992E-01	0.0000E+00	5.5440E-07	2.2763E-08
387.	BE42	7.5393E-05	1.0016E+00	9.9992E-01	5.1409E-07	4.4130E-02	2.2687E-08
388.	VS91	7.2484E-05	1.0000E+00	1.0000E+00	0.0000E+00	7.0000E-01	2.1812E-08
389.	VSA3	7.2484E-05	1.0007E+00	9.9993E-01	2.1812E-07	1.0000E-01	2.1812E-08
390.	D12	7.0442E-05	8.7416E-01	1.0004E+00	-3.7978E-05	2.9367E-03	2.1197E-08
391.	SEI	6.8685E-05	1.0244E+00	9.9994E-01	7.3629E-06	2.2730E-03	2.0669E-08
392.	D22	6.3518E-05	8.7405E-01	1.0003E+00	-3.8000E-05	2.6488E-03	1.9114E-08
393.	VT1BR1	5.2304E-05	8.1629E-01	1.0004E+00	-5.5402E-05	2.1820E-03	1.5739E-08
394.	VT1AR1	5.0190E-05	8.4878E-01	1.0003E+00	-4.5601E-05	2.0940E-03	1.5103E-08
395.	PB9	4.9866E-05	1.0069E+00	9.9998E-01	2.0911E-06	3.2550E-03	1.5005E-08
396.	DCAC3	4.9021E-05	1.0126E+00	9.9999E-01	3.7944E-06	7.2772E-04	1.4751E-08
397.	VNV1R1	4.8726E-05	8.6868E-01	1.0003E+00	-3.9595E-05	2.0100E-03	1.4663E-08
398.	V32	4.5574E-05	0.0000E+00	9.9995E-01	0.0000E+00	6.0280E-06	1.3714E-08
399.	AF3	4.1883E-05	0.0000E+00	9.9996E-01	0.0000E+00	2.8698E-06	1.2603E-08
400.	RI1	4.0370E-05	9.4811E-01	1.0000E+00	-1.5619E-05	3.2090E-04	1.2148E-08

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
401.	RW1	3.9009E-05	0.0000E+00	9.9996E-01	0.0000E+00	6.5900E-07	1.1738E-08
402.	RI2	3.8899E-05	9.5519E-01	1.0000E+00	-1.3489E-05	5.0320E-04	1.1705E-08
403.	BE90	3.8761E-05	1.2867E+00	9.9996E-01	8.6287E-05	1.3440E-04	1.1664E-08
404.	OT1	3.8016E-05	8.3552E-01	1.0003E+00	-4.9578E-05	1.6490E-03	1.1440E-08
405.	MA5	3.7966E-05	9.7200E-01	1.0002E+00	-8.4913E-06	7.6720E-03	1.1425E-08
406.	DC2	3.7709E-05	1.0125E+00	9.9999E-01	3.7544E-06	5.5948E-04	1.1347E-08
407.	LYNF	3.6200E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0893E-08
408.	VC2	3.5259E-05	9.7080E-01	1.0003E+00	-8.8651E-06	8.9203E-03	1.0610E-08
409.	RT6	3.4003E-05	1.1879E+00	9.9997E-01	5.6567E-05	1.8024E-04	1.0232E-08
410.	RS1	3.3598E-05	8.9973E-01	1.0005E+00	-3.0332E-05	5.2243E-03	1.0110E-08
411.	VSA1	3.1065E-05	1.0003E+00	9.9997E-01	9.3478E-08	1.0000E-01	9.3478E-09
412.	VS11	2.0697E-05	1.0238E+00	9.9998E-01	7.1680E-06	8.6510E-04	6.2280E-09
413.	VS4F	2.0137E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.0595E-09
414.	CDBF	1.0992E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.3078E-09
415.	VI71	1.0631E-05	1.0001E+00	9.9999E-01	1.9943E-08	1.6040E-01	3.1989E-09
416.	VI81	1.0631E-05	1.0002E+00	9.9999E-01	6.3978E-08	5.0000E-02	3.1989E-09
417.	VI91	1.0631E-05	1.0001E+00	9.9999E-01	3.1989E-08	1.0000E-01	3.1989E-09
418.	VS31	7.3962E-07	1.0000E+00	1.0000E+00	-1.1267E-11	3.5490E-02	2.2256E-10
419.	VI11	3.2989E-07	1.0001E+00	1.0000E+00	3.2477E-08	2.7803E-03	9.9270E-11
420.	VI72	2.7535E-07	1.0000E+00	1.0000E+00	1.1049E-09	7.4990E-02	8.2857E-11
421.	VI83	1.9274E-07	1.0000E+00	1.0000E+00	0.0000E+00	7.0000E-01	5.8000E-11
422.	VI95	1.9274E-07	1.0000E+00	1.0000E+00	5.8000E-10	1.0000E-01	5.8000E-11
423.	VS21	1.7941E-07	0.0000E+00	1.0000E+00	0.0000E+00	7.5940E-06	5.3988E-11
424.	VI94	8.2605E-08	1.0000E+00	1.0000E+00	2.4857E-10	1.0000E-01	2.4857E-11
425.	VI61	6.5696E-08	0.0000E+00	1.0000E+00	0.0000E+00	4.9560E-05	1.9769E-11
426.	VI92	5.9126E-08	1.0000E+00	1.0000E+00	1.7792E-10	1.0000E-01	1.7792E-11
427.	VI21	5.0312E-08	1.0000E+00	1.0000E+00	2.6141E-09	5.6100E-03	1.5140E-11
428.	AR1	3.8688E-08	3.2311E-01	1.0002E+00	-2.0375E-04	3.1684E-04	1.1642E-11
429.	VI41	3.7135E-08	1.0000E+00	1.0000E+00	6.3428E-11	1.6040E-01	1.1175E-11
430.	VI98	1.7408E-08	1.0000E+00	1.0000E+00	5.2383E-11	1.0000E-01	5.2383E-12
431.	VI82	6.5696E-09	1.0000E+00	1.0000E+00	0.0000E+00	1.0000E-01	1.9769E-12
432.	VI93	6.5696E-09	1.0000E+00	1.0000E+00	1.9769E-11	1.0000E-01	1.9769E-12
433.	VI31	4.2305E-09	1.0000E+00	1.0000E+00	1.4948E-09	8.0690E-04	1.2730E-12
434.	VS71	3.5818E-09	1.0000E+00	1.0000E+00	3.0370E-11	3.5490E-02	1.0778E-12
435.	VS92	3.5818E-09	1.0000E+00	1.0000E+00	1.3473E-12	8.0000E-01	1.0778E-12
436.	VS61	3.5818E-09	9.9996E-01	1.0000E+00	-1.0977E-08	5.3400E-05	1.0778E-12
437.	VSA4	3.5818E-09	1.0000E+00	1.0000E+00	1.0778E-11	1.0000E-01	1.0778E-12
438.	VI99	3.3256E-09	1.0000E+00	1.0000E+00	-1.2969E-12	1.0000E-01	1.0007E-12
439.	A31	0.0000E+00	1.4996E-01	1.0004E+00	-2.5590E-04	4.3770E-04	0.0000E+00
440.	VINV11	0.0000E+00	2.1059E-01	1.0002E+00	-2.3759E-04	1.9250E-04	0.0000E+00
441.	VB5	0.0000E+00	9.9883E-01	1.0000E+00	-3.5474E-07	8.8330E-03	0.0000E+00
442.	VC1	0.0000E+00	5.3148E-01	1.0003E+00	-1.4109E-04	7.0947E-04	0.0000E+00
443.	A1LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
444.	VT2BR1	0.0000E+00	9.3753E-01	1.0001E+00	-1.8838E-05	2.0810E-03	0.0000E+00
445.	AB9	0.0000E+00	9.4457E-01	1.0000E+00	-1.6691E-05	6.6400E-04	0.0000E+00
446.	VT2B1	0.0000E+00	1.6949E-01	1.0003E+00	-2.5000E-04	3.4730E-04	0.0000E+00
447.	A2U21	0.0000E+00	5.4930E-02	1.0005E+00	-2.8454E-04	5.4685E-04	0.0000E+00
448.	VINV21	0.0000E+00	1.7240E-01	1.0002E+00	-2.4909E-04	1.9050E-04	0.0000E+00
449.	VB4	0.0000E+00	9.9954E-01	1.0000E+00	-1.3912E-07	8.8110E-03	0.0000E+00
450.	VB3	0.0000E+00	9.9894E-01	1.0000E+00	-3.1912E-07	3.8680E-03	0.0000E+00

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
451.	VT2B2	0.0000E+00	8.9312E-01	1.0000E+00	-3.2173E-05	3.3920E-04	0.0000E+00
452.	ABLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
453.	VINV12	0.0000E+00	9.4511E-01	1.0000E+00	-1.6529E-05	6.6040E-04	0.0000E+00
454.	TP2	0.0000E+00	9.9723E-01	1.0002E+00	-8.9038E-07	6.3100E-02	0.0000E+00
455.	ZB2	0.0000E+00	9.8423E-01	1.0001E+00	-4.7857E-06	8.6460E-03	0.0000E+00
456.	ZB3	0.0000E+00	9.9989E-01	1.0000E+00	-3.2709E-08	1.0040E-02	0.0000E+00
457.	ZA4	0.0000E+00	9.9905E-01	1.0000E+00	-2.8968E-07	8.5896E-03	0.0000E+00
458.	ZA3	0.0000E+00	9.9989E-01	1.0000E+00	-3.2735E-08	1.0807E-02	0.0000E+00
459.	ZB4	0.0000E+00	9.9905E-01	1.0000E+00	-2.8952E-07	8.0530E-03	0.0000E+00
460.	SYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
461.	VI62	0.0000E+00	1.0000E+00	1.0000E+00	-8.2863E-11	7.4640E-05	0.0000E+00
462.	WC1	0.0000E+00	9.9909E-01	1.0000E+00	-2.7458E-07	3.6640E-03	0.0000E+00
463.	WCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
464.	A2U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
465.	TB3	0.0000E+00	9.9927E-01	1.0000E+00	-2.2034E-07	1.2852E-03	0.0000E+00
466.	SYCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
467.	TB1	0.0000E+00	8.2414E-01	1.0001E+00	-5.2934E-05	3.1053E-04	0.0000E+00
468.	ZA2	0.0000E+00	9.8423E-01	1.0001E+00	-4.7884E-06	9.2023E-03	0.0000E+00
469.	VF1	0.0000E+00	9.9250E-01	1.0000E+00	-2.2583E-06	7.3823E-04	0.0000E+00
470.	UB1C2	0.0000E+00	9.9897E-01	1.0001E+00	-3.2694E-07	5.2060E-02	0.0000E+00
471.	UB1B3	0.0000E+00	9.9892E-01	1.0000E+00	-3.2595E-07	2.7550E-03	0.0000E+00
472.	VT2A1	0.0000E+00	5.5067E-02	1.0003E+00	-2.8444E-04	3.3920E-04	0.0000E+00
473.	AB2	0.0000E+00	9.7777E-01	1.0000E+00	-6.6942E-06	5.5650E-04	0.0000E+00
474.	V14	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.4330E-05	0.0000E+00
475.	V15	0.0000E+00	9.5108E-01	1.0002E+00	-1.4778E-05	3.7870E-03	0.0000E+00
476.	V13	0.0000E+00	9.5888E-01	1.0001E+00	-1.2415E-05	3.2660E-03	0.0000E+00
477.	V21	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	7.7860E-06	0.0000E+00
478.	UB1B2	0.0000E+00	9.9949E-01	1.0001E+00	-1.7467E-07	1.1290E-01	0.0000E+00
479.	V1R1	0.0000E+00	9.9996E-01	1.0000E+00	-1.2133E-08	3.8210E-04	0.0000E+00
480.	AB1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.5520E-05	0.0000E+00
481.	V219	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3880E-05	0.0000E+00
482.	UB1D2	0.0000E+00	9.9846E-01	1.0001E+00	-4.8594E-07	4.3340E-02	0.0000E+00
483.	VT1A2	0.0000E+00	9.5831E-01	1.0000E+00	-1.2549E-05	3.3920E-04	0.0000E+00
484.	UB1D5	0.0000E+00	9.9892E-01	1.0000E+00	-3.2585E-07	2.4510E-03	0.0000E+00
485.	UB1C4	0.0000E+00	9.9903E-01	1.0000E+00	-2.9322E-07	2.4510E-03	0.0000E+00
486.	VT1A1	0.0000E+00	2.1702E-01	1.0003E+00	-2.3569E-04	3.4730E-04	0.0000E+00
487.	A1U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
488.	V12	0.0000E+00	9.8560E-01	1.0001E+00	-4.3486E-06	3.7900E-03	0.0000E+00
489.	V11	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	7.9970E-06	0.0000E+00
490.	AB3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.4650E-05	0.0000E+00
491.	VT1B1	0.0000E+00	2.0781E-01	1.0003E+00	-2.3846E-04	3.3920E-04	0.0000E+00
492.	AALS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
493.	V29	0.0000E+00	9.9972E-01	1.0000E+00	-8.5024E-08	3.2720E-03	0.0000E+00
494.	V27	0.0000E+00	9.9700E-01	1.0000E+00	-9.0439E-07	3.2650E-03	0.0000E+00
495.	VS2	0.0000E+00	9.9325E-01	1.0001E+00	-2.0511E-06	9.1389E-03	0.0000E+00
496.	V25	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	7.6690E-06	0.0000E+00
497.	AB8	0.0000E+00	9.9960E-01	1.0001E+00	-1.3655E-07	1.1370E-01	0.0000E+00
498.	VS3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.5700E-06	0.0000E+00
499.	A2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
500.	VT2AR1	0.0000E+00	9.4507E-01	1.0001E+00	-1.6565E-05	2.1050E-03	0.0000E+00

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

Sorted by Importance

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
501.	V2R1	0.0000E+00	9.9965E-01	1.0000E+00	-1.0422E-07	3.5340E-04	0.0000E+00
502.	TP7	0.0000E+00	9.7802E-01	1.0000E+00	-6.6160E-06	1.4650E-04	0.0000E+00
503.	V220	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3430E-05	0.0000E+00
504.	TT2	0.0000E+00	9.9781E-01	1.0000E+00	-6.5792E-07	9.4482E-05	0.0000E+00
505.	TTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
506.	TT1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.0797E-05	0.0000E+00
507.	V221	0.0000E+00	9.9403E-01	1.0000E+00	-1.8043E-06	3.7860E-03	0.0000E+00
508.	V24	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	7.6610E-06	0.0000E+00
509.	V226	0.0000E+00	9.5467E-01	1.0000E+00	-1.3652E-05	8.2410E-04	0.0000E+00
510.	V224	0.0000E+00	9.4983E-01	1.0000E+00	-1.5100E-05	2.5060E-04	0.0000E+00
511.	VS51	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.2860E-05	0.0000E+00
512.	V222	0.0000E+00	9.6795E-01	1.0001E+00	-9.6806E-06	3.7890E-03	0.0000E+00
513.	BE17	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.9350E-05	0.0000E+00
514.	DP4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.5659E-05	0.0000E+00
515.	DP3	0.0000E+00	9.9992E-01	1.0000E+00	-2.3577E-08	1.5416E-04	0.0000E+00
516.	DP8	0.0000E+00	9.9977E-01	1.0000E+00	-7.5641E-08	9.1117E-02	0.0000E+00
517.	DP2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.4122E-05	0.0000E+00
518.	DP1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.1384E-06	0.0000E+00
519.	DSLRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
520.	DS9	0.0000E+00	9.9697E-01	1.0000E+00	-9.2421E-07	1.4270E-02	0.0000E+00
521.	DS3	0.0000E+00	9.9997E-01	1.0000E+00	-1.0691E-08	2.0877E-02	0.0000E+00
522.	DS5	0.0000E+00	9.9987E-01	1.0000E+00	-4.1444E-08	6.8065E-02	0.0000E+00
523.	BB2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.4650E-05	0.0000E+00
524.	DDAC1	0.0000E+00	6.7198E-02	1.0007E+00	-2.8089E-04	7.0382E-04	0.0000E+00
525.	DD2	0.0000E+00	9.3500E-01	1.0000E+00	-1.9572E-05	5.8880E-04	0.0000E+00
526.	DDAC2	0.0000E+00	9.9906E-01	1.0000E+00	-2.8261E-07	6.9688E-04	0.0000E+00
527.	DCAC2	0.0000E+00	9.9354E-01	1.0000E+00	-1.9463E-06	6.9063E-04	0.0000E+00
528.	DHS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
529.	DG1	0.0000E+00	1.7533E-01	1.0003E+00	-2.4824E-04	3.4414E-04	0.0000E+00
530.	DDAC3	0.0000E+00	9.3784E-01	1.0000E+00	-1.8719E-05	7.2193E-04	0.0000E+00
531.	BB9	0.0000E+00	9.4909E-01	1.0000E+00	-1.5328E-05	5.8890E-04	0.0000E+00
532.	DBAC3	0.0000E+00	7.9301E-01	1.0002E+00	-6.2331E-05	7.3040E-04	0.0000E+00
533.	BB1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.5520E-05	0.0000E+00
534.	BB10	0.0000E+00	9.8892E-01	1.0000E+00	-3.3358E-06	6.6400E-04	0.0000E+00
535.	GAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
536.	FW1	0.0000E+00	9.6185E-01	1.0002E+00	-1.1538E-05	4.9150E-03	0.0000E+00
537.	BB11	0.0000E+00	9.9938E-01	1.0000E+00	-1.9758E-07	5.5550E-02	0.0000E+00
538.	GDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
539.	GCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
540.	BALS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
541.	GBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
542.	EB2	0.0000E+00	9.9976E-01	1.0000E+00	-7.5022E-08	4.3911E-02	0.0000E+00
543.	FAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
544.	EXS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
545.	FBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
546.	EB7	0.0000E+00	9.9929E-01	1.0000E+00	-2.1987E-07	3.5000E-02	0.0000E+00
547.	FDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
548.	FD2	0.0000E+00	9.9616E-01	1.0000E+00	-1.1603E-06	4.4460E-03	0.0000E+00
549.	FC2	0.0000E+00	9.9661E-01	1.0000E+00	-1.0238E-06	4.4460E-03	0.0000E+00
550.	FCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

Sorted by Importance

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
551.	GE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
552.	BE86	0.0000E+00	9.7521E-01	1.0001E+00	-7.4845E-06	3.4110E-03	0.0000E+00
553.	BE69	0.0000E+00	9.9992E-01	1.0000E+00	-2.3575E-08	8.4130E-05	0.0000E+00
554.	BE13	0.0000E+00	9.9907E-01	1.0000E+00	-2.7889E-07	8.0040E-05	0.0000E+00
555.	BE65	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.0870E-05	0.0000E+00
556.	BE57	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.0840E-05	0.0000E+00
557.	CAVS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
558.	BE11	0.0000E+00	9.9969E-01	1.0000E+00	-9.3044E-08	1.0680E-02	0.0000E+00
559.	BYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
560.	BYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
561.	BE10	0.0000E+00	9.9985E-01	1.0000E+00	-4.6601E-08	3.0510E-04	0.0000E+00
562.	BE25	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.9380E-05	0.0000E+00
563.	BE21	0.0000E+00	9.9708E-01	1.0000E+00	-8.7736E-07	8.2440E-05	0.0000E+00
564.	BE4	0.0000E+00	9.9980E-01	1.0000E+00	-6.9409E-08	1.2350E-01	0.0000E+00
565.	BE19	0.0000E+00	9.9959E-01	1.0000E+00	-1.2409E-07	1.2310E-02	0.0000E+00
566.	BE53	0.0000E+00	9.9929E-01	1.0000E+00	-2.1417E-07	8.3940E-05	0.0000E+00
567.	BE5	0.0000E+00	9.7204E-01	1.0000E+00	-8.4152E-06	8.2450E-05	0.0000E+00
568.	BE44	0.0000E+00	9.9959E-01	1.0000E+00	-1.2610E-07	2.3230E-02	0.0000E+00
569.	BE49	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.0870E-05	0.0000E+00
570.	DBAC2	0.0000E+00	9.6655E-01	1.0000E+00	-1.0073E-05	6.9588E-04	0.0000E+00
571.	DA2	0.0000E+00	8.2481E-01	1.0001E+00	-5.2749E-05	5.8037E-04	0.0000E+00
572.	BBLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
573.	DAAC2	0.0000E+00	9.6502E-01	1.0000E+00	-1.0534E-05	7.0144E-04	0.0000E+00
574.	CT1	0.0000E+00	1.3545E-04	1.0001E+00	-3.0090E-04	9.5251E-05	0.0000E+00
575.	CSRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
576.	DBAC1	0.0000E+00	2.4498E-01	1.0005E+00	-2.2736E-04	6.9267E-04	0.0000E+00
577.	DAAC3	0.0000E+00	8.2506E-01	1.0001E+00	-5.2680E-05	7.2218E-04	0.0000E+00
578.	DB2	0.0000E+00	8.4444E-01	1.0001E+00	-4.6838E-05	5.9108E-04	0.0000E+00
579.	CCSRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
580.	CI2	0.0000E+00	9.9985E-01	1.0000E+00	-4.5218E-08	2.3442E-02	0.0000E+00
581.	CH1	0.0000E+00	8.9624E-01	1.0002E+00	-3.1292E-05	2.2297E-03	0.0000E+00
582.	CL1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	9.0020E-06	0.0000E+00
583.	CDBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
584.	CSIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
585.	CSB2	0.0000E+00	9.9776E-01	1.0002E+00	-7.2105E-07	6.5180E-02	0.0000E+00
586.	CMS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
587.	CP2	0.0000E+00	9.9985E-01	1.0000E+00	-4.4239E-08	1.8292E-03	0.0000E+00
588.	SYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
589.	AF1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6831E-06	0.0000E+00
590.	AF2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.0331E-06	0.0000E+00
591.	RF3	0.0000E+00	9.9792E-01	1.0000E+00	-6.3039E-07	5.7840E-03	0.0000E+00
592.	RB2	0.0000E+00	9.9994E-01	1.0000E+00	-1.8325E-08	1.9070E-02	0.0000E+00
593.	AF4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	7.0914E-06	0.0000E+00
594.	RI4	0.0000E+00	9.8481E-01	1.0000E+00	-4.5737E-06	5.0350E-04	0.0000E+00
595.	RI3	0.0000E+00	9.9977E-01	1.0000E+00	-6.9841E-08	3.2110E-04	0.0000E+00
596.	AE9	0.0000E+00	9.9360E-01	1.0000E+00	-1.9274E-06	8.4961E-05	0.0000E+00
597.	RHRSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
598.	RL2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.7877E-05	0.0000E+00
599.	PE2	0.0000E+00	8.4782E-01	1.0000E+00	-4.5798E-05	1.1338E-04	0.0000E+00
600.	PE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	9.9705E-07	0.0000E+00

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 3.0092E-04

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
601.	PI1	0.0000E+00	9.9230E-01	1.0000E+00	-2.3167E-06	1.4208E-04	0.0000E+00
602.	AFA3	0.0000E+00	9.9135E-01	1.0003E+00	-2.6837E-06	3.0460E-02	0.0000E+00
603.	PRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
604.	AF5	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.9616E-05	0.0000E+00
605.	AF6	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.2722E-05	0.0000E+00
606.	PR6	0.0000E+00	9.9951E-01	1.0000E+00	-1.5570E-07	4.6109E-02	0.0000E+00
607.	PD3	0.0000E+00	9.8316E-01	1.0000E+00	-5.0750E-06	1.3808E-03	0.0000E+00
608.	SE9	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	5.3569E-07	0.0000E+00
609.	SE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	5.7463E-07	0.0000E+00
610.	SES	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
611.	AE3	0.0000E+00	9.7234E-01	1.0000E+00	-8.3226E-06	8.3513E-05	0.0000E+00
612.	RTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
613.	SRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
614.	SLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
615.	SGCLGS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
616.	SI1	0.0000E+00	6.5098E-01	1.0004E+00	-1.0514E-04	1.0315E-03	0.0000E+00
617.	RL3	0.0000E+00	9.9969E-01	1.0000E+00	-9.3913E-08	3.3109E-04	0.0000E+00
618.	RR8	0.0000E+00	9.9975E-01	1.0000E+00	-7.4312E-08	4.6390E-03	0.0000E+00
619.	AE8	0.0000E+00	9.9992E-01	1.0000E+00	-2.4235E-08	1.1472E-02	0.0000E+00
620.	RR9	0.0000E+00	9.9864E-01	1.0000E+00	-4.1028E-07	4.7274E-03	0.0000E+00
621.	RL5	0.0000E+00	9.9995E-01	1.0000E+00	-1.4726E-08	4.2921E-03	0.0000E+00
622.	RT9	0.0000E+00	9.9995E-01	1.0000E+00	-1.3765E-08	1.6824E-03	0.0000E+00
623.	RT5	0.0000E+00	9.9968E-01	1.0000E+00	-9.6581E-08	1.7351E-04	0.0000E+00
624.	AE4	0.0000E+00	9.9827E-01	1.0000E+00	-5.2189E-07	1.5823E-03	0.0000E+00
625.	RT3	0.0000E+00	9.9732E-01	1.0000E+00	-8.0733E-07	6.1438E-04	0.0000E+00
626.	HE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
627.	MB15	0.0000E+00	9.9906E-01	1.0000E+00	-2.8534E-07	6.2180E-03	0.0000E+00
628.	MB13	0.0000E+00	9.7581E-01	1.0002E+00	-7.3306E-06	7.1530E-03	0.0000E+00
629.	MB17	0.0000E+00	9.9996E-01	1.0000E+00	-1.2701E-08	1.0210E-01	0.0000E+00
630.	BA2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.4650E-05	0.0000E+00
631.	MACROS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
632.	MB7	0.0000E+00	9.9817E-01	1.0000E+00	-5.5547E-07	7.0850E-03	0.0000E+00
633.	MB5	0.0000E+00	9.8688E-01	1.0001E+00	-3.9789E-06	7.6720E-03	0.0000E+00
634.	MB28	0.0000E+00	9.9909E-01	1.0000E+00	-2.7839E-07	1.2920E-02	0.0000E+00
635.	MB3	0.0000E+00	9.8286E-01	1.0001E+00	-5.1971E-06	7.6220E-03	0.0000E+00
636.	MELTBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
637.	IP1	0.0000E+00	9.8423E-01	1.0000E+00	-4.7486E-06	9.0383E-04	0.0000E+00
638.	INTPRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
639.	LOWPRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
640.	IC1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	9.9040E-07	0.0000E+00
641.	MA6	0.0000E+00	9.9856E-01	1.0000E+00	-4.3652E-07	6.6650E-03	0.0000E+00
642.	LYCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
643.	LYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
644.	LYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
645.	PD2	0.0000E+00	9.9202E-01	1.0000E+00	-2.4104E-06	3.5332E-03	0.0000E+00
646.	PA3	0.0000E+00	9.3055E-01	1.0003E+00	-2.0983E-05	4.0285E-03	0.0000E+00
647.	OTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
648.	PB10	0.0000E+00	9.9981E-01	1.0000E+00	-5.6979E-08	2.1040E-02	0.0000E+00
649.	OSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
650.	B1LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

MODEL Name: WBNNEW

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 3.0092E-04

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
651.	PB7	0.0000E+00	9.7323E-01	1.0001E+00	-8.0889E-06	4.0060E-03	0.0000E+00
652.	PB12	0.0000E+00	9.9388E-01	1.0000E+00	-1.8485E-06	4.0040E-03	0.0000E+00
653.	PB5	0.0000E+00	9.3667E-01	1.0002E+00	-1.9119E-05	3.2120E-03	0.0000E+00
654.	B2U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
655.	MS1	0.0000E+00	5.8982E-01	1.0001E+00	-1.2346E-04	2.2688E-04	0.0000E+00
656.	MELTSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
657.	B2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
658.	MELTIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
659.	MU8	0.0000E+00	9.9997E-01	1.0000E+00	-1.9541E-08	4.8404E-01	0.0000E+00
660.	MU5	0.0000E+00	9.9904E-01	1.0000E+00	-2.9919E-07	3.2572E-02	0.0000E+00
661.	MSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
662.	B1U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

.L Name: WBNHA Top-Ranking Sequences Contributing to Group : MELT Frequency 08:45:50 06 AUG 1992
MELT = ALL CORE DAMAGE SEQUENCES

Rank No.	Sequence Description	Events: Guaranteed Events/Comments	End State	Frequency (per year)	Percent
1	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	1.58E-04	5.83
2	STEAM GENERATOR TUBE RUPTURE - MAKEUP TO RWST - OPERATOR DEPRESSURIZES THE RCS USING THE STEAM GENERATOR PORVS	- RHR NORMAL DECAY HEAT REMOVAL - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - MELT WITH SGTR BYPASS	EIB	1.53E-04	5.64
3	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - MAKEUP TO RWST - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	1.25E-04	4.60
4	LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	7.57E-05	2.79
5	SMALL LOCA ISOLATABLE, PZR PORV LEAK - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RHR SPRAY RECIRCULATION	FCI	6.41E-05	2.36
6	LOSS OF COMPONENT COOLING WATER TRAIN A - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	6.22E-05	2.29
7	SMALL LOCA ISOLATABLE, PZR PORV LEAK - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RHR SPRAY RECIRCULATION	FCI	5.06E-05	1.86
8	TOTAL LOSS OF COMPONENT COOLING WATER - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - MAKEUP TO RWST	- TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	ENI	4.07E-05	1.50
9	TOTAL LOSS OF COMPONENT COOLING WATER - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P	- TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FNI	3.76E-05	1.39
10	TOTAL LOSS OF COMPONENT COOLING WATER - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A	- TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	ENI	3.34E-05	1.23

11	TOTAL LOSS OF COMPONENT COOLING WATER - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P-	- TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FNI	3.09E-05	1.14
12	STEAM GENERATOR TUBE RUPTURE - MAKEUP TO RWST - OPERATOR IDENTIFIES & ISOLATES RUPTURES STEAM GENERATOR - OPERATOR DEPRESSURIZES THE RCS USING THE STEAM GENERATOR PORVS	- RHR NORMAL DECAY HEAT REMOVAL - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - MELT WITH SGTR BYPASS	EIB	2.83E-05	1.04
13	STEAM GENERATOR TUBE RUPTURE - MAKEUP TO RWST - OPERATOR IDENTIFIES & ISOLATES RUPTURES STEAM GENERATOR - RHR NORMAL DECAY HEAT REMOVAL	- TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - MELT WITH SGTR BYPASS	EIB	2.52E-05	.93
14	LOSS OF 1 OR MORE RCPS/PRIMARY FLOW - MAKEUP TO RWST - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RHR NORMAL DECAY HEAT REMOVAL - RHR SPRAY RECIRCULATION	FCI	2.24E-05	.83
15	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MANUAL OPERATOR BACKUP OF ESFAS ALIGNMENTS - MAKEUP TO RWST - OPERATOR ACTIONS TO RECOVER MAIN FEEDWATER	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - TURBINE DRIVEN AFW PUMP - RECOVERY OF TD AFW PUMP START FAILURES IN 30 MINUTES - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - AIR RETURN FANS - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - CONTAINMENT ISOLATION - STEAM GENERATOR COOLING - MELT WITH CI FAILURE AND CONT. PURGE SUCCESS - - RHR SPRAY RECIRCULATION	KNS	1.96E-05	.72
16	LOSS OF 1 OR MORE RCPS/PRIMARY FLOW - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RHR NORMAL DECAY HEAT REMOVAL - RHR SPRAY RECIRCULATION	FCI	1.84E-05	.68
17	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI- - CONTAINMENT SPRAY HEAT EXCHANGERS	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FGI	1.80E-05	.66
18	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL	FCI	1.77E-05	.65

	- MAKEUP TO THE CST - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RHR SPRAY RECIRCULATION			
19	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI - HYDROGEN IGNITORS	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	1.76E-05	.65
20	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - OPERATOR CONTROLS CONTAINMENT SPRAY - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	1.76E-05	.65
21	STEAM GENERATOR TUBE RUPTURE - MAKEUP TO RWST - MAKEUP TO THE CST - OPERATOR DEPRESSURIZES THE RCS USING THE STEAM GENERATOR PORVS	- RHR NORMAL DECAY HEAT REMOVAL - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - MELT WITH SGTR BYPASS	EIB	1.71E-05	.63
22	STEAM GENERATOR TUBE RUPTURE - MAKEUP TO RWST - OPERATOR DEPRESSURIZES THE RCS USING THE STEAM GENERATOR PORVS - RHR SPRAY	- RHR NORMAL DECAY HEAT REMOVAL - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - MELT WITH SGTR BYPASS - RHR SPRAY RECIRCULATION	ENB	1.71E-05	.63
23	STEAM GENERATOR TUBE RUPTURE - MAKEUP TO RWST - OPERATOR DEPRESSURIZES THE RCS USING THE STEAM GENERATOR PORVS - HYDROGEN IGNITORS	- RHR NORMAL DECAY HEAT REMOVAL - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - MELT WITH SGTR BYPASS -	EIB	1.70E-05	.63
24	LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - RHR PUMP 1B-B	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	1.64E-05	.60
25	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MANUAL OPERATOR BACKUP OF ESFAS ALIGNMENTS - OPERATOR ACTIONS TO RECOVER MAIN FEEDWATER	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - TURBINE DRIVEN AFW PUMP - RECOVERY OF TD AFW PUMP START FAILURES IN 30 MINUTES - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - AIR RETURN FANS - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - CONTAINMENT ISOLATION - STEAM GENERATOR COOLING - MELT WITH CI FAILURE AND CONT. PURGE SUCCESS - - RHR SPRAY RECIRCULATION	KNS	1.60E-05	.59
26	MEDIUM BREAK LOCA - MAKEUP TO RWST	- NO INJECTION FOR MLOCA (200-400 PSI) - RHR SPRAY RECIRCULATION	BCI	1.50E-05	.55

	- AUTOMATIC/MANUAL SWAPOVER FROM THE RWST TO THE CONTAINMENT SUMP				
27	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - MAKEUP TO RWST - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI - CONTAINMENT SPRAY HEAT EXCHANGERS	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FGI	1.42E-05	.52
28	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - MAKEUP TO RWST - MAKEUP TO THE CST - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	1.40E-05	.52
29	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - MAKEUP TO RWST - OPERATOR CONTROLS CONTAINMENT SPRAY - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	1.39E-05	.51
30	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - MAKEUP TO RWST - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI - HYDROGEN IGNITORS	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	1.39E-05	.51
31	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - MAKEUP TO RWST - LEVEL CONTROL SWITCHES FOR RHR SWAPOVER	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	FCI	1.28E-05	.47
32	MEDIUM BREAK LOCA - AUTOMATIC/MANUAL SWAPOVER FROM THE RWST TO THE CONTAINMENT SUMP	- NO INJECTION FOR MLOCA (200-400 PSI) - RHR SPRAY RECIRCULATION	BCI	1.23E-05	.45
33	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MANUAL OPERATOR BACKUP OF ESFAS ALIGNMENTS - MAKEUP TO RWST - REACTOR TRIPS, CONTROL RODS INSERT - POWER LEVEL IS LESS THAN 40%, ATWS ONLY	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - CENTRIFUGAL CHARGING PUMP 1B-B - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - AIR RETURN FANS - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - CONTAINMENT ISOLATION - MELT WITH CI FAILURE AND CONT. PURGE SUCCESS - - RHR SPRAY RECIRCULATION	ENS	1.17E-05	.43
34	LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI- - CONTAINMENT SPRAY HEAT EXCHANGERS	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FGI	1.06E-05	.39
35	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MAKEUP TO RWST - REACTOR TRIPS, CONTROL RODS INSERT	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AIR RETURN FANS	FCI	1.01E-05	.37

	- POWER LEVEL IS LESS THAN 40%, ATWS ONLY - EMERGENCY BORATION, OPERATOR ACTIONS & EQUIPEMENT				
36	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MAKEUP TO RWST - REACTOR TRIPS, CONTROL RODS INSERT - POWER LEVEL IS LESS THAN 40%, ATWS ONLY - LEVEL CONTROL SWITCHES FOR RHR SWAPOVER	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AIR RETURN FANS - TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	FCI	9.69E-06	.36
37	LOSS OF 6.9 SHUTDOWN BOARD 1B-B - ERCW TRAIN B PUMPS - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - MAKEUP TO RWST	- SD TRANSFORMER ROOM 1B VENTILATION - 480V SHUTDOWN BOARD ROOM VENTILATION B - ERCW/DIESEL 1B/6.9 SHUTDOWN BD 1B-B DEPENDENCY - TRAIN A COMPONENT COOLING WATER SYSTEM - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	ENI	9.66E-06	.36
38	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MANUAL OPERATOR BACKUP OF ESFAS ALIGNMENTS - REACTOR TRIPS, CONTROL RODS INSERT - POWER LEVEL IS LESS THAN 40%, ATWS ONLY	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - CENTRIFUGAL CHARGING PUMP 1B-B - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - AIR RETURN FANS - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - CONTAINMENT ISOLATION - MELT WITH CI FAILURE AND CONT. PURGE SUCCESS - - RHR SPRAY RECIRCULATION	ENS	9.62E-06	.35
39	TOTAL LOSS OF ERCW	- ERCW TRAIN A PUMPS - ERCW TRAIN B PUMPS - ERCW COOLING TO CAS COMPRESSORS - CONTROL AIR (NON-ESSENTIAL AIR) - TRAIN A ESSENTIAL AIR - TRAIN B ESSENTIAL AIR - CCS PUMPS AND MOTOR DRIVEN AUXILIARY FEEDWATER VENTILIATIO - TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B	ENI	9.34E-06	.34

	- CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION			
40 SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - TURBINE DRIVEN AFW PUMP - RECOVERY OF TD AFW PUMP START FAILURES IN 30 MINUTES - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	8.97E-06	.33
41 LOSS OF 6.9 SHUTDOWN BOARD 1B-B - ERCW TRAIN B PUMPS - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P-	- SD TRANSFORMER ROOM 1B VENTILATION - 480V SHUTDOWN BOARD ROOM VENTILATION B - ERCW/DIESEL 1B/6.9 SHUTDOWN BD 1B-B DEPENDENCY - TRAIN A COMPONENT COOLING WATER SYSTEM - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	FNI	8.86E-06	.33
42 LOSS OF COMPONENT COOLING WATER TRAIN A - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI- - CONTAINMENT SPRAY HEAT EXCHANGERS	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FGI	8.72E-06	.32
43 LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MAKEUP TO RWST - REACTOR TRIPS, CONTROL RODS INSERT - POWER LEVEL IS LESS THAN 40%, ATWS ONLY - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AIR RETURN FANS - RHR SPRAY RECIRCULATION	FCI	8.64E-06	.32
44 LOSS OF OFFSITE POWER - RECOVERY OF OFFSITE POWER IN 1 HOUR - UNIT 1 DIESEL 1B-B - RECOVERY OF 480 V BD RM VENTILATION B IN 6 HOURS - MANUAL OPERATOR BACKUP OF ESFAS ALIGNMENTS	- SD TRANSFORMER ROOM 1B VENTILATION - 480V SHUTDOWN BOARD ROOM VENTILATION B - 120V VITAL INST. CHANNEL 1-I - 120V VITAL INST. CHANNEL 1-II - 6.9KV UNIT BOARD 1A - 6.9KV UNIT BOARD 1B - 6.9KV UNIT BOARD 1C - 6.9KV UNIT BOARD 1D - TRAIN A ESFAS - TRAIN B ESFAS - ERCW/DIESEL 1B/6.9 SHUTDOWN BD 1B-B DEPENDENCY - CONTROL AIR (NON-ESSENTIAL AIR)	KNS	8.60E-06	.32

	- COOLDOWN USING STEAM DUMPS, CONDENSER, & HOTWELL PUMPS TO - TURBINE DRIVEN AFW PUMP - RECOVERY OF TD AFW PUMP START FAILURES IN 30 MINUTES - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - AIR RETURN FANS - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - CONTAINMENT ISOLATION - STEAM GENERATOR COOLING - MELT WITH CI FAILURE AND CONT. PURGE SUCCESS - - RHR SPRAY RECIRCULATION			
45 LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - SAFETY INJECTION PUMP 1B-B	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	8.58E-06	.32
46 LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO RWST - MAKEUP TO THE CST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI-	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	8.49E-06	.31
47 LOSS OF COMPONENT COOLING WATER TRAIN A - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI-	- TRAIN A COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1A-A - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	8.48E-06	.31
48 LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - OPERATOR CONTROLS CONTAINMENT SPRAY - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI-	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	8.41E-06	.31
49 LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI- - HYDROGEN IGNITORS	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	8.41E-06	.31
50 FLOODING, ERCW STRAINER ROOM - RECOVER CCS HTX BY REALIGNING ERCW - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A	- ERCW TRAIN B PUMPS - TRAIN A COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1A-A	ENI	8.40E-06	.31

	- MAKEUP TO RWST	- CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION			
51	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - REACTOR TRIPS, CONTROL RODS INSERT - POWER LEVEL IS LESS THAN 40%, ATWS ONLY - EMERGENCY BORATION, OPERATOR ACTIONS & EQUIPEMENT	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AIR RETURN FANS	FCI	8.27E-06	.30
52	LOSS OF 6.9 SHUTDOWN BOARD 1B-B - TRAIN A COMPONENT COOLING WATER SYSTEM - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - MAKEUP TO RWST	- SD TRANSFORMER ROOM 1B VENTILATION - 480V SHUTDOWN BOARD ROOM VENTILATION B - ERCW/DIESEL 1B/6.9 SHUTDOWN BD 1B-B DEPENDENCY - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	ENI	7.94E-06	.29
53	LOSS OF 6.9 SHUTDOWN BOARD 1B-B - ERCW TRAIN B PUMPS - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A	- SD TRANSFORMER ROOM 1B VENTILATION - 480V SHUTDOWN BOARD ROOM VENTILATION B - ERCW/DIESEL 1B/6.9 SHUTDOWN BD 1B-B DEPENDENCY - TRAIN A COMPONENT COOLING WATER SYSTEM - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	ENI	7.93E-06	.29
54	FLOODING, ERCW STRAINER ROOM - RECOVER CCS HTX BY REALIGNING ERCW - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P-	- ERCW TRAIN B PUMPS - TRAIN A COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B	FNI	7.77E-06	.29

		- TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION			
55	SMALL LOCA ISOLATABLE, PZR PORV LEAK - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI - CONTAINMENT SPRAY HEAT EXCHANGERS	- RHR SPRAY RECIRCULATION	FGI	7.28E-06	.27
56	LOSS OF 6.9 SHUTDOWN BOARD 1B-B - TRAIN A COMPONENT COOLING WATER SYSTEM - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P-	- SD TRANSFORMER ROOM 1B VENTILATION - 480V SHUTDOWN BOARD ROOM VENTILATION B - ERCW/DIESEL 1B/6.9 SHUTDOWN BD 1B-B DEPENDENCY - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	FNI	7.28E-06	.27
57	LOSS OF 6.9 SHUTDOWN BOARD 1B-B - ERCW TRAIN B PUMPS - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P-	- SD TRANSFORMER ROOM 1B VENTILATION - 480V SHUTDOWN BOARD ROOM VENTILATION B - ERCW/DIESEL 1B/6.9 SHUTDOWN BD 1B-B DEPENDENCY - TRAIN A COMPONENT COOLING WATER SYSTEM - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	FNI	7.27E-06	.27
58	SMALL LOCA ISOLATABLE, PZR PORV LEAK - MAKEUP TO THE CST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RHR SPRAY RECIRCULATION	FCI	7.19E-06	.27
59	LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - LEVEL CONTROL SWITCHES FOR RHR SWAPOVER	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	FCI	7.17E-06	.26
60	SMALL LOCA ISOLATABLE, PZR PORV LEAK - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - OPERATOR CONTROLS CONTAINMENT SPRAY - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RHR SPRAY RECIRCULATION	FCI	7.13E-06	.26

61	SMALL LOCA ISOLATABLE, PZR PORV LEAK - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI - HYDROGEN IGNITORS	- RHR SPRAY RECIRCULATION	FCI	7.13E-06	.26
62	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - REACTOR TRIPS, CONTROL RODS INSERT - POWER LEVEL IS LESS THAN 40%, ATWS ONLY - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AIR RETURN FANS - RHR SPRAY RECIRCULATION	FCI	7.09E-06	.26
63	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - MAKEUP TO RWST - TURBINE DRIVEN AFW PUMP - RECOVERY OF TD AFW PUMP START FAILURES IN 30 MINUTES - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	7.08E-06	.26
64	LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO THE CST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	6.97E-06	.26
65	LOSS OF COMPONENT COOLING WATER TRAIN A - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- TRAIN A COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1A-A - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	6.96E-06	.26
66	LOSS OF COMPONENT COOLING WATER TRAIN A - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - OPERATOR CONTROLS CONTAINMENT SPRAY - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	6.91E-06	.25
67	LOSS OF COMPONENT COOLING WATER TRAIN A - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI - HYDROGEN IGNITORS	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	6.91E-06	.25
68	FLOODING, ERCW STRAINER ROOM - RECOVER CCS HTX BY REALIGNING ERCW - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A	- ERCW TRAIN B PUMPS - TRAIN A COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	ENI	6.90E-06	.25
69	LARGE & EXCESSIVE BREAK LOCA	- RHR SPRAY IN RECIRCULATION	BCI	6.85E-06	.25

- MAKEUP TO RWST - RHR & SIS HOT LEG RECIRCULATION				
70 LOSS OF 6.9 SHUTDOWN BOARD 1B-B - TRAIN A COMPONENT COOLING WATER SYSTEM - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A	- SD TRANSFORMER ROOM 1B VENTILATION - 480V SHUTDOWN BOARD ROOM VENTILATION B - ERCW/DIESEL 1B/6.9 SHUTDOWN BD 1B-B DEPENDENCY - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	ENI	6.51E-06	.24
71 FLOODING, ERCW STRAINER ROOM - RECOVER CCS HTX BY REALIGNING ERCW - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P-	- ERCW TRAIN B PUMPS - TRAIN A COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FNI	6.38E-06	.24
72 LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A - RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FCI	6.06E-06	.22
73 LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MANUAL OPERATOR BACKUP OF ESFAS ALIGNMENTS - MAKEUP TO RWST - REACTOR TRIPS, CONTROL RODS INSERT	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - TURBINE DRIVEN AFW PUMP - RECOVERY OF TD AFW PUMP START FAILURES IN 30 MINUTES - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1B-B - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - OPERATOR ACTION TO FEED & BLEED RCS - RHR PUMP 1A-A - RHR PUMP 1B-B - AIR RETURN FANS - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - CONTAINMENT ISOLATION - MELT WITH CI FAILURE AND CONT. PURGE SUCCESS - - RHR SPRAY RECIRCULATION	ENS	5.98E-06	.22

74	LOSS OF 6.9 SHUTDOWN BOARD 1B-B - TRAIN A COMPONENT COOLING WATER SYSTEM - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P-	- SD TRANSFORMER ROOM 1B VENTILATION - 480V SHUTDOWN BOARD ROOM VENTILATION B - ERCW/DIESEL 1B/6.9 SHUTDOWN BD 1B-B DEPENDENCY - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	FNI	5.97E-06	.22
75	REACTOR TRIP INITIATING EVENT - ERCW TRAIN A PUMPS - ERCW TRAIN B PUMPS	- ERCW COOLING TO CAS COMPRESSORS - CONTROL AIR (NON-ESSENTIAL AIR) - TRAIN A ESSENTIAL AIR - TRAIN B ESSENTIAL AIR - CCS PUMPS AND MOTOR DRIVEN AUXILIARY FEEDWATER VENTILIATIO - TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	ENI	5.89E-06	.22
76	SMALL LOCA ISOLATABLE, PZR PORV LEAK - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI - CONTAINMENT SPRAY HEAT EXCHANGERS	- RHR SPRAY RECIRCULATION	FGI	5.74E-06	.21
77	SMALL LOCA ISOLATABLE, PZR PORV LEAK - MAKEUP TO RWST - MAKEUP TO THE CST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RHR SPRAY RECIRCULATION	FCI	5.67E-06	.21
78	LARGE & EXCESSIVE BREAK LOCA - RHR & SIS HOT LEG RECIRCULATION	- RHR SPRAY IN RECIRCULATION	BCI	5.62E-06	.21
79	SMALL LOCA ISOLATABLE, PZR PORV LEAK - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - OPERATOR CONTROLS CONTAINMENT SPRAY - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RHR SPRAY RECIRCULATION	FCI	5.62E-06	.21

80	SMALL LOCA ISOLATABLE, PZR PORV LEAK - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI - HYDROGEN IGNITORS	- RHR SPRAY RECIRCULATION	FCI	5.62E-06	.21
81	SMALL LOCA ISOLATABLE, PZR PORV LEAK - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - LEVEL CONTROL SWITCHES FOR RHR SWAPOVER	- TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 RHR SPRAY RECIRCULATION	FCI	5.18E-06	.19
82	PARTIAL LOSS OF MAIN FEEDWATER - ERCW TRAIN A PUMPS - ERCW TRAIN B PUMPS	- ERCW COOLING TO CAS COMPRESSORS - CONTROL AIR (NON-ESSENTIAL AIR) - TRAIN A ESSENTIAL AIR - TRAIN B ESSENTIAL AIR - CCS PUMPS AND MOTOR DRIVEN AUXILIARY FEEDWATER VENTILIATIO - TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	ENI	4.93E-06	.18
83	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MANUAL OPERATOR BACKUP OF ESFAS ALIGNMENTS - REACTOR TRIPS, CONTROL RODS INSERT	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - TURBINE DRIVEN AFW PUMP - RECOVERY OF TD AFW PUMP START FAILURES IN 30 MINUTES - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1B-B - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - OPERATOR ACTION TO FEED & BLEED RCS - RHR PUMP 1A-A - RHR PUMP 1B-B - AIR RETURN FANS - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - CONTAINMENT ISOLATION - MELT WITH CI FAILURE AND CONT. PURGE SUCCESS - - RHR SPRAY RECIRCULATION	ENS	4.91E-06	.18
84	LOSS OF OFFSITE POWER - RECOVERY OF OFFSITE POWER IN 1 HOUR	- 480V SD TRANSFORMER ROOM 1A VENTILATION - 120V AC INSTRUMENT UNIT 1 POWER	ENI	4.77E-06	.18

	- UNIT 1 DIESEL 1A-A - UNIT 1 DIESEL 1B-B - RECOVERY OF FAILED SEQUENCES	- SD TRANSFORMER ROOM 1B VENTILATION - UNIT 1 SHUTDOWN BOARD VENTILATION - RECOVERY OF UNIT 1 SHUTDOWN BD ROOM VENTILATION IN 12 HOUR - 480V SHUTDOWN BOARD ROOM VENTILATION B - 6.9KV UNIT BOARD 1A - 6.9KV UNIT BOARD 1B - 6.9KV UNIT BOARD 1C - 6.9KV UNIT BOARD 1D - ERCW/DIESEL 1A/6.9 SHUTDOWN BD 1A-A DEPENDENCY TOP - ERCW/DIESEL 1B/6.9 SHUTDOWN BD 1B-B DEPENDENCY - CONTROL AIR (NON-ESSENTIAL AIR) - TRAIN A COMPONENT COOLING WATER SYSTEM - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - AIR RETURN FANS - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - HYDROGEN IGNITORS - RHR SPRAY RECIRCULATION			
85	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MAKEUP TO RWST - REACTOR TRIPS, CONTROL RODS INSERT - EMERGENCY BORATION, OPERATOR ACTIONS & EQUIPEMENT	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AIR RETURN FANS	FCI	4.75E-06	.18
86	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MANUAL OPERATOR BACKUP OF ESFAS ALIGNMENTS - MAKEUP TO RWST - EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - TURBINE DRIVEN AFW PUMP - RECOVERY OF TD AFW PUMP START FAILURES IN 30 MINUTES - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - AIR RETURN FANS - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - CONTAINMENT ISOLATION - STEAM GENERATOR COOLING - MELT WITH CI FAILURE AND CONT. PURGE SUCCESS - - RHR SPRAY RECIRCULATION	KNS	4.75E-06	.18
87	TURBINE TRIP INITIATING EVENT	- ERCW COOLING TO CAS COMPRESSORS	ENI	4.67E-06	.17

	- ERCW TRAIN A PUMPS - ERCW TRAIN B PUMPS	- CONTROL AIR (NON-ESSENTIAL AIR) - TRAIN A ESSENTIAL AIR - TRAIN B ESSENTIAL AIR - CCS PUMPS AND MOTOR DRIVEN AUXILIARY FEEDWATER VENTILIATIO - TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION			
88	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MAKEUP TO RWST - REACTOR TRIPS, CONTROL RODS INSERT - LEVEL CONTROL SWITCHES FOR RHR SWAPOVER	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AIR RETURN FANS - TRAIN A SUMP SWAPOVER VALVE, 1-FCV-63-72 - TRAIN B SUMP SWAPOVER VALVE, 1-FCV-63-73 - RHR SPRAY RECIRCULATION	FCI	4.57E-06	.17
89	TOTAL LOSS OF COMPONENT COOLING WATER - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - MAKEUP TO RWST - MAKEUP TO THE CST	- TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	ENI	4.56E-06	.17
90	TOTAL LOSS OF COMPONENT COOLING WATER - RECOVER CCP A BY ALIGNING ERCW A TRAIN ON LOSS OF CCS A - MAKEUP TO RWST - HYDROGEN IGNITORS	- TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1A-A - CENTRIFUGAL CHARGING PUMP 1B-B - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	ENI	4.52E-06	.17
91	LOSS OF COMPONENT COOLING WATER TRAIN A - MAKEUP TO RWST	- TRAIN A COMPONENT COOLING WATER SYSTEM - SAFETY INJECTION PUMP 1A-A	FCI	4.30E-06	.16

	- TURBINE DRIVEN AFW PUMP - RECOVERY OF TD AFW PUMP START FAILURES IN 30 MINUTES - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RHR PUMP 1A-A - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION			
92	TOTAL LOSS OF COMPONENT COOLING WATER - MAKEUP TO RWST - MAKEUP TO THE CST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P-	- TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FNI	4.22E-06	.16
93	TOTAL LOSS OF COMPONENT COOLING WATER - MAKEUP TO RWST - RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL BARRIERS P- - HYDROGEN IGNITORS	- TRAIN A COMPONENT COOLING WATER SYSTEM - TRAIN B COMPONENT COOLING WATER SYSTEM - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY RECIRCULATION	FNI	4.18E-06	.15
94	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MAKEUP TO RWST - REACTOR TRIPS, CONTROL RODS INSERT - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI-	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AIR RETURN FANS - RHR SPRAY RECIRCULATION	FCI	4.08E-06	.15
95	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - REACTOR TRIPS, CONTROL RODS INSERT - EMERGENCY BORATION, OPERATOR ACTIONS & EQUIPEMENT	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - PZR PORVS OPEN TO CONTROL RCS PRESSURE & RECLOSE - AIR RETURN FANS	FCI	3.90E-06	.14
96	LOSS OF 120 VAC VITAL BOARD 1-I - TRAIN B ESFAS - MANUAL OPERATOR BACKUP OF ESFAS ALIGNMENTS - EQUIPMENT NEEDED TO RECOVER MAIN FEEDWATER	- 120V VITAL INST. CHANNEL 1-I - TRAIN A ESFAS - TURBINE DRIVEN AFW PUMP - RECOVERY OF TD AFW PUMP START FAILURES IN 30 MINUTES - MOTOR DRIVEN AFW PUMP 1A-A - MOTOR DRIVEN AFW PUMP 1B-B - CENTRIFUGAL CHARGING PUMP 1B-B - SAFETY INJECTION PUMP 1A-A - SAFETY INJECTION PUMP 1B-B - RHR PUMP 1A-A - RHR PUMP 1B-B - AIR RETURN FANS - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - CONTAINMENT ISOLATION - STEAM GENERATOR COOLING - MELT WITH CI FAILURE AND CONT. PURGE SUCCESS -	KNS	3.90E-06	.14

		- RHR SPRAY RECIRCULATION			
97	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - RHR PUMP 1A-A - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	3.82E-06	.14
98	SMALL LOCA NON-ISOLATABLE, RCP SEAL LOCA - RHR PUMP 1B-B - AUTOMATIC/MANUAL SWAPOVER TO CONTAINMENT SUMP FOR RHR & SUPPLY TO SI	- RCP SEAL INTEGRITY, SEAL COOLING IS MAINTAINED OR THERMAL - RHR SPRAY RECIRCULATION	FCI	3.82E-06	.14
99	STEAM GENERATOR TUBE RUPTURE - MAKEUP TO RWST - OPERATOR DEPRESSURIZES THE RCS USING THE STEAM GENERATOR PORVS - RHR PUMP 1A-A	- RHR NORMAL DECAY HEAT REMOVAL - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY - MELT WITH SGTR BYPASS - RHR SPRAY RECIRCULATION	ENB	3.80E-06	.14
100	STEAM GENERATOR TUBE RUPTURE - MAKEUP TO RWST - OPERATOR DEPRESSURIZES THE RCS USING THE STEAM GENERATOR PORVS - RHR PUMP 1B-B	- RHR NORMAL DECAY HEAT REMOVAL - TRAIN A CONTAINMENT SPRAY PUMP & VALVES - TRAIN B CONTAINMENT SPRAY PUMP & VALVES - RHR SPRAY - MELT WITH SGTR BYPASS - RHR SPRAY RECIRCULATION	ENB	3.80E-06	.14

Top Event Importance for Model: WBNHA

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.....	Top.....	Guar. Event....	Probabilistic..	Total.....	Frequency.....
1.	MELT	1.0000E+00	0.0000E+00	1.0000E+00	2.7129E-03
2.	REC	9.9155E-01	8.4528E-03	1.0000E+00	2.7129E-03
3.	INTPR	9.1292E-01	0.0000E+00	9.1292E-01	2.4767E-03
4.	DP	8.7196E-01	0.0000E+00	8.7196E-01	2.3656E-03
5.	DS	7.6116E-01	1.1080E-01	8.7196E-01	2.3656E-03
6.	RHRS	8.6007E-01	0.0000E+00	8.6007E-01	2.3333E-03
7.	RR	3.6453E-01	4.6096E-01	8.2548E-01	2.2395E-03
8.	MELTI	7.8548E-01	0.0000E+00	7.8548E-01	2.1310E-03
9.	IYA	7.8348E-01	0.0000E+00	7.8348E-01	2.1255E-03
10.	RQ	6.4514E-01	0.0000E+00	6.4514E-01	1.7502E-03
11.	TB	6.4391E-01	8.3703E-04	6.4475E-01	1.7492E-03
12.	SE	3.4518E-01	2.9799E-01	6.4317E-01	1.7449E-03
13.	MS	6.3920E-01	0.0000E+00	6.3920E-01	1.7341E-03
14.	MU	5.9304E-02	5.6316E-01	6.2246E-01	1.6887E-03
15.	CSA	5.6327E-01	5.6722E-03	5.6895E-01	1.5435E-03
16.	CSR	4.8713E-01	0.0000E+00	4.8713E-01	1.3216E-03
17.	CH	4.2942E-01	5.5863E-02	4.8529E-01	1.3166E-03
18.	RA	4.3933E-01	1.1438E-02	4.5077E-01	1.2229E-03
19.	S1	4.3933E-01	3.9654E-03	4.4330E-01	1.2026E-03
20.	CSB	4.3141E-01	8.2366E-03	4.3965E-01	1.1927E-03
21.	CSI	4.2974E-01	0.0000E+00	4.2974E-01	1.1659E-03
22.	CAV	3.4466E-01	0.0000E+00	3.4466E-01	9.3505E-04
23.	AC	2.9333E-01	5.0647E-02	3.4397E-01	9.3318E-04
24.	CM	3.3106E-01	0.0000E+00	3.3106E-01	8.9814E-04
25.	RB	3.0537E-01	2.4884E-02	3.3025E-01	8.9595E-04
26.	S2	3.0537E-01	1.0446E-02	3.1581E-01	8.5678E-04
27.	VB	3.0497E-01	3.2712E-03	3.0824E-01	8.3623E-04

Top Event Importance for Model: WBNHA

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.....	Top.....	Guar. Event....	Probabilistic..	Total.....	Frequency.....
28.	SI	3.0711E-01	1.7070E-04	3.0728E-01	8.3365E-04
29.	VC	2.1853E-01	8.3887E-05	2.1862E-01	5.9309E-04
30.	RD	1.4241E-01	1.5625E-02	1.5803E-01	4.2873E-04
31.	VA	1.4987E-01	7.3629E-03	1.5723E-01	4.2656E-04
32.	AR	1.5210E-01	0.0000E+00	1.5210E-01	4.1264E-04
33.	ZB	2.9699E-02	1.2137E-01	1.5106E-01	4.0983E-04
34.	ZA	1.1279E-01	3.6708E-02	1.4950E-01	4.0559E-04
35.	MB	1.4227E-01	5.1540E-03	1.4742E-01	3.9995E-04
36.	PR	1.1231E-01	3.0574E-02	1.4288E-01	3.8763E-04
37.	RVB	1.2108E-01	8.2108E-03	1.2929E-01	3.5076E-04
38.	CCPR	2.5429E-02	1.0237E-01	1.2780E-01	3.4671E-04
39.	MELTB	1.2675E-01	0.0000E+00	1.2675E-01	3.4388E-04
40.	BC	1.0282E-01	1.4439E-02	1.1726E-01	3.1811E-04
41.	BYA	1.1508E-01	0.0000E+00	1.1508E-01	3.1220E-04
42.	DAAC	1.1164E-01	1.1511E-03	1.1279E-01	3.0600E-04
43.	RT	0.0000E+00	1.1156E-01	1.1156E-01	3.0266E-04
44.	MA	1.0597E-01	4.9711E-03	1.1094E-01	3.0097E-04
45.	TP	6.9664E-02	3.7146E-02	1.0681E-01	2.8977E-04
46.	TPR	6.9664E-02	3.3686E-02	1.0335E-01	2.8038E-04
47.	CTMU	2.0151E-02	8.1073E-02	1.0122E-01	2.7461E-04
48.	HH	7.7153E-03	8.1257E-02	8.8972E-02	2.4138E-04
49.	OT	4.4624E-02	4.3385E-02	8.8009E-02	2.3876E-04
50.	CI	8.5903E-02	2.0449E-03	8.7948E-02	2.3860E-04
51.	OS	0.0000E+00	8.7868E-02	8.7868E-02	2.3838E-04
52.	MELTS	8.0045E-02	0.0000E+00	8.0045E-02	2.1716E-04
53.	B1L	8.0020E-02	0.0000E+00	8.0020E-02	2.1709E-04
54.	PL	0.0000E+00	7.9165E-02	7.9165E-02	2.1477E-04

Top Event Importance for Model: WBNHA

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.....	Top.....	Guar. Event....	Probabilistic..	Total.....	Frequency.....
55.	VT1B	7.8529E-02	4.5460E-04	7.8983E-02	2.1428E-04
56.	B1	5.4337E-02	2.4192E-02	7.8529E-02	2.1304E-04
57.	SYC	7.2321E-02	0.0000E+00	7.2321E-02	1.9620E-04
58.	DE	6.4208E-02	4.0108E-03	6.8219E-02	1.8507E-04
59.	SGCLG	6.7500E-02	0.0000E+00	6.7500E-02	1.8312E-04
60.	CCSR	4.0040E-02	2.5858E-02	6.5898E-02	1.7878E-04
61.	FE	6.2795E-02	2.6238E-04	6.3057E-02	1.7107E-04
62.	BE	2.6980E-02	3.5815E-02	6.2795E-02	1.7036E-04
63.	RVA	5.7085E-02	4.4388E-03	6.1524E-02	1.6691E-04
64.	B2L	5.9050E-02	0.0000E+00	5.9050E-02	1.6020E-04
65.	VINV1	5.6349E-02	4.0270E-04	5.6751E-02	1.5396E-04
66.	B2	5.4337E-02	2.0118E-03	5.6349E-02	1.5287E-04
67.	BAL	5.5374E-02	0.0000E+00	5.5374E-02	1.5023E-04
68.	BA	5.3391E-02	9.4584E-04	5.4337E-02	1.4741E-04
69.	RL	1.2296E-04	4.2067E-02	4.2190E-02	1.1446E-04
70.	EB	0.0000E+00	3.9032E-02	3.9032E-02	1.0589E-04
71.	PD	3.4742E-02	2.6612E-03	3.7404E-02	1.0147E-04
72.	MF	2.8873E-02	6.3534E-03	3.5226E-02	9.5567E-05
73.	SL	2.5563E-03	3.1177E-02	3.3733E-02	9.1515E-05
74.	OF	0.0000E+00	3.1865E-02	3.1865E-02	8.6449E-05
75.	DBAC	2.9141E-02	5.5862E-04	2.9699E-02	8.0573E-05
76.	RS	1.3304E-02	1.3296E-02	2.6600E-02	7.2164E-05
77.	CE	2.1645E-02	3.9212E-03	2.5566E-02	6.9359E-05
78.	PB	2.3472E-02	1.6195E-03	2.5092E-02	6.8072E-05
79.	PA	2.1717E-02	2.6338E-03	2.4351E-02	6.6062E-05
80.	V3	2.2147E-02	1.4841E-03	2.3631E-02	6.4109E-05
81.	CD	1.8795E-02	3.8974E-03	2.2693E-02	6.1564E-05

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.....	Top.....	Guar. Event....	Probabilistic..	Total.....	Frequency.....
82.	EE	2.1645E-02	3.4436E-04	2.1989E-02	5.9655E-05
83.	AE	9.0551E-03	1.2590E-02	2.1645E-02	5.8721E-05
84.	OG	2.0151E-02	0.0000E+00	2.0151E-02	5.4668E-05
85.	UB1A	1.8830E-02	5.8827E-04	1.9418E-02	5.2681E-05
86.	UB1C	1.8830E-02	5.8822E-04	1.9418E-02	5.2681E-05
87.	UB1B	1.8721E-02	5.8835E-04	1.9309E-02	5.2385E-05
88.	UB1D	1.8721E-02	5.8830E-04	1.9309E-02	5.2384E-05
89.	PE	1.9059E-02	0.0000E+00	1.9059E-02	5.1705E-05
90.	LOWPR	1.8657E-02	0.0000E+00	1.8657E-02	5.0615E-05
91.	B3	1.7390E-02	0.0000E+00	1.7390E-02	4.7179E-05
92.	OGR1	0.0000E+00	1.7390E-02	1.7390E-02	4.7179E-05
93.	A3	1.7390E-02	0.0000E+00	1.7390E-02	4.7179E-05
94.	FW	1.6127E-02	0.0000E+00	1.6127E-02	4.3752E-05
95.	A1L	1.4937E-02	0.0000E+00	1.4937E-02	4.0524E-05
96.	VNV1R	0.0000E+00	1.4526E-02	1.4526E-02	3.9407E-05
97.	VT1A	1.3976E-02	0.0000E+00	1.3976E-02	3.7916E-05
98.	DG	1.3976E-02	0.0000E+00	1.3976E-02	3.7916E-05
99.	A1	1.0999E-02	2.9771E-03	1.3976E-02	3.7916E-05
100.	OB	1.2340E-02	7.4750E-04	1.3087E-02	3.5504E-05
101.	GB	1.2867E-04	1.2134E-02	1.2262E-02	3.3267E-05
102.	A2L	1.2158E-02	0.0000E+00	1.2158E-02	3.2985E-05
103.	AAL	1.1960E-02	0.0000E+00	1.1960E-02	3.2448E-05
104.	BYB	1.1677E-02	0.0000E+00	1.1677E-02	3.1679E-05
105.	A2	1.0999E-02	2.7104E-04	1.1270E-02	3.0574E-05
106.	AA	1.0191E-02	8.0822E-04	1.0999E-02	2.9839E-05
107.	MR	0.0000E+00	8.5655E-03	8.5655E-03	2.3238E-05
108.	CP	0.0000E+00	7.8063E-03	7.8063E-03	2.1178E-05

Top Event Importance for Model: WBNHA

Sorted by Total Importance

Total Sequence Frequency = 2.7129E-03

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.....	Top.....	Guar. Event....	Probabilistic..	Total.....	Frequency.....
109.	MELTL	7.7236E-03	0.0000E+00	7.7236E-03	2.0954E-05
110.	GA	4.1433E-05	7.5953E-03	7.6367E-03	2.0718E-05
111.	LYC	7.1784E-03	0.0000E+00	7.1784E-03	1.9475E-05
112.	V1R	5.6884E-03	9.7331E-04	6.6617E-03	1.8073E-05
113.	V1	5.6884E-03	9.7331E-04	6.6617E-03	1.8073E-05
114.	RH	1.1940E-04	6.4597E-03	6.5791E-03	1.7849E-05
115.	SYN	6.4166E-03	0.0000E+00	6.4166E-03	1.7408E-05
116.	VT1BR	0.0000E+00	5.4263E-03	5.4263E-03	1.4721E-05
117.	B2U2L	5.3294E-03	0.0000E+00	5.3294E-03	1.4458E-05
118.	DA	1.9186E-03	3.3513E-03	5.2699E-03	1.4297E-05
119.	B2U2	4.4500E-03	6.8743E-04	5.1374E-03	1.3938E-05
120.	VINV2	5.1374E-03	0.0000E+00	5.1374E-03	1.3938E-05
121.	B1U2L	4.7180E-03	0.0000E+00	4.7180E-03	1.2800E-05
122.	BBL	4.6420E-03	0.0000E+00	4.6420E-03	1.2593E-05
123.	VT2B	4.5260E-03	0.0000E+00	4.5260E-03	1.2279E-05
124.	B1U2	4.4500E-03	7.5993E-05	4.5260E-03	1.2279E-05
125.	BB	3.9570E-03	4.9294E-04	4.4500E-03	1.2073E-05
126.	GD	0.0000E+00	3.9570E-03	3.9570E-03	1.0735E-05
127.	DB	1.0748E-03	2.7560E-03	3.8308E-03	1.0393E-05
128.	DCAC	3.7402E-03	8.2288E-05	3.8225E-03	1.0370E-05
129.	SR	8.8017E-04	2.5631E-03	3.4433E-03	9.3414E-06
130.	A1U2L	3.2213E-03	0.0000E+00	3.2213E-03	8.7392E-06
131.	ABL	3.1453E-03	0.0000E+00	3.1453E-03	8.5330E-06
132.	A2U2L	3.1453E-03	0.0000E+00	3.1453E-03	8.5330E-06
133.	DDAC	2.8523E-03	7.9564E-05	2.9318E-03	7.9539E-06
134.	A1U2	2.6952E-03	7.6026E-05	2.7712E-03	7.5182E-06
135.	VT2A	2.7712E-03	0.0000E+00	2.7712E-03	7.5182E-06

Top Event Importance for Model: WBNHA

Sorted by Total Importance

Total Sequence Frequency = 2.7129E-03

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.....	Top.....	Guar. Event....	Probabilistic..	Total.....	Frequency.....
136.	DH	2.7712E-03	0.0000E+00	2.7712E-03	7.5182E-06
137.	AB	2.2735E-03	4.2176E-04	2.6952E-03	7.3120E-06
138.	A2U2	2.6952E-03	0.0000E+00	2.6952E-03	7.3120E-06
139.	GC	0.0000E+00	2.2735E-03	2.2735E-03	6.1678E-06
140.	IYB	1.9962E-03	0.0000E+00	1.9962E-03	5.4155E-06
141.	SU	0.0000E+00	1.8426E-03	1.8426E-03	4.9990E-06
142.	PI	0.0000E+00	1.7142E-03	1.7142E-03	4.6505E-06
143.	MDE	0.0000E+00	1.6091E-03	1.6091E-03	4.3654E-06
144.	VNV2R	0.0000E+00	1.4694E-03	1.4694E-03	3.9864E-06
145.	D1	0.0000E+00	1.4399E-03	1.4399E-03	3.9064E-06
146.	AF	0.0000E+00	1.3424E-03	1.3424E-03	3.6419E-06
147.	D2	0.0000E+00	1.3305E-03	1.3305E-03	3.6095E-06
148.	SYA	1.2681E-03	0.0000E+00	1.2681E-03	3.4403E-06
149.	VS	3.9997E-04	3.7479E-04	7.7476E-04	2.1019E-06
150.	WC	0.0000E+00	7.7152E-04	7.7152E-04	2.0931E-06
151.	DC	0.0000E+00	4.9294E-04	4.9294E-04	1.3373E-06
152.	VT1AR	0.0000E+00	4.6684E-04	4.6684E-04	1.2665E-06
153.	DSLR	3.3797E-04	6.5057E-05	4.0302E-04	1.0934E-06
154.	LYN	3.5114E-04	0.0000E+00	3.5114E-04	9.5262E-07
155.	LYA	1.9404E-04	0.0000E+00	1.9404E-04	5.2642E-07
156.	DD	0.0000E+00	1.6273E-04	1.6273E-04	4.4147E-07
157.	LCL	0.0000E+00	1.5313E-04	1.5313E-04	4.1543E-07
158.	FB	0.0000E+00	1.2867E-04	1.2867E-04	3.4909E-07
159.	VT2BR	0.0000E+00	1.0014E-04	1.0014E-04	2.7169E-07
160.	VT2AR	0.0000E+00	7.9931E-05	7.9931E-05	2.1685E-07
161.	FA	0.0000E+00	4.1433E-05	4.1433E-05	1.1241E-07
162.	SYB	3.9676E-05	0.0000E+00	3.9676E-05	1.0764E-07

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
1.	MELTF	1.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7129E-03
2.	RECF	9.9155E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.6900E-03
3.	INTPRF	9.1292E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.4767E-03
4.	DPF	8.7196E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3656E-03
5.	RHRSF	8.6007E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3333E-03
6.	MELTIF	7.8548E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1310E-03
7.	IYAF	7.8348E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1255E-03
8.	DSNN	7.6116E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0650E-03
9.	RQF	6.4514E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7502E-03
10.	TBF	6.4391E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7469E-03
11.	MSF	6.3920E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7341E-03
12.	CSAF	5.6327E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5281E-03
13.	CSRF	4.8713E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3216E-03
14.	RAF	4.3933E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1919E-03
15.	S1F	4.3933E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1919E-03
16.	CSBF	4.3141E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1704E-03
17.	CSIF	4.2974E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1659E-03
18.	CHF	4.2942E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1650E-03
19.	RRF	3.6453E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.8894E-04
20.	SEF	3.4518E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.3646E-04
21.	CAVF	3.4466E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.3505E-04
22.	RR1	3.3826E-01	4.0131E+00	6.6174E-01	9.0922E-03	1.0093E-01	9.1767E-04
23.	CMF	3.3106E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.9814E-04
24.	SIF	3.0711E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.3318E-04
25.	S2F	3.0537E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2844E-04
26.	RBF	3.0537E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2844E-04
27.	VBF	3.0497E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2736E-04
28.	ACF	2.9333E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.9578E-04
29.	VCF	2.1853E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.9287E-04
30.	SED	2.1396E-01	2.8668E+00	7.8615E-01	5.6447E-03	1.0278E-01	5.8046E-04
31.	MU4	2.0637E-01	1.0229E+00	9.7216E-01	1.3754E-04	5.4906E-01	5.5987E-04
32.	ARF	1.5210E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.1264E-04
33.	VAF	1.4987E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0659E-04
34.	RDF	1.4241E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8634E-04
35.	MBF	1.4227E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8597E-04
36.	MU2	1.3605E-01	1.0139E+00	9.8905E-01	6.7351E-05	4.4090E-01	3.6909E-04
37.	MELTBF	1.2675E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4388E-04
38.	MU3	1.2327E-01	2.0146E+00	8.7695E-01	3.0865E-03	1.0816E-01	3.3443E-04
39.	RVBF	1.2108E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2849E-04
40.	ZB6	1.1708E-01	2.8869E+00	8.8312E-01	5.4361E-03	5.8330E-02	3.1763E-04
41.	BYAF	1.1508E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.1220E-04
42.	ZAF	1.1279E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0600E-04
43.	PRF	1.1231E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0468E-04
44.	DAACF	1.1164E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0288E-04
45.	RR5	1.1148E-01	1.9096E+00	8.8852E-01	2.7700E-03	1.0918E-01	3.0243E-04
46.	MAF	1.0597E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.8748E-04
47.	BCF	1.0282E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7893E-04
48.	CCPR1	1.0237E-01	1.7052E+00	9.2165E-01	2.1256E-03	1.0000E-01	2.7772E-04
49.	MU6	9.6704E-02	1.0101E+00	9.8772E-01	6.0656E-05	5.4931E-01	2.6235E-04
50.	DS8	9.1348E-02	1.8206E+00	9.0882E-01	2.4737E-03	1.0000E-01	2.4782E-04
51.	OS3	8.7408E-02	1.7220E+00	9.1978E-01	2.1764E-03	1.0000E-01	2.3713E-04
52.	CIF	8.5903E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3305E-04
53.	SEH	8.4029E-02	1.7333E+00	9.1600E-01	2.2172E-03	1.0278E-01	2.2796E-04

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
54.	RT8	8.3675E-02	1.7025E+00	9.2181E-01	2.1179E-03	1.0016E-01	2.2701E-04
55.	CTMU1	8.1073E-02	8.2429E-01	1.0197E+00	-5.3015E-04	1.0082E-01	2.1995E-04
56.	MELTSF	8.0045E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1716E-04
57.	B1LF	8.0020E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1709E-04
58.	PL1	7.9165E-02	1.0080E+00	9.8428E-01	6.4410E-05	6.6200E-01	2.1477E-04
59.	VT1BF	7.8529E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1304E-04
60.	HH1	7.6344E-02	8.5068E-01	1.0166E+00	-4.5011E-04	1.0000E-01	2.0712E-04
61.	SYCF	7.2321E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9620E-04
62.	TPF	6.9664E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8899E-04
63.	TPRF	6.9664E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8899E-04
64.	SGCLGF	6.7500E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8312E-04
65.	DEF	6.4208E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7419E-04
66.	FEF	6.2795E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7036E-04
67.	MUF	5.9304E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6089E-04
68.	B2LF	5.9050E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6020E-04
69.	RVAF	5.7085E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5487E-04
70.	VINV1F	5.6349E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5287E-04
71.	BALF	5.5374E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5023E-04
72.	B1F	5.4337E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4741E-04
73.	B2F	5.4337E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4741E-04
74.	BAF	5.3391E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4485E-04
75.	OTF	4.4624E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2106E-04
76.	OT1	4.3385E-02	9.3202E-01	1.0076E+00	-2.0492E-04	1.0000E-01	1.1770E-04
77.	AC2	4.1012E-02	1.3528E+00	9.5966E-01	1.0666E-03	1.0260E-01	1.1126E-04
78.	CCSRF	4.0040E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0863E-04
79.	TP1	3.6060E-02	8.7550E-01	1.0084E+00	-3.6046E-04	6.2970E-02	9.7829E-05
80.	CH4	3.5711E-02	9.7443E-01	1.0029E+00	-7.7248E-05	1.0196E-01	9.6883E-05
81.	PDF	3.4742E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.4254E-05
82.	ZA1	3.4519E-02	4.5575E+00	9.6897E-01	9.7355E-03	8.6459E-03	9.3647E-05
83.	TPR1	3.3686E-02	1.0028E+00	9.8503E-01	4.8115E-05	8.4400E-01	9.1388E-05
84.	OF1	3.1865E-02	1.2866E+00	9.6816E-01	8.6383E-04	1.0000E-01	8.6449E-05
85.	SL1	3.1177E-02	1.0825E+00	9.8552E-01	2.6307E-04	1.4934E-01	8.4580E-05
86.	ZBF	2.9699E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.0573E-05
87.	DBACF	2.9141E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.9057E-05
88.	MFF	2.8873E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.8331E-05
89.	PR1	2.8640E-02	6.8829E+00	9.7145E-01	1.6037E-02	4.8296E-03	7.7699E-05
90.	BEF	2.6980E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3195E-05
91.	CCSR3	2.5858E-02	1.2301E+00	9.7443E-01	6.9372E-04	1.0000E-01	7.0151E-05
92.	CCPRF	2.5429E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.8986E-05
93.	EB3	2.4978E-02	1.1581E+00	9.8122E-01	4.7983E-04	1.0619E-01	6.7763E-05
94.	B11	2.4192E-02	3.2950E+01	9.7649E-01	8.6742E-02	7.3542E-04	6.5631E-05
95.	RT1	2.4049E-02	1.5346E+02	9.7607E-01	4.1369E-01	1.5696E-04	6.5245E-05
96.	PBF	2.3472E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.3679E-05
97.	RL1	2.2365E-02	2.3585E+00	9.8620E-01	3.7228E-03	1.0053E-02	6.0674E-05
98.	V3F	2.2147E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.0083E-05
99.	PAF	2.1717E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8917E-05
100.	EEF	2.1645E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8721E-05
101.	CEF	2.1645E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8721E-05
102.	BE3	2.0855E-02	1.1467E+00	9.8168E-01	4.4765E-04	1.1100E-01	5.6579E-05
103.	CTMUF	2.0151E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4668E-05
104.	OGF	2.0151E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4668E-05
105.	PEF	1.9059E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1705E-05
106.	UB1AF	1.8830E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1085E-05

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
107.	UB1CF	1.8830E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1085E-05
108.	CDF	1.8795E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0990E-05
109.	UB1DF	1.8721E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0788E-05
110.	UB1BF	1.8721E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0788E-05
111.	LOWPRF	1.8657E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0615E-05
112.	RL4	1.8308E-02	1.0719E+00	9.9201E-01	2.1688E-04	1.0000E-01	4.9668E-05
113.	DS4	1.7515E-02	1.1324E+00	9.8439E-01	4.0156E-04	1.0546E-01	4.7518E-05
114.	B3F	1.7390E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7179E-05
115.	OGR11	1.7390E-02	1.0480E+00	9.8355E-01	1.7496E-04	2.5500E-01	4.7179E-05
116.	A3F	1.7390E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7179E-05
117.	CH5	1.6832E-02	1.0002E+00	9.9997E-01	5.6389E-07	1.2296E-01	4.5663E-05
118.	FWF	1.6127E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.3752E-05
119.	A1LF	1.4937E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0524E-05
120.	VNV1R1	1.4526E-02	1.0885E+00	9.9017E-01	2.6679E-04	1.0000E-01	3.9407E-05
121.	RD1	1.4126E-02	1.1203E+00	9.8587E-01	3.6473E-04	1.0507E-01	3.8322E-05
122.	DGF	1.3976E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.7916E-05
123.	VT1AF	1.3976E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.7916E-05
124.	EB1	1.3489E-02	1.0961E+00	9.8859E-01	2.9158E-04	1.0618E-01	3.6594E-05
125.	RB5	1.3488E-02	1.4455E+00	9.8947E-01	1.2373E-03	2.3080E-02	3.6592E-05
126.	RSF	1.3304E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.6094E-05
127.	RS1	1.3296E-02	9.7911E-01	1.0023E+00	-6.3008E-05	1.0047E-01	3.6070E-05
128.	OBF	1.2340E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.3476E-05
129.	A2LF	1.2158E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2985E-05
130.	AALF	1.1960E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2448E-05
131.	BYBF	1.1677E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.1679E-05
132.	RA2	1.1024E-02	9.4073E-01	1.0014E+00	-1.6458E-04	2.3082E-02	2.9907E-05
133.	A2F	1.0999E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9839E-05
134.	A1F	1.0999E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9839E-05
135.	AE1	1.0353E-02	5.5206E+01	9.8974E-01	1.4709E-01	1.8919E-04	2.8086E-05
136.	AAF	1.0191E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7646E-05
137.	BE2	9.9166E-03	1.2559E+00	9.9009E-01	7.2118E-04	3.7270E-02	2.6903E-05
138.	AEF	9.0551E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.4566E-05
139.	RR4	8.9594E-03	1.0731E+00	9.9104E-01	2.2263E-04	1.0918E-01	2.4306E-05
140.	RB4	8.5919E-03	8.7220E-01	1.0029E+00	-3.5447E-04	2.1850E-02	2.3309E-05
141.	MR1	8.5655E-03	9.7409E-01	1.0029E+00	-7.8088E-05	1.0000E-01	2.3238E-05
142.	AC1	8.0914E-03	3.1175E+01	9.9208E-01	8.1885E-02	2.6250E-04	2.1952E-05
143.	MELTLF	7.7236E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0954E-05
144.	RVB1	7.7202E-03	1.0253E+00	9.9978E-01	6.9234E-05	8.6670E-03	2.0944E-05
145.	HHF	7.7153E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0931E-05
146.	GA1	7.5953E-03	1.0383E+00	9.9395E-01	1.2031E-04	1.3650E-01	2.0606E-05
147.	CP3	7.5296E-03	9.7921E-01	1.0027E+00	-6.3781E-05	1.1564E-01	2.0427E-05
148.	VA1	7.3629E-03	1.1319E+00	9.9899E-01	3.6052E-04	7.5650E-03	1.9975E-05
149.	GB1	7.2477E-03	1.0449E+00	9.9312E-01	1.4038E-04	1.3290E-01	1.9663E-05
150.	LYCF	7.1784E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9475E-05
151.	S22	6.4805E-03	1.3919E+00	9.9516E-01	1.0763E-03	1.2210E-02	1.7581E-05
152.	BC33	6.4302E-03	2.5432E+00	9.9425E-01	4.2024E-03	3.7150E-03	1.7445E-05
153.	SYNF	6.4166E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7408E-05
154.	MF1	6.3534E-03	1.2293E+00	9.9443E-01	6.3718E-04	2.3713E-02	1.7236E-05
155.	RH1	6.2751E-03	1.0534E+00	9.9374E-01	1.6189E-04	1.0486E-01	1.7024E-05
156.	BC21	6.1187E-03	1.0562E+00	9.9409E-01	1.6852E-04	9.5160E-02	1.6600E-05
157.	V1F	5.6884E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5432E-05
158.	V1RF	5.6884E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5432E-05
159.	CSA1	5.6722E-03	8.3541E-01	1.0035E+00	-4.5602E-04	2.0843E-02	1.5388E-05

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
160.	CSB1	5.4548E-03	8.4696E-01	1.0031E+00	-4.2363E-04	1.9940E-02	1.4799E-05
161.	VT1BR1	5.4263E-03	9.7528E-01	1.0027E+00	-7.4516E-05	1.0000E-01	1.4721E-05
162.	B2U2LF	5.3294E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4458E-05
163.	VINV2F	5.1374E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3938E-05
164.	HH2	4.9133E-03	9.6946E-01	1.0034E+00	-9.2092E-05	1.0030E-01	1.3330E-05
165.	GB2	4.8446E-03	1.0229E+00	9.9567E-01	7.3815E-05	1.5920E-01	1.3143E-05
166.	B1U2LF	4.7180E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2800E-05
167.	BBLF	4.6420E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2593E-05
168.	VT2BF	4.5260E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2279E-05
169.	B1U2F	4.4500E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2073E-05
170.	B2U2F	4.4500E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2073E-05
171.	RVA1	4.4388E-03	5.4744E-01	1.0041E+00	-1.2390E-03	9.0863E-03	1.2042E-05
172.	S11	3.9654E-03	7.6407E-01	1.0029E+00	-6.4798E-04	1.2211E-02	1.0758E-05
173.	BBF	3.9570E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0735E-05
174.	DE1	3.9082E-03	2.2272E+01	9.9626E-01	5.7719E-02	1.7602E-04	1.0603E-05
175.	CD1	3.8974E-03	8.6475E-01	1.0011E+00	-3.6990E-04	8.0334E-03	1.0573E-05
176.	S21	3.8000E-03	7.8065E-01	1.0025E+00	-6.0195E-04	1.1430E-02	1.0309E-05
177.	BE1	3.7862E-03	2.1338E+01	9.9629E-01	5.5187E-02	1.8220E-04	1.0272E-05
178.	DCACF	3.7402E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0147E-05
179.	RT4	3.5674E-03	8.8450E+00	9.9644E-01	2.1293E-02	4.5407E-04	9.6782E-06
180.	DA1	3.3513E-03	3.3275E+00	9.9764E-01	6.3208E-03	1.0120E-03	9.0920E-06
181.	REC1	3.2315E-03	1.0827E+00	9.9677E-01	2.3316E-04	3.7600E-02	8.7668E-06
182.	A1U2LF	3.2213E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.7392E-06
183.	ABLF	3.1453E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.5330E-06
184.	A2U2LF	3.1453E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.5330E-06
185.	A11	2.9771E-03	4.0592E+00	9.9775E-01	8.3056E-03	7.3542E-04	8.0768E-06
186.	MA3	2.9054E-03	6.2127E-01	1.0029E+00	-1.0353E-03	7.5200E-03	7.8823E-06
187.	MB9	2.9053E-03	6.9311E-01	1.0022E+00	-8.3846E-04	7.0170E-03	7.8820E-06
188.	DDACF	2.8523E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.7381E-06
189.	CH1	2.8029E-03	9.8319E-01	1.0019E+00	-5.0770E-05	1.0196E-01	7.6041E-06
190.	VB1	2.7986E-03	6.9906E-01	1.0023E+00	-8.2268E-04	7.5950E-03	7.5926E-06
191.	VT2AF	2.7712E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.5182E-06
192.	DHF	2.7712E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.5182E-06
193.	DB1	2.7560E-03	2.7807E+00	9.9820E-01	4.8360E-03	1.0120E-03	7.4769E-06
194.	A2U2F	2.6952E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3120E-06
195.	A1U2F	2.6952E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3120E-06
196.	CSB3	2.5642E-03	9.8672E-01	1.0003E+00	-3.6781E-05	2.0840E-02	6.9564E-06
197.	SLF	2.5563E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.9350E-06
198.	REC3	2.4983E-03	1.0252E+00	9.9750E-01	7.5042E-05	9.0320E-02	6.7778E-06
199.	CE1	2.4589E-03	1.8365E+00	9.9883E-01	2.2726E-03	1.3908E-03	6.6708E-06
200.	RB6	2.3899E-03	1.0209E+00	9.9830E-01	6.1412E-05	7.4960E-02	6.4836E-06
201.	ABF	2.2735E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.1678E-06
202.	ZA5	2.1458E-03	8.4376E-01	1.0012E+00	-4.2726E-04	7.9249E-03	5.8214E-06
203.	ZB1	2.0961E-03	8.5744E-01	1.0012E+00	-3.8995E-04	8.2130E-03	5.6867E-06
204.	B21	2.0118E-03	3.5138E+00	9.9854E-01	6.8238E-03	5.8153E-04	5.4579E-06
205.	IYBF	1.9962E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4155E-06
206.	ZB5	1.9535E-03	8.3419E-01	1.0013E+00	-4.5325E-04	7.5410E-03	5.2998E-06
207.	AE5	1.9351E-03	1.2766E+00	9.9811E-01	7.5563E-04	6.7815E-03	5.2499E-06
208.	DAF	1.9186E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.2050E-06
209.	SR4	1.8406E-03	1.0016E+00	9.9836E-01	8.9196E-06	4.9980E-01	4.9934E-06
210.	GD2	1.7315E-03	1.0025E+00	9.9955E-01	7.9569E-06	1.5470E-01	4.6975E-06
211.	PI1	1.6691E-03	1.6224E+00	9.9837E-01	1.6928E-03	2.6076E-03	4.5283E-06
212.	CI1	1.6417E-03	5.0325E-01	1.0024E+00	-1.3543E-03	4.8871E-03	4.4538E-06

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
213.	MDE1	1.6091E-03	1.3244E+00	9.9961E-01	8.8101E-04	1.2150E-03	4.3654E-06
214.	DS2	1.5866E-03	1.0135E+00	9.9841E-01	4.0816E-05	1.0546E-01	4.3045E-06
215.	RD2	1.4992E-03	1.0122E+00	9.9850E-01	3.7255E-05	1.0917E-01	4.0672E-06
216.	PD4	1.4963E-03	9.7394E-01	1.0010E+00	-7.3497E-05	3.8160E-02	4.0593E-06
217.	PA1	1.4927E-03	6.1295E-01	1.0012E+00	-1.0534E-03	3.2129E-03	4.0495E-06
218.	RR7	1.4886E-03	1.0107E+00	9.9851E-01	3.3167E-05	1.2176E-01	4.0384E-06
219.	VNV2R1	1.4694E-03	1.0096E+00	9.9894E-01	2.8808E-05	1.0000E-01	3.9864E-06
220.	GD3	1.4666E-03	1.0037E+00	9.9929E-01	1.1916E-05	1.6140E-01	3.9787E-06
221.	MA4	1.4641E-03	1.1647E+00	9.9877E-01	4.5023E-04	7.4210E-03	3.9721E-06
222.	CE2	1.4623E-03	2.0029E+00	9.9860E-01	2.7245E-03	1.3930E-03	3.9672E-06
223.	D11	1.4399E-03	4.6713E-01	1.0017E+00	-1.4503E-03	3.2017E-03	3.9064E-06
224.	PB1	1.4295E-03	6.3664E-01	1.0012E+00	-9.8895E-04	3.2130E-03	3.8782E-06
225.	REC2	1.4196E-03	1.0363E+00	9.9858E-01	1.0243E-04	3.7600E-02	3.8513E-06
226.	RL5	1.3946E-03	9.9838E-01	1.0002E+00	-4.8703E-06	1.0032E-01	3.7833E-06
227.	GC2	1.3585E-03	9.9877E-01	1.0002E+00	-3.9584E-06	1.5570E-01	3.6855E-06
228.	AC3	1.3463E-03	1.0042E+00	9.9951E-01	1.2660E-05	1.0520E-01	3.6524E-06
229.	AFR1	1.3424E-03	9.9626E-01	1.0004E+00	-1.1267E-05	1.0000E-01	3.6419E-06
230.	V37	1.3388E-03	1.0252E+00	9.9895E-01	7.1291E-05	4.0089E-02	3.6320E-06
231.	D21	1.3305E-03	4.5007E-01	1.0017E+00	-1.4965E-03	3.0750E-03	3.6095E-06
232.	SYAF	1.2681E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4403E-06
233.	SU3	1.1832E-03	8.0967E-01	1.0016E+00	-5.2072E-04	8.4073E-03	3.2099E-06
234.	DAAC1	1.1511E-03	1.7906E+00	9.9945E-01	2.1464E-03	6.9340E-04	3.1230E-06
235.	BC1	1.1447E-03	6.6871E-01	1.0012E+00	-9.0209E-04	3.6910E-03	3.1056E-06
236.	REC4	1.1425E-03	1.0292E+00	9.9886E-01	8.2431E-05	3.7600E-02	3.0994E-06
237.	PA2	1.1411E-03	9.3258E-01	1.0014E+00	-1.8683E-04	2.0976E-02	3.0958E-06
238.	PD1	1.1229E-03	1.2846E+00	9.9973E-01	7.7294E-04	9.5564E-04	3.0462E-06
239.	TP3	1.0857E-03	1.0021E+00	9.9983E-01	6.2470E-06	7.2270E-02	2.9455E-06
240.	DBF	1.0748E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9160E-06
241.	MB4	9.9957E-04	1.1337E+00	9.9900E-01	3.6542E-04	7.4210E-03	2.7118E-06
242.	V1R1	9.7331E-04	1.0088E+00	9.9903E-01	2.6405E-05	1.0000E-01	2.6405E-06
243.	SRF	8.8017E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3879E-06
244.	AA2	8.0822E-04	2.1836E+00	9.9920E-01	3.2132E-03	6.7570E-04	2.1927E-06
245.	GC3	7.9996E-04	9.9966E-01	1.0001E+00	-1.1225E-06	1.7760E-01	2.1703E-06
246.	WC1	7.7152E-04	1.0058E+00	9.9936E-01	1.7462E-05	1.0000E-01	2.0931E-06
247.	BA4	7.6102E-04	1.0061E+00	9.9924E-01	1.8540E-05	1.1050E-01	2.0646E-06
248.	PR2	7.5656E-04	1.2326E+00	9.9926E-01	6.3298E-04	3.1810E-03	2.0525E-06
249.	OB1	7.4750E-04	1.0013E+00	9.9983E-01	3.9884E-06	1.1765E-01	2.0279E-06
250.	SR1	7.2251E-04	1.0110E+00	9.9960E-01	3.0935E-05	3.4944E-02	1.9601E-06
251.	B2U21	6.8743E-04	1.1865E+00	9.9989E-01	5.0639E-04	5.8153E-04	1.8649E-06
252.	PRA	6.8714E-04	1.0915E+00	9.9931E-01	2.5005E-04	7.4482E-03	1.8642E-06
253.	RR6	6.6971E-04	1.0050E+00	9.9933E-01	1.5426E-05	1.1778E-01	1.8169E-06
254.	SU2	6.5947E-04	2.5643E+00	9.9953E-01	4.2451E-03	2.9848E-04	1.7891E-06
255.	MU1	6.4906E-04	1.0000E+00	1.0000E+00	1.0492E-08	4.4090E-01	1.7609E-06
256.	MB12	6.4388E-04	1.0080E+00	9.9936E-01	2.3403E-05	7.4640E-02	1.7468E-06
257.	GD1	5.9806E-04	1.0025E+00	9.9965E-01	7.6262E-06	1.2560E-01	1.6225E-06
258.	UB1B1	5.8835E-04	2.5543E-01	1.0019E+00	-2.0250E-03	2.5070E-03	1.5962E-06
259.	UB1D1	5.8830E-04	2.7627E-01	1.0017E+00	-1.9680E-03	2.3130E-03	1.5960E-06
260.	UB1A1	5.8827E-04	2.2885E-01	1.0022E+00	-2.0980E-03	2.8010E-03	1.5959E-06
261.	UB1C1	5.8822E-04	2.6684E-01	1.0018E+00	-1.9938E-03	2.3960E-03	1.5958E-06
262.	EB7	5.6559E-04	1.0022E+00	9.9976E-01	6.6186E-06	1.0000E-01	1.5344E-06
263.	DBAC1	5.5862E-04	9.0439E-01	1.0001E+00	-2.5955E-04	6.9340E-04	1.5155E-06
264.	TB2	5.3972E-04	1.0065E+00	9.9963E-01	1.8760E-05	5.3944E-02	1.4642E-06
265.	DC1	4.9294E-04	4.8987E-01	1.0005E+00	-1.3854E-03	1.0120E-03	1.3373E-06

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Importance

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
266.	PR4	4.8970E-04	1.0144E+00	9.9963E-01	4.0106E-05	2.5234E-02	1.3285E-06
267.	V11	4.7708E-04	0.0000E+00	9.9953E-01	0.0000E+00	7.3100E-06	1.2943E-06
268.	VB2	4.7255E-04	1.0476E+00	9.9964E-01	1.3007E-04	7.5650E-03	1.2820E-06
269.	VT1AR1	4.6684E-04	9.9069E-01	1.0010E+00	-2.8056E-05	1.0000E-01	1.2665E-06
270.	BE41	4.6599E-04	1.0695E+00	9.9953E-01	1.8979E-04	6.6530E-03	1.2642E-06
271.	OS2	4.6005E-04	1.0005E+00	9.9994E-01	1.5108E-06	1.0000E-01	1.2481E-06
272.	VT1B1	4.5460E-04	1.5041E+00	9.9984E-01	1.3679E-03	3.1890E-04	1.2333E-06
273.	RVB3	4.5238E-04	1.0011E+00	9.9994E-01	3.0746E-06	5.4830E-02	1.2273E-06
274.	MA1	4.4409E-04	1.0577E+00	9.9956E-01	1.5783E-04	7.5140E-03	1.2048E-06
275.	AB6	4.2176E-04	9.9998E-01	1.0000E+00	-1.0416E-07	5.6660E-01	1.1442E-06
276.	RA1	4.1414E-04	9.9793E-01	1.0000E+00	-5.7331E-06	1.9057E-02	1.1235E-06
277.	BC22	4.0868E-04	1.0621E+00	9.9975E-01	1.6924E-04	3.9620E-03	1.1087E-06
278.	CH6	4.0831E-04	9.9561E-01	1.0006E+00	-1.3570E-05	1.2296E-01	1.1077E-06
279.	CI4	4.0316E-04	9.9577E-01	1.0006E+00	-1.3010E-05	1.1757E-01	1.0937E-06
280.	VSF	3.9997E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0851E-06
281.	VS1	3.7479E-04	1.0988E+00	9.9993E-01	2.6816E-04	6.9239E-04	1.0168E-06
282.	LYNF	3.5114E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.5262E-07
283.	BB14	3.4731E-04	1.0000E+00	9.9998E-01	6.8624E-08	8.1440E-01	9.4223E-07
284.	DSLRF	3.3797E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.1688E-07
285.	V12	3.2615E-04	1.0820E+00	9.9968E-01	2.2344E-04	3.8430E-03	8.8483E-07
286.	BE33	3.2020E-04	1.0407E+00	9.9972E-01	1.1115E-04	6.7800E-03	8.6869E-07
287.	AE2	3.0177E-04	1.0002E+00	9.9998E-01	4.8826E-07	1.1120E-01	8.1870E-07
288.	VINV11	2.9985E-04	1.6217E+00	9.9988E-01	1.6871E-03	1.9240E-04	8.1347E-07
289.	TB4	2.9731E-04	9.9809E-01	1.0001E+00	-5.4904E-06	5.6007E-02	8.0658E-07
290.	RB1	2.9469E-04	9.9276E-01	1.0001E+00	-2.0014E-05	1.8250E-02	7.9948E-07
291.	CP1	2.7677E-04	2.7670E-01	1.0011E+00	-1.9652E-03	1.4657E-03	7.5085E-07
292.	A21	2.7104E-04	4.7707E-01	1.0003E+00	-1.4195E-03	5.8153E-04	7.3531E-07
293.	EE1	2.6260E-04	2.5736E-01	1.0010E+00	-2.0175E-03	1.3908E-03	7.1243E-07
294.	FE1	2.6238E-04	2.5720E-01	1.0010E+00	-2.0180E-03	1.3908E-03	7.1182E-07
295.	DS6	2.6080E-04	9.9541E-01	1.0005E+00	-1.3933E-05	1.0636E-01	7.0753E-07
296.	MB8	2.5755E-04	1.0032E+00	9.9974E-01	9.4524E-06	7.3920E-02	6.9872E-07
297.	CSB2	2.1765E-04	9.9777E-01	1.0002E+00	-6.4715E-06	6.3310E-02	5.9047E-07
298.	RT2	2.0599E-04	2.2383E+00	9.9980E-01	3.3600E-03	1.6534E-04	5.5884E-07
299.	BC28	1.9786E-04	1.0014E+00	9.9980E-01	4.2068E-06	1.2760E-01	5.3679E-07
300.	AC8	1.9786E-04	1.2197E+00	9.9980E-01	5.9644E-04	8.9420E-04	5.3679E-07
301.	LYAF	1.9404E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.2642E-07
302.	ZB10	1.9351E-04	1.0013E+00	9.9992E-01	3.7676E-06	5.5980E-02	5.2499E-07
303.	MB1	1.9022E-04	1.0251E+00	9.9981E-01	6.8679E-05	7.5140E-03	5.1606E-07
304.	RH2	1.8456E-04	1.0014E+00	9.9982E-01	4.4219E-06	1.1323E-01	5.0069E-07
305.	SI1	1.7070E-04	4.9803E-01	1.0005E+00	-1.3632E-03	1.0215E-03	4.6311E-07
306.	V13	1.7008E-04	1.0119E+00	9.9996E-01	3.2308E-05	3.0920E-03	4.6141E-07
307.	S23	1.6585E-04	9.9823E-01	1.0001E+00	-5.1911E-06	7.5510E-02	4.4994E-07
308.	DD1	1.6273E-04	1.6594E-01	1.0008E+00	-2.2651E-03	1.0120E-03	4.4147E-07
309.	REC5	1.6090E-04	1.0023E+00	9.9984E-01	6.7444E-06	6.4720E-02	4.3650E-07
310.	GD4	1.6090E-04	9.9984E-01	1.0001E+00	-5.8969E-07	2.5240E-01	4.3650E-07
311.	MB27	1.5745E-04	9.9995E-01	1.0000E+00	-1.4204E-07	1.1160E-01	4.2716E-07
312.	MA7	1.5744E-04	9.9994E-01	1.0000E+00	-1.8750E-07	1.0140E-01	4.2714E-07
313.	LCL1	1.5313E-04	1.0323E+00	9.9987E-01	8.8021E-05	3.8880E-03	4.1543E-07
314.	V33	1.4536E-04	1.5283E+00	9.9987E-01	1.4337E-03	2.5274E-04	3.9436E-07
315.	BC2	1.3899E-04	1.0318E+00	9.9988E-01	8.6584E-05	3.6870E-03	3.7707E-07
316.	BE90	1.3792E-04	1.1705E+00	9.9986E-01	4.6299E-04	7.9950E-04	3.7418E-07
317.	FB1	1.2867E-04	1.0200E+00	9.9993E-01	5.4393E-05	3.4470E-03	3.4909E-07
318.	GBF	1.2867E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4909E-07

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Importance

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
319.	BE34	1.2695E-04	1.0164E+00	9.9989E-01	4.4846E-05	6.9180E-03	3.4442E-07
320.	RLF	1.2296E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.3359E-07
321.	PB3	1.2216E-04	9.9974E-01	1.0000E+00	-7.1034E-07	2.0640E-02	3.3140E-07
322.	RB3	1.1940E-04	1.0016E+00	9.9990E-01	4.5059E-06	6.0470E-02	3.2394E-07
323.	RHF	1.1940E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2394E-07
324.	GC1	1.1500E-04	9.9847E-01	1.0002E+00	-4.7676E-06	1.2940E-01	3.1198E-07
325.	MU5	1.1410E-04	1.0006E+00	9.9993E-01	1.7005E-06	1.0841E-01	3.0954E-07
326.	RR3	1.0663E-04	1.0009E+00	9.9989E-01	2.6496E-06	1.0918E-01	2.8928E-07
327.	BE10	1.0539E-04	1.0637E+00	9.9989E-01	1.7297E-04	1.6480E-03	2.8593E-07
328.	BA3	1.0374E-04	1.1681E+00	9.9990E-01	4.5637E-04	6.0140E-04	2.8143E-07
329.	VINV12	1.0285E-04	1.1451E+00	9.9990E-01	3.9398E-04	6.7640E-04	2.7903E-07
330.	DE2	1.0258E-04	1.5784E+00	9.9990E-01	1.5695E-03	1.7602E-04	2.7829E-07
331.	BE4	1.0058E-04	1.0000E+00	9.9990E-01	2.8176E-07	9.6850E-01	2.7288E-07
332.	VT2BR1	1.0014E-04	9.9648E-01	1.0004E+00	-1.0624E-05	1.0000E-01	2.7169E-07
333.	DS9	8.7558E-05	1.0002E+00	9.9998E-01	6.3759E-07	1.0000E-01	2.3754E-07
334.	BB1	8.4380E-05	0.0000E+00	9.9994E-01	0.0000E+00	2.6740E-05	2.2892E-07
335.	VC1	8.3887E-05	3.9697E-01	1.0004E+00	-1.6371E-03	6.9303E-04	2.2758E-07
336.	DCAC1	8.2288E-05	1.2544E-01	1.0006E+00	-2.3743E-03	6.9340E-04	2.2324E-07
337.	EE2	8.1753E-05	1.0119E+00	9.9998E-01	3.2271E-05	1.3908E-03	2.2179E-07
338.	BA1	8.1089E-05	0.0000E+00	9.9994E-01	0.0000E+00	2.6740E-05	2.1999E-07
339.	VT2AR1	7.9931E-05	9.9803E-01	1.0002E+00	-5.9442E-06	1.0000E-01	2.1685E-07
340.	DDAC1	7.9564E-05	1.2082E-01	1.0006E+00	-2.3868E-03	6.9340E-04	2.1585E-07
341.	A1U21	7.6026E-05	1.0607E-01	1.0007E+00	-2.4270E-03	7.3542E-04	2.0626E-07
342.	B1U21	7.5993E-05	1.0778E-01	1.0007E+00	-2.4223E-03	7.3542E-04	2.0617E-07
343.	CH2	7.1261E-05	9.9852E-01	1.0002E+00	-4.5888E-06	1.2296E-01	1.9333E-07
344.	PB10	6.7772E-05	9.9677E-01	1.0001E+00	-8.9502E-06	2.0940E-02	1.8386E-07
345.	DSLR1	6.5057E-05	9.9723E-01	1.0001E+00	-7.7548E-06	2.9970E-02	1.7650E-07
346.	RT9	6.2197E-05	1.0002E+00	9.9998E-01	6.7448E-07	1.0016E-01	1.6874E-07
347.	BB7	6.1254E-05	9.9991E-01	1.0000E+00	-3.1078E-07	2.4260E-01	1.6618E-07
348.	PI3	4.5048E-05	9.9502E-01	1.0001E+00	-1.3854E-05	2.5000E-02	1.2221E-07
349.	ZA2	4.3218E-05	9.8093E-01	1.0002E+00	-5.2210E-05	9.1268E-03	1.1725E-07
350.	ZB2	4.3216E-05	9.8123E-01	1.0002E+00	-5.1369E-05	8.6600E-03	1.1724E-07
351.	PD5	4.2081E-05	9.9581E-01	1.0001E+00	-1.1723E-05	3.0838E-02	1.1416E-07
352.	FA1	4.1433E-05	9.9434E-01	1.0000E+00	-1.5408E-05	3.5320E-03	1.1241E-07
353.	GAF	4.1433E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1241E-07
354.	GB3	4.1433E-05	1.0003E+00	9.9996E-01	8.2349E-07	1.3650E-01	1.1241E-07
355.	SYBF	3.9676E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0764E-07
356.	RVB2	3.8287E-05	9.9978E-01	1.0000E+00	-6.1591E-07	9.0860E-03	1.0387E-07
357.	CH3	3.7186E-05	9.9816E-01	1.0003E+00	-5.6975E-06	1.2296E-01	1.0088E-07
358.	TB1	0.0000E+00	6.7982E-01	1.0001E+00	-8.6892E-04	3.2555E-04	0.0000E+00
359.	AFA1	0.0000E+00	9.8896E-01	1.0000E+00	-3.0013E-05	2.3760E-03	0.0000E+00
360.	AF6	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0804E-05	0.0000E+00
361.	AF5	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.9248E-05	0.0000E+00
362.	TB3	0.0000E+00	9.9858E-01	1.0000E+00	-3.8586E-06	1.2166E-03	0.0000E+00
363.	AE7	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.0291E-05	0.0000E+00
364.	SYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
365.	SES	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
366.	AE9	0.0000E+00	9.9778E-01	1.0000E+00	-6.0223E-06	8.1416E-05	0.0000E+00
367.	SEI	0.0000E+00	9.9965E-01	1.0000E+00	-9.4974E-07	2.3345E-03	0.0000E+00
368.	AF1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6562E-06	0.0000E+00
369.	SLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
370.	SRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
371.	SGCLGS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
372.	SU1	0.0000E+00	9.7620E-01	1.0000E+00	-6.4595E-05	2.3186E-04	0.0000E+00
373.	AE4	0.0000E+00	9.9967E-01	1.0000E+00	-8.8631E-07	1.6184E-03	0.0000E+00
374.	SE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0752E-06	0.0000E+00
375.	AF4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.4009E-06	0.0000E+00
376.	SYCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
377.	SL3	0.0000E+00	9.8827E-01	1.0002E+00	-3.2376E-05	1.6996E-02	0.0000E+00
378.	AF2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.8286E-06	0.0000E+00
379.	AF3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.8286E-06	0.0000E+00
380.	AE6	0.0000E+00	9.9267E-01	1.0000E+00	-1.9950E-05	3.4298E-03	0.0000E+00
381.	SE9	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0752E-06	0.0000E+00
382.	SYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
383.	AFA3	0.0000E+00	9.9945E-01	1.0000E+00	-1.5430E-06	3.0710E-02	0.0000E+00
384.	AA1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6740E-05	0.0000E+00
385.	VF1	0.0000E+00	9.8326E-01	1.0000E+00	-4.5441E-05	6.9392E-04	0.0000E+00
386.	VINV21	0.0000E+00	2.0923E-02	1.0002E+00	-2.6567E-03	1.9040E-04	0.0000E+00
387.	VC2	0.0000E+00	9.6641E-01	1.0003E+00	-9.1934E-05	8.8737E-03	0.0000E+00
388.	AALS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
389.	A2U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
390.	VINV22	0.0000E+00	9.8421E-01	1.0002E+00	-4.3281E-05	1.0530E-02	0.0000E+00
391.	A31	0.0000E+00	1.7390E-02	1.0004E+00	-2.6669E-03	4.1950E-04	0.0000E+00
392.	VS2	0.0000E+00	9.9730E-01	1.0000E+00	-7.3769E-06	8.8731E-03	0.0000E+00
393.	AB3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.8580E-05	0.0000E+00
394.	V36	0.0000E+00	9.9284E-01	1.0000E+00	-1.9440E-05	4.8115E-04	0.0000E+00
395.	AB2	0.0000E+00	9.9585E-01	1.0000E+00	-1.1272E-05	5.6940E-04	0.0000E+00
396.	V35	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.0398E-05	0.0000E+00
397.	VB5	0.0000E+00	9.9991E-01	1.0000E+00	-2.3308E-07	9.1160E-03	0.0000E+00
398.	VB3	0.0000E+00	9.9720E-01	1.0000E+00	-7.6202E-06	3.5120E-03	0.0000E+00
399.	VA2	0.0000E+00	9.9911E-01	1.0000E+00	-2.4497E-06	9.1160E-03	0.0000E+00
400.	AB1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6740E-05	0.0000E+00
401.	V34	0.0000E+00	9.9885E-01	1.0000E+00	-3.1621E-06	1.5295E-02	0.0000E+00
402.	ZA4	0.0000E+00	9.9982E-01	1.0000E+00	-4.8792E-07	8.6464E-03	0.0000E+00
403.	ZA3	0.0000E+00	9.9876E-01	1.0000E+00	-3.3876E-06	1.0810E-02	0.0000E+00
404.	ZB3	0.0000E+00	9.9876E-01	1.0000E+00	-3.3856E-06	1.0230E-02	0.0000E+00
405.	A1U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
406.	WCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
407.	A1LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
408.	ZB4	0.0000E+00	9.9982E-01	1.0000E+00	-4.8771E-07	8.2130E-03	0.0000E+00
409.	ZB7	0.0000E+00	9.9996E-01	1.0000E+00	-1.2470E-07	5.9770E-02	0.0000E+00
410.	VS3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.6996E-06	0.0000E+00
411.	VT1A2	0.0000E+00	9.8835E-01	1.0000E+00	-3.1614E-05	3.1890E-04	0.0000E+00
412.	A2U21	0.0000E+00	2.6952E-03	1.0006E+00	-2.7072E-03	5.8153E-04	0.0000E+00
413.	VT1A1	0.0000E+00	2.5625E-02	1.0003E+00	-2.6443E-03	3.1770E-04	0.0000E+00
414.	VT2B2	0.0000E+00	9.8421E-01	1.0000E+00	-4.2838E-05	3.1890E-04	0.0000E+00
415.	VT2B1	0.0000E+00	2.0311E-02	1.0003E+00	-2.6587E-03	3.1770E-04	0.0000E+00
416.	A2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
417.	VT2A1	0.0000E+00	2.7712E-03	1.0003E+00	-2.7063E-03	3.1890E-04	0.0000E+00
418.	AE3	0.0000E+00	9.9682E-01	1.0000E+00	-8.6376E-06	2.3574E-04	0.0000E+00
419.	UB1C4	0.0000E+00	9.9867E-01	1.0000E+00	-3.6186E-06	2.5070E-03	0.0000E+00
420.	UB1C2	0.0000E+00	9.9882E-01	1.0001E+00	-3.3476E-06	4.6460E-02	0.0000E+00
421.	AB9	0.0000E+00	9.9587E-01	1.0000E+00	-1.1205E-05	6.7570E-04	0.0000E+00
422.	UB1B3	0.0000E+00	9.9856E-01	1.0000E+00	-3.9174E-06	2.8010E-03	0.0000E+00
423.	UB1B2	0.0000E+00	9.9941E-01	1.0001E+00	-1.7884E-06	1.0760E-01	0.0000E+00
424.	AB7	0.0000E+00	9.9131E-01	1.0000E+00	-2.3578E-05	6.0140E-04	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Importance

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
425.	UB1D2	0.0000E+00	9.9824E-01	1.0001E+00	-4.9723E-06	3.7090E-02	0.0000E+00
426.	UB1D5	0.0000E+00	9.9856E-01	1.0000E+00	-3.9162E-06	2.5070E-03	0.0000E+00
427.	V14	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3710E-05	0.0000E+00
428.	TP7	0.0000E+00	8.7174E-01	1.0000E+00	-3.4801E-04	1.3890E-04	0.0000E+00
429.	TP5	0.0000E+00	9.9996E-01	1.0000E+00	-1.2164E-07	8.0120E-02	0.0000E+00
430.	AE10	0.0000E+00	9.9801E-01	1.0000E+00	-5.4014E-06	8.0047E-04	0.0000E+00
431.	TP2	0.0000E+00	9.9839E-01	1.0001E+00	-4.6776E-06	6.3430E-02	0.0000E+00
432.	ABLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
433.	TTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
434.	TT1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.8253E-06	0.0000E+00
435.	TT2	0.0000E+00	9.9723E-01	1.0000E+00	-7.5165E-06	7.3004E-05	0.0000E+00
436.	V32	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.5407E-06	0.0000E+00
437.	V226	0.0000E+00	9.9824E-01	1.0000E+00	-4.7797E-06	7.7540E-04	0.0000E+00
438.	V224	0.0000E+00	9.9607E-01	1.0000E+00	-1.0659E-05	2.4320E-04	0.0000E+00
439.	V24	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.9740E-06	0.0000E+00
440.	V222	0.0000E+00	9.9691E-01	1.0000E+00	-8.4154E-06	3.8460E-03	0.0000E+00
441.	V221	0.0000E+00	9.9929E-01	1.0000E+00	-1.9420E-06	3.8420E-03	0.0000E+00
442.	V31	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	5.6297E-07	0.0000E+00
443.	V25	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.9840E-06	0.0000E+00
444.	V27	0.0000E+00	9.9923E-01	1.0000E+00	-2.1004E-06	3.0910E-03	0.0000E+00
445.	V15	0.0000E+00	9.8972E-01	1.0000E+00	-2.8006E-05	3.8430E-03	0.0000E+00
446.	V21	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	7.0910E-06	0.0000E+00
447.	V210	0.0000E+00	9.9967E-01	1.0000E+00	-8.8492E-07	9.4420E-05	0.0000E+00
448.	AB4	0.0000E+00	9.9985E-01	1.0000E+00	-4.3279E-07	5.3850E-02	0.0000E+00
449.	V220	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.2820E-05	0.0000E+00
450.	V22	0.0000E+00	9.9952E-01	1.0000E+00	-1.3344E-06	3.0030E-02	0.0000E+00
451.	V211	0.0000E+00	9.9983E-01	1.0000E+00	-4.6146E-07	1.1240E-04	0.0000E+00
452.	V219	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3270E-05	0.0000E+00
453.	DAAC3	0.0000E+00	9.8624E-01	1.0000E+00	-3.7354E-05	7.2834E-04	0.0000E+00
454.	GE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
455.	GDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
456.	HE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
457.	GD8	0.0000E+00	9.9992E-01	1.0000E+00	-2.5929E-07	1.3290E-01	0.0000E+00
458.	GD5	0.0000E+00	9.9991E-01	1.0000E+00	-2.7183E-07	1.2940E-01	0.0000E+00
459.	IP1	0.0000E+00	9.7620E-01	1.0000E+00	-6.4639E-05	9.1965E-04	0.0000E+00
460.	INTPRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
461.	CI2	0.0000E+00	9.9832E-01	1.0000E+00	-4.6777E-06	2.3533E-02	0.0000E+00
462.	IC1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.0020E-06	0.0000E+00
463.	IYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
464.	GAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
465.	CL1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.8220E-06	0.0000E+00
466.	CI3	0.0000E+00	9.2792E-01	1.0007E+00	-1.9732E-04	8.9763E-03	0.0000E+00
467.	CMS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
468.	GCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
469.	GC6	0.0000E+00	9.9992E-01	1.0000E+00	-2.6038E-07	1.3650E-01	0.0000E+00
470.	GBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
471.	GC4	0.0000E+00	9.9991E-01	1.0000E+00	-2.7293E-07	1.3290E-01	0.0000E+00
472.	FW1	0.0000E+00	9.0558E-01	1.0005E+00	-2.5744E-04	5.0000E-03	0.0000E+00
473.	MB5	0.0000E+00	9.9786E-01	1.0000E+00	-5.8374E-06	7.5630E-03	0.0000E+00
474.	MB3	0.0000E+00	9.9538E-01	1.0000E+00	-1.2640E-05	7.5200E-03	0.0000E+00
475.	MB7	0.0000E+00	9.9908E-01	1.0000E+00	-2.5020E-06	7.0110E-03	0.0000E+00
476.	MB28	0.0000E+00	9.9984E-01	1.0000E+00	-4.3191E-07	1.1050E-02	0.0000E+00
477.	MB13	0.0000E+00	9.9765E-01	1.0000E+00	-6.4212E-06	7.0550E-03	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
478.	BYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
479.	MELTBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
480.	CCSRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
481.	CAVS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
482.	LOWPRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
483.	LYCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
484.	LYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
485.	MA11	0.0000E+00	9.9996E-01	1.0000E+00	-1.2471E-07	1.0280E-01	0.0000E+00
486.	LYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
487.	MB11	0.0000E+00	9.7022E-01	1.0002E+00	-8.1359E-05	6.9180E-03	0.0000E+00
488.	MB10	0.0000E+00	9.9709E-01	1.0002E+00	-8.5110E-06	7.3870E-02	0.0000E+00
489.	MA5	0.0000E+00	9.9702E-01	1.0000E+00	-8.1384E-06	7.5630E-03	0.0000E+00
490.	MACROS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
491.	MELTIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
492.	D22	0.0000E+00	9.8261E-01	1.0000E+00	-4.7306E-05	2.6886E-03	0.0000E+00
493.	DDAC3	0.0000E+00	9.9694E-01	1.0000E+00	-8.2983E-06	7.2834E-04	0.0000E+00
494.	DG1	0.0000E+00	1.3976E-02	1.0004E+00	-2.6760E-03	3.6298E-04	0.0000E+00
495.	DDAC2	0.0000E+00	9.9984E-01	1.0000E+00	-4.4178E-07	6.9983E-04	0.0000E+00
496.	DD2	0.0000E+00	9.9486E-01	1.0000E+00	-1.3946E-05	5.7890E-04	0.0000E+00
497.	DP2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.1999E-05	0.0000E+00
498.	DP1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.1494E-06	0.0000E+00
499.	D12	0.0000E+00	9.8261E-01	1.0000E+00	-4.7312E-05	2.8153E-03	0.0000E+00
500.	DHS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
501.	DP4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3827E-05	0.0000E+00
502.	DBAC2	0.0000E+00	9.9617E-01	1.0000E+00	-1.0400E-05	6.9983E-04	0.0000E+00
503.	DB2	0.0000E+00	9.4365E-01	1.0000E+00	-1.5296E-04	5.7890E-04	0.0000E+00
504.	DBAC3	0.0000E+00	9.3420E-01	1.0000E+00	-1.7864E-04	7.2834E-04	0.0000E+00
505.	DAAC2	0.0000E+00	9.9493E-01	1.0000E+00	-1.3767E-05	6.9983E-04	0.0000E+00
506.	DA2	0.0000E+00	9.8602E-01	1.0000E+00	-3.7938E-05	5.7890E-04	0.0000E+00
507.	DCAC3	0.0000E+00	9.9747E-01	1.0000E+00	-6.8735E-06	7.2834E-04	0.0000E+00
508.	DC2	0.0000E+00	9.9723E-01	1.0000E+00	-7.5226E-06	5.7890E-04	0.0000E+00
509.	DCAC2	0.0000E+00	9.9951E-01	1.0000E+00	-1.3383E-06	6.9983E-04	0.0000E+00
510.	FE2	0.0000E+00	9.9425E-01	1.0000E+00	-1.5628E-05	1.3930E-03	0.0000E+00
511.	FC2	0.0000E+00	9.9983E-01	1.0000E+00	-4.6309E-07	3.4460E-03	0.0000E+00
512.	FC1	0.0000E+00	9.8278E-01	1.0001E+00	-4.6879E-05	3.4470E-03	0.0000E+00
513.	FCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
514.	FBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
515.	FB2	0.0000E+00	9.9996E-01	1.0000E+00	-1.1561E-07	2.7700E-02	0.0000E+00
516.	FDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
517.	FD1	0.0000E+00	9.8278E-01	1.0001E+00	-4.6879E-05	3.4470E-03	0.0000E+00
518.	FD2	0.0000E+00	9.9983E-01	1.0000E+00	-4.6309E-07	3.4460E-03	0.0000E+00
519.	DP7	0.0000E+00	9.9259E-01	1.0001E+00	-2.0294E-05	8.9256E-03	0.0000E+00
520.	CSRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
521.	DS5	0.0000E+00	9.9994E-01	1.0000E+00	-1.7101E-07	1.0546E-01	0.0000E+00
522.	DSLRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
523.	CT1	0.0000E+00	0.0000E+00	1.0001E+00	-2.7132E-03	9.3318E-05	0.0000E+00
524.	FAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
525.	EXS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
526.	CSIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
527.	CP2	0.0000E+00	9.9804E-01	1.0000E+00	-5.3404E-06	1.7895E-03	0.0000E+00
528.	RW1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.3840E-07	0.0000E+00
529.	RHRSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
530.	BA5	0.0000E+00	9.9729E-01	1.0000E+00	-7.3552E-06	6.7570E-04	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Importance

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
531.	RI1	0.0000E+00	4.8790E-01	1.0002E+00	-1.3897E-03	3.2260E-04	0.0000E+00
532.	BALS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
533.	RF3	0.0000E+00	9.9985E-01	1.0000E+00	-4.1574E-07	7.3460E-04	0.0000E+00
534.	RI5	0.0000E+00	9.9983E-01	1.0000E+00	-4.6326E-07	3.2260E-04	0.0000E+00
535.	RI4	0.0000E+00	9.9359E-01	1.0000E+00	-1.7387E-05	5.0730E-04	0.0000E+00
536.	RI2	0.0000E+00	8.5907E-01	1.0001E+00	-3.8253E-04	5.0730E-04	0.0000E+00
537.	RI3	0.0000E+00	9.9983E-01	1.0000E+00	-4.5009E-07	3.2260E-04	0.0000E+00
538.	RL2	0.0000E+00	9.9631E-01	1.0000E+00	-1.0119E-05	1.0053E-02	0.0000E+00
539.	BB8	0.0000E+00	9.9293E-01	1.0000E+00	-1.9189E-05	5.6940E-04	0.0000E+00
540.	BB9	0.0000E+00	9.9598E-01	1.0000E+00	-1.0911E-05	6.0140E-04	0.0000E+00
541.	BB6	0.0000E+00	9.9985E-01	1.0000E+00	-4.2794E-07	4.3110E-02	0.0000E+00
542.	PRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
543.	RF1	0.0000E+00	9.7647E-01	1.0000E+00	-6.3873E-05	5.0780E-04	0.0000E+00
544.	BB10	0.0000E+00	9.9936E-01	1.0000E+00	-1.7349E-06	6.7570E-04	0.0000E+00
545.	BB5	0.0000E+00	9.9645E-01	1.0000E+00	-9.6479E-06	5.4520E-04	0.0000E+00
546.	BB2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.8580E-05	0.0000E+00
547.	BBLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
548.	RTB	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.4121E-06	0.0000E+00
549.	AR2	0.0000E+00	9.2825E-01	1.0004E+00	-1.9578E-04	5.7667E-03	0.0000E+00
550.	RTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
551.	RT6	0.0000E+00	9.9965E-01	1.0000E+00	-9.6375E-07	7.4597E-04	0.0000E+00
552.	B1LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
553.	AFA5	0.0000E+00	9.9982E-01	1.0000E+00	-5.2905E-07	5.8710E-02	0.0000E+00
554.	AR1	0.0000E+00	2.2385E-01	1.0002E+00	-2.1063E-03	2.9630E-04	0.0000E+00
555.	AM1	0.0000E+00	9.8741E-01	1.0000E+00	-3.4191E-05	1.0000E-03	0.0000E+00
556.	RL3	0.0000E+00	9.9853E-01	1.0000E+00	-4.0282E-06	1.0369E-02	0.0000E+00
557.	RR8	0.0000E+00	9.9963E-01	1.0000E+00	-1.0036E-06	4.6243E-03	0.0000E+00
558.	B2U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
559.	RR9	0.0000E+00	9.9948E-01	1.0000E+00	-1.4181E-06	4.6243E-03	0.0000E+00
560.	B31	0.0000E+00	1.7390E-02	1.0004E+00	-2.6669E-03	4.1960E-04	0.0000E+00
561.	RT3	0.0000E+00	9.9984E-01	1.0000E+00	-4.3828E-07	6.1145E-04	0.0000E+00
562.	B1U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
563.	RRB	0.0000E+00	8.2822E-01	1.0001E+00	-4.6624E-04	4.2417E-04	0.0000E+00
564.	B2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
565.	BE9	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.6980E-06	0.0000E+00
566.	OF2	0.0000E+00	9.9981E-01	1.0000E+00	-5.8332E-07	1.0000E-01	0.0000E+00
567.	BE21	0.0000E+00	9.9984E-01	1.0000E+00	-4.3812E-07	2.2870E-04	0.0000E+00
568.	OG1	0.0000E+00	2.0151E-02	1.0005E+00	-2.6595E-03	4.6313E-04	0.0000E+00
569.	BE43	0.0000E+00	9.9396E-01	1.0000E+00	-1.6445E-05	3.3620E-03	0.0000E+00
570.	BE49	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.9360E-05	0.0000E+00
571.	OSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
572.	OS1	0.0000E+00	9.9991E-01	1.0000E+00	-2.6054E-07	1.0000E-01	0.0000E+00
573.	BE17	0.0000E+00	9.9698E-01	1.0000E+00	-8.1991E-06	1.8220E-04	0.0000E+00
574.	BE13	0.0000E+00	9.9995E-01	1.0000E+00	-1.4202E-07	5.3200E-05	0.0000E+00
575.	BC8	0.0000E+00	9.9858E-01	1.0000E+00	-3.8781E-06	6.2180E-03	0.0000E+00
576.	BE85	0.0000E+00	9.9990E-01	1.0000E+00	-2.7457E-07	6.7810E-03	0.0000E+00
577.	MELTSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
578.	BE65	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.9360E-05	0.0000E+00
579.	BE86	0.0000E+00	9.9849E-01	1.0000E+00	-4.0987E-06	3.4290E-03	0.0000E+00
580.	MSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
581.	BE5	0.0000E+00	9.9674E-01	1.0000E+00	-8.8335E-06	2.2870E-04	0.0000E+00
582.	BE53	0.0000E+00	9.9965E-01	1.0000E+00	-9.3953E-07	8.0490E-05	0.0000E+00
583.	MS1	0.0000E+00	6.6346E-01	1.0001E+00	-9.1322E-04	2.1398E-04	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
584.	PR3	0.0000E+00	9.9984E-01	1.0000E+00	-4.4182E-07	8.6088E-03	0.0000E+00
585.	PD3	0.0000E+00	9.9790E-01	1.0000E+00	-5.6929E-06	1.1743E-03	0.0000E+00
586.	PD2	0.0000E+00	9.9800E-01	1.0000E+00	-5.4342E-06	1.8824E-03	0.0000E+00
587.	BC23	0.0000E+00	9.9892E-01	1.0000E+00	-2.9428E-06	7.5100E-03	0.0000E+00
588.	PB9	0.0000E+00	8.9602E-01	1.0003E+00	-2.8300E-04	3.2130E-03	0.0000E+00
589.	PB7	0.0000E+00	9.5814E-01	1.0002E+00	-1.1402E-04	4.0570E-03	0.0000E+00
590.	PI2	0.0000E+00	9.9949E-01	1.0000E+00	-1.3908E-06	1.3804E-02	0.0000E+00
591.	PE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.0078E-06	0.0000E+00
592.	PE2	0.0000E+00	9.4433E-01	1.0000E+00	-1.5104E-04	1.1448E-04	0.0000E+00
593.	BC34	0.0000E+00	9.9568E-01	1.0000E+00	-1.1807E-05	6.3260E-03	0.0000E+00
594.	BC3	0.0000E+00	9.9389E-01	1.0000E+00	-1.6671E-05	6.1870E-03	0.0000E+00
595.	PA3	0.0000E+00	9.9517E-01	1.0000E+00	-1.3154E-05	4.0566E-03	0.0000E+00
596.	PB12	0.0000E+00	9.9932E-01	1.0000E+00	-1.8417E-06	4.0570E-03	0.0000E+00
597.	OTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
598.	PB6	0.0000E+00	9.9667E-01	1.0000E+00	-9.0546E-06	3.2130E-03	0.0000E+00
599.	PB5	0.0000E+00	9.9585E-01	1.0000E+00	-1.1302E-05	3.2130E-03	0.0000E+00
600.	PB2	0.0000E+00	9.9851E-01	1.0000E+00	-4.0626E-06	3.2130E-03	0.0000E+00
601.	PB4	0.0000E+00	9.9988E-01	1.0000E+00	-3.2716E-07	3.4550E-02	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Achievement Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
1.	RT1	2.4049E-02	1.5346E+02	9.7607E-01	4.1369E-01	1.5696E-04	6.5245E-05
2.	AE1	1.0353E-02	5.5206E+01	9.8974E-01	1.4709E-01	1.8919E-04	2.8086E-05
3.	B11	2.4192E-02	3.2950E+01	9.7649E-01	8.6742E-02	7.3542E-04	6.5631E-05
4.	AC1	8.0914E-03	3.1175E+01	9.9208E-01	8.1885E-02	2.6250E-04	2.1952E-05
5.	DE1	3.9082E-03	2.2272E+01	9.9626E-01	5.7719E-02	1.7602E-04	1.0603E-05
6.	BE1	3.7862E-03	2.1338E+01	9.9629E-01	5.5187E-02	1.8220E-04	1.0272E-05
7.	RT4	3.5674E-03	8.8450E+00	9.9644E-01	2.1293E-02	4.5407E-04	9.6782E-06
8.	PR1	2.8640E-02	6.8829E+00	9.7145E-01	1.6037E-02	4.8296E-03	7.7699E-05
9.	ZA1	3.4519E-02	4.5575E+00	9.6897E-01	9.7355E-03	8.6459E-03	9.3647E-05
10.	A11	2.9771E-03	4.0592E+00	9.9775E-01	8.3056E-03	7.3542E-04	8.0768E-06
11.	RR1	3.3826E-01	4.0131E+00	6.6174E-01	9.0922E-03	1.0093E-01	9.1767E-04
12.	B21	2.0118E-03	3.5138E+00	9.9854E-01	6.8238E-03	5.8153E-04	5.4579E-06
13.	DA1	3.3513E-03	3.3275E+00	9.9764E-01	6.3208E-03	1.0120E-03	9.0920E-06
14.	ZB6	1.1708E-01	2.8869E+00	8.8312E-01	5.4361E-03	5.8330E-02	3.1763E-04
15.	SED	2.1396E-01	2.8668E+00	7.8615E-01	5.6447E-03	1.0278E-01	5.8046E-04
16.	DB1	2.7560E-03	2.7807E+00	9.9820E-01	4.8360E-03	1.0120E-03	7.4769E-06
17.	SU2	6.5947E-04	2.5643E+00	9.9953E-01	4.2451E-03	2.9848E-04	1.7891E-06
18.	BC33	6.4302E-03	2.5432E+00	9.9425E-01	4.2024E-03	3.7150E-03	1.7445E-05
19.	RL1	2.2365E-02	2.3585E+00	9.8620E-01	3.7228E-03	1.0053E-02	6.0674E-05
20.	RT2	2.0599E-04	2.2383E+00	9.9980E-01	3.3600E-03	1.6534E-04	5.5884E-07
21.	AA2	8.0822E-04	2.1836E+00	9.9920E-01	3.2132E-03	6.7570E-04	2.1927E-06
22.	MU3	1.2327E-01	2.0146E+00	8.7695E-01	3.0865E-03	1.0816E-01	3.3443E-04
23.	CE2	1.4623E-03	2.0029E+00	9.9860E-01	2.7245E-03	1.3930E-03	3.9672E-06
24.	RR5	1.1148E-01	1.9096E+00	8.8852E-01	2.7700E-03	1.0918E-01	3.0243E-04
25.	CE1	2.4589E-03	1.8365E+00	9.9883E-01	2.2726E-03	1.3908E-03	6.6708E-06
26.	DS8	9.1348E-02	1.8206E+00	9.0882E-01	2.4737E-03	1.0000E-01	2.4782E-04
27.	DAAC1	1.1511E-03	1.7906E+00	9.9945E-01	2.1464E-03	6.9340E-04	3.1230E-06
28.	SEH	8.4029E-02	1.7333E+00	9.1600E-01	2.2172E-03	1.0278E-01	2.2796E-04
29.	OS3	8.7408E-02	1.7220E+00	9.1978E-01	2.1764E-03	1.0000E-01	2.3713E-04
30.	CCPR1	1.0237E-01	1.7052E+00	9.2165E-01	2.1256E-03	1.0000E-01	2.7772E-04
31.	RT8	8.3675E-02	1.7025E+00	9.2181E-01	2.1179E-03	1.0016E-01	2.2701E-04
32.	PI1	1.6691E-03	1.6224E+00	9.9837E-01	1.6928E-03	2.6076E-03	4.5283E-06
33.	VINV11	2.9985E-04	1.6217E+00	9.9988E-01	1.6871E-03	1.9240E-04	8.1347E-07
34.	DE2	1.0258E-04	1.5784E+00	9.9990E-01	1.5695E-03	1.7602E-04	2.7829E-07
35.	V33	1.4536E-04	1.5283E+00	9.9987E-01	1.4337E-03	2.5274E-04	3.9436E-07
36.	VT1B1	4.5460E-04	1.5041E+00	9.9984E-01	1.3679E-03	3.1890E-04	1.2333E-06
37.	RB5	1.3488E-02	1.4455E+00	9.8947E-01	1.2373E-03	2.3080E-02	3.6592E-05
38.	S22	6.4805E-03	1.3919E+00	9.9516E-01	1.0763E-03	1.2210E-02	1.7581E-05
39.	AC2	4.1012E-02	1.3528E+00	9.5966E-01	1.0666E-03	1.0260E-01	1.1126E-04
40.	MDE1	1.6091E-03	1.3244E+00	9.9961E-01	8.8101E-04	1.2150E-03	4.3654E-06
41.	OF1	3.1865E-02	1.2866E+00	9.6816E-01	8.6383E-04	1.0000E-01	8.6449E-05
42.	PD1	1.1229E-03	1.2846E+00	9.9973E-01	7.7294E-04	9.5564E-04	3.0462E-06
43.	AE5	1.9351E-03	1.2766E+00	9.9811E-01	7.5563E-04	6.7815E-03	5.2499E-06
44.	BE2	9.9166E-03	1.2559E+00	9.9009E-01	7.2118E-04	3.7270E-02	2.6903E-05
45.	PR2	7.5656E-04	1.2326E+00	9.9926E-01	6.3298E-04	3.1810E-03	2.0525E-06
46.	CCSR3	2.5858E-02	1.2301E+00	9.7443E-01	6.9372E-04	1.0000E-01	7.0151E-05
47.	MF1	6.3534E-03	1.2293E+00	9.9443E-01	6.3718E-04	2.3713E-02	1.7236E-05
48.	AC8	1.9786E-04	1.2197E+00	9.9980E-01	5.9644E-04	8.9420E-04	5.3679E-07
49.	B2U21	6.8743E-04	1.1865E+00	9.9989E-01	5.0639E-04	5.8153E-04	1.8649E-06
50.	BE90	1.3792E-04	1.1705E+00	9.9986E-01	4.6299E-04	7.9950E-04	3.7418E-07
51.	BA3	1.0374E-04	1.1681E+00	9.9990E-01	4.5637E-04	6.0140E-04	2.8143E-07
52.	MA4	1.4641E-03	1.1647E+00	9.9877E-01	4.5023E-04	7.4210E-03	3.9721E-06
53.	EB3	2.4978E-02	1.1581E+00	9.8122E-01	4.7983E-04	1.0619E-01	6.7763E-05

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Achievement Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
54.	BE3	2.0855E-02	1.1467E+00	9.8168E-01	4.4765E-04	1.1100E-01	5.6579E-05
55.	VINV12	1.0285E-04	1.1451E+00	9.9990E-01	3.9398E-04	6.7640E-04	2.7903E-07
56.	MB4	9.9957E-04	1.1337E+00	9.9900E-01	3.6542E-04	7.4210E-03	2.7118E-06
57.	DS4	1.7515E-02	1.1324E+00	9.8439E-01	4.0156E-04	1.0546E-01	4.7518E-05
58.	VA1	7.3629E-03	1.1319E+00	9.9899E-01	3.6052E-04	7.5650E-03	1.9975E-05
59.	RD1	1.4126E-02	1.1203E+00	9.8587E-01	3.6473E-04	1.0507E-01	3.8322E-05
60.	VS1	3.7479E-04	1.0988E+00	9.9993E-01	2.6816E-04	6.9239E-04	1.0168E-06
61.	EB1	1.3489E-02	1.0961E+00	9.8859E-01	2.9158E-04	1.0618E-01	3.6594E-05
62.	PRA	6.8714E-04	1.0915E+00	9.9931E-01	2.5005E-04	7.4482E-03	1.8642E-06
63.	VNV1R1	1.4526E-02	1.0885E+00	9.9017E-01	2.6679E-04	1.0000E-01	3.9407E-05
64.	REC1	3.2315E-03	1.0827E+00	9.9677E-01	2.3316E-04	3.7600E-02	8.7668E-06
65.	SL1	3.1177E-02	1.0825E+00	9.8552E-01	2.6307E-04	1.4934E-01	8.4580E-05
66.	V12	3.2615E-04	1.0820E+00	9.9968E-01	2.2344E-04	3.8430E-03	8.8483E-07
67.	RR4	8.9594E-03	1.0731E+00	9.9104E-01	2.2263E-04	1.0918E-01	2.4306E-05
68.	RL4	1.8308E-02	1.0719E+00	9.9201E-01	2.1688E-04	1.0000E-01	4.9668E-05
69.	BE41	4.6599E-04	1.0695E+00	9.9953E-01	1.8979E-04	6.6530E-03	1.2642E-06
70.	BE10	1.0539E-04	1.0637E+00	9.9989E-01	1.7297E-04	1.6480E-03	2.8593E-07
71.	BC22	4.0868E-04	1.0621E+00	9.9975E-01	1.6924E-04	3.9620E-03	1.1087E-06
72.	MA1	4.4409E-04	1.0577E+00	9.9956E-01	1.5783E-04	7.5140E-03	1.2048E-06
73.	BC21	6.1187E-03	1.0562E+00	9.9409E-01	1.6852E-04	9.5160E-02	1.6600E-05
74.	RH1	6.2751E-03	1.0534E+00	9.9374E-01	1.6189E-04	1.0486E-01	1.7024E-05
75.	OGR11	1.7390E-02	1.0480E+00	9.8355E-01	1.7496E-04	2.5500E-01	4.7179E-05
76.	VB2	4.7255E-04	1.0476E+00	9.9964E-01	1.3007E-04	7.5650E-03	1.2820E-06
77.	GB1	7.2477E-03	1.0449E+00	9.9312E-01	1.4038E-04	1.3290E-01	1.9663E-05
78.	BE33	3.2020E-04	1.0407E+00	9.9972E-01	1.1115E-04	6.7800E-03	8.6869E-07
79.	GA1	7.5953E-03	1.0383E+00	9.9395E-01	1.2031E-04	1.3650E-01	2.0606E-05
80.	REC2	1.4196E-03	1.0363E+00	9.9858E-01	1.0243E-04	3.7600E-02	3.8513E-06
81.	LCL1	1.5313E-04	1.0323E+00	9.9987E-01	8.8021E-05	3.8880E-03	4.1543E-07
82.	BC2	1.3899E-04	1.0318E+00	9.9988E-01	8.6584E-05	3.6870E-03	3.7707E-07
83.	REC4	1.1425E-03	1.0292E+00	9.9886E-01	8.2431E-05	3.7600E-02	3.0994E-06
84.	RVB1	7.7202E-03	1.0253E+00	9.9978E-01	6.9234E-05	8.6670E-03	2.0944E-05
85.	V37	1.3388E-03	1.0252E+00	9.9895E-01	7.1291E-05	4.0089E-02	3.6320E-06
86.	REC3	2.4983E-03	1.0252E+00	9.9750E-01	7.5042E-05	9.0320E-02	6.7778E-06
87.	MB1	1.9022E-04	1.0251E+00	9.9981E-01	6.8679E-05	7.5140E-03	5.1606E-07
88.	GB2	4.8446E-03	1.0229E+00	9.9567E-01	7.3815E-05	1.5920E-01	1.3143E-05
89.	MU4	2.0637E-01	1.0229E+00	9.7216E-01	1.3754E-04	5.4906E-01	5.5987E-04
90.	RB6	2.3899E-03	1.0209E+00	9.9830E-01	6.1412E-05	7.4960E-02	6.4836E-06
91.	FB1	1.2867E-04	1.0200E+00	9.9993E-01	5.4393E-05	3.4470E-03	3.4909E-07
92.	BE34	1.2695E-04	1.0164E+00	9.9989E-01	4.4846E-05	6.9180E-03	3.4442E-07
93.	PR4	4.8970E-04	1.0144E+00	9.9963E-01	4.0106E-05	2.5234E-02	1.3285E-06
94.	MU2	1.3605E-01	1.0139E+00	9.8905E-01	6.7351E-05	4.4090E-01	3.6909E-04
95.	DS2	1.5866E-03	1.0135E+00	9.9841E-01	4.0816E-05	1.0546E-01	4.3045E-06
96.	RD2	1.4992E-03	1.0122E+00	9.9850E-01	3.7255E-05	1.0917E-01	4.0672E-06
97.	V13	1.7008E-04	1.0119E+00	9.9996E-01	3.2308E-05	3.0920E-03	4.6141E-07
98.	EE2	8.1753E-05	1.0119E+00	9.9998E-01	3.2271E-05	1.3908E-03	2.2179E-07
99.	SR1	7.2251E-04	1.0110E+00	9.9960E-01	3.0935E-05	3.4944E-02	1.9601E-06
100.	RR7	1.4886E-03	1.0107E+00	9.9851E-01	3.3167E-05	1.2176E-01	4.0384E-06
101.	MU6	9.6704E-02	1.0101E+00	9.8772E-01	6.0656E-05	5.4931E-01	2.6235E-04
102.	VNV2R1	1.4694E-03	1.0096E+00	9.9894E-01	2.8808E-05	1.0000E-01	3.9864E-06
103.	V1R1	9.7331E-04	1.0088E+00	9.9903E-01	2.6405E-05	1.0000E-01	2.6405E-06
104.	PL1	7.9165E-02	1.0080E+00	9.8428E-01	6.4410E-05	6.6200E-01	2.1477E-04
105.	MB12	6.4388E-04	1.0080E+00	9.9936E-01	2.3403E-05	7.4640E-02	1.7468E-06
106.	TB2	5.3972E-04	1.0065E+00	9.9963E-01	1.8760E-05	5.3944E-02	1.4642E-06

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Achievement Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
107.	BA4	7.6102E-04	1.0061E+00	9.9924E-01	1.8540E-05	1.1050E-01	2.0646E-06
108.	WC1	7.7152E-04	1.0058E+00	9.9936E-01	1.7462E-05	1.0000E-01	2.0931E-06
109.	RR6	6.6971E-04	1.0050E+00	9.9933E-01	1.5426E-05	1.1778E-01	1.8169E-06
110.	AC3	1.3463E-03	1.0042E+00	9.9951E-01	1.2660E-05	1.0520E-01	3.6524E-06
111.	GD3	1.4666E-03	1.0037E+00	9.9929E-01	1.1916E-05	1.6140E-01	3.9787E-06
112.	MB8	2.5755E-04	1.0032E+00	9.9974E-01	9.4524E-06	7.3920E-02	6.9872E-07
113.	TPR1	3.3686E-02	1.0028E+00	9.8503E-01	4.8115E-05	8.4400E-01	9.1388E-05
114.	GD2	1.7315E-03	1.0025E+00	9.9955E-01	7.9569E-06	1.5470E-01	4.6975E-06
115.	GD1	5.9806E-04	1.0025E+00	9.9965E-01	7.6262E-06	1.2560E-01	1.6225E-06
116.	REC5	1.6090E-04	1.0023E+00	9.9984E-01	6.7444E-06	6.4720E-02	4.3650E-07
117.	EB7	5.6559E-04	1.0022E+00	9.9976E-01	6.6186E-06	1.0000E-01	1.5344E-06
118.	TP3	1.0857E-03	1.0021E+00	9.9983E-01	6.2470E-06	7.2270E-02	2.9455E-06
119.	RB3	1.1940E-04	1.0016E+00	9.9990E-01	4.5059E-06	6.0470E-02	3.2394E-07
120.	SR4	1.8406E-03	1.0016E+00	9.9836E-01	8.9196E-06	4.9980E-01	4.9934E-06
121.	BC28	1.9786E-04	1.0014E+00	9.9980E-01	4.2068E-06	1.2760E-01	5.3679E-07
122.	RH2	1.8456E-04	1.0014E+00	9.9982E-01	4.4219E-06	1.1323E-01	5.0069E-07
123.	ZB10	1.9351E-04	1.0013E+00	9.9992E-01	3.7676E-06	5.5980E-02	5.2499E-07
124.	OB1	7.4750E-04	1.0013E+00	9.9983E-01	3.9884E-06	1.1765E-01	2.0279E-06
125.	RVB3	4.5238E-04	1.0011E+00	9.9994E-01	3.0746E-06	5.4830E-02	1.2273E-06
126.	RR3	1.0663E-04	1.0009E+00	9.9989E-01	2.6496E-06	1.0918E-01	2.8928E-07
127.	MU5	1.1410E-04	1.0006E+00	9.9993E-01	1.7005E-06	1.0841E-01	3.0954E-07
128.	OS2	4.6005E-04	1.0005E+00	9.9994E-01	1.5108E-06	1.0000E-01	1.2481E-06
129.	GB3	4.1433E-05	1.0003E+00	9.9996E-01	8.2349E-07	1.3650E-01	1.1241E-07
130.	RT9	6.2197E-05	1.0002E+00	9.9998E-01	6.7448E-07	1.0016E-01	1.6874E-07
131.	DS9	8.7558E-05	1.0002E+00	9.9998E-01	6.3759E-07	1.0000E-01	2.3754E-07
132.	AE2	3.0177E-04	1.0002E+00	9.9998E-01	4.8826E-07	1.1120E-01	8.1870E-07
133.	CH5	1.6832E-02	1.0002E+00	9.9997E-01	5.6389E-07	1.2296E-01	4.5663E-05
134.	B2U2F	4.4500E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2073E-05
135.	A2U2LF	3.1453E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.5330E-06
136.	B1U2F	4.4500E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2073E-05
137.	A1U2LF	3.2213E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.7392E-06
138.	ABLF	3.1453E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.5330E-06
139.	DCACF	3.7402E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0147E-05
140.	BBF	3.9570E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0735E-05
141.	VT2BF	4.5260E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2279E-05
142.	BBLF	4.6420E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2593E-05
143.	DSLRF	3.3797E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.1688E-07
144.	BB14	3.4731E-04	1.0000E+00	9.9998E-01	6.8624E-08	8.1440E-01	9.4223E-07
145.	LYAF	1.9404E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.2642E-07
146.	GBF	1.2867E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4909E-07
147.	VSF	3.9997E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0851E-06
148.	LYNF	3.5114E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.5262E-07
149.	MU1	6.4906E-04	1.0000E+00	1.0000E+00	1.0492E-08	4.4090E-01	1.7609E-06
150.	SYBF	3.9676E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0764E-07
151.	GAF	4.1433E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1241E-07
152.	RLF	1.2296E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.3359E-07
153.	RHF	1.1940E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2394E-07
154.	BE4	1.0058E-04	1.0000E+00	9.9990E-01	2.8176E-07	9.6850E-01	2.7288E-07
155.	DDACF	2.8523E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.7381E-06
156.	A1U2F	2.6952E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3120E-06
157.	A2U2F	2.6952E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3120E-06
158.	SLF	2.5563E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.9350E-06
159.	VT2AF	2.7712E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.5182E-06

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Achievement Worth

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
160.	DHF	2.7712E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.5182E-06
161.	SRF	8.8017E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3879E-06
162.	DBF	1.0748E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9160E-06
163.	SYAF	1.2681E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4403E-06
164.	ABF	2.2735E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.1678E-06
165.	IYBF	1.9962E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4155E-06
166.	DAF	1.9186E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.2050E-06
167.	MELTF	1.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7129E-03
168.	TPF	6.9664E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8899E-04
169.	SYCF	7.2321E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9620E-04
170.	TPRF	6.9664E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8899E-04
171.	VT1BF	7.8529E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1304E-04
172.	B1LF	8.0020E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1709E-04
173.	FEF	6.2795E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7036E-04
174.	SGCLGF	6.7500E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8312E-04
175.	DEF	6.4208E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7419E-04
176.	MUF	5.9304E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6089E-04
177.	PRF	1.1231E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0468E-04
178.	DAACF	1.1164E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0288E-04
179.	ZAF	1.1279E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0600E-04
180.	MELTSF	8.0045E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1716E-04
181.	CIF	8.5903E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3305E-04
182.	MAF	1.0597E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.8748E-04
183.	BCF	1.0282E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7893E-04
184.	BYAF	1.1508E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.1220E-04
185.	DBACF	2.9141E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.9057E-05
186.	ZBF	2.9699E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.0573E-05
187.	MFF	2.8873E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.8331E-05
188.	PDF	3.4742E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.4254E-05
189.	CCSRF	4.0040E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0863E-04
190.	PBF	2.3472E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.3679E-05
191.	BEF	2.6980E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3195E-05
192.	CCPRF	2.5429E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.8986E-05
193.	B2LF	5.9050E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6020E-04
194.	VINV1F	5.6349E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5287E-04
195.	BALF	5.5374E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5023E-04
196.	RVAF	5.7085E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5487E-04
197.	OTF	4.4624E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2106E-04
198.	BAF	5.3391E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4485E-04
199.	B1F	5.4337E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4741E-04
200.	B2F	5.4337E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4741E-04
201.	V3F	2.2147E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.0083E-05
202.	CSAF	5.6327E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5281E-03
203.	MSF	6.3920E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7341E-03
204.	CSRF	4.8713E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3216E-03
205.	TBF	6.4391E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7469E-03
206.	RQF	6.4514E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7502E-03
207.	CSBF	4.3141E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1704E-03
208.	RAF	4.3933E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1919E-03
209.	S1F	4.3933E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1919E-03
210.	CSIF	4.2974E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1659E-03
211.	INTPRF	9.1292E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.4767E-03
212.	DPF	8.7196E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3656E-03

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
213.	RECF	9.9155E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.6900E-03
214.	DSNN	7.6116E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0650E-03
215.	IYAF	7.8348E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1255E-03
216.	RHRSF	8.6007E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3333E-03
217.	MELTIF	7.8548E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1310E-03
218.	RVBF	1.2108E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2849E-04
219.	ARF	1.5210E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.1264E-04
220.	VCF	2.1853E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.9287E-04
221.	VAF	1.4987E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0659E-04
222.	ACF	2.9333E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.9578E-04
223.	VBF	3.0497E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2736E-04
224.	MELTBF	1.2675E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4388E-04
225.	RDF	1.4241E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8634E-04
226.	MBF	1.4227E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8597E-04
227.	CHF	4.2942E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1650E-03
228.	SEF	3.4518E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.3646E-04
229.	CAVF	3.4466E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.3505E-04
230.	RRF	3.6453E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.8894E-04
231.	RBF	3.0537E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2844E-04
232.	S2F	3.0537E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2844E-04
233.	CMF	3.3106E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.9814E-04
234.	SIF	3.0711E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.3318E-04
235.	B1U2LF	4.7180E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2800E-05
236.	UB1BF	1.8721E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0788E-05
237.	LOWPRF	1.8657E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0615E-05
238.	MELTLF	7.7236E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0954E-05
239.	AEF	9.0551E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.4566E-05
240.	B3F	1.7390E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7179E-05
241.	AAF	1.0191E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7646E-05
242.	V1F	5.6884E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5432E-05
243.	UB1DF	1.8721E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0788E-05
244.	HHF	7.7153E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0931E-05
245.	LYCF	7.1784E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9475E-05
246.	SYNF	6.4166E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7408E-05
247.	V1RF	5.6884E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5432E-05
248.	DGF	1.3976E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.7916E-05
249.	VT1AF	1.3976E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.7916E-05
250.	AALF	1.1960E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2448E-05
251.	RSF	1.3304E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.6094E-05
252.	A2LF	1.2158E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2985E-05
253.	A3F	1.7390E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7179E-05
254.	A1F	1.0999E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9839E-05
255.	FWF	1.6127E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.3752E-05
256.	A1LF	1.4937E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0524E-05
257.	BYBF	1.1677E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.1679E-05
258.	A2F	1.0999E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9839E-05
259.	OBF	1.2340E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.3476E-05
260.	CTMUF	2.0151E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4668E-05
261.	CEF	2.1645E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8721E-05
262.	VINV2F	5.1374E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3938E-05
263.	OGF	2.0151E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4668E-05
264.	PAF	2.1717E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8917E-05
265.	EEF	2.1645E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8721E-05

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Achievement Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
266.	B2U2LF	5.3294E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4458E-05
267.	CDF	1.8795E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0990E-05
268.	PEF	1.9059E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1705E-05
269.	UB1CF	1.8830E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1085E-05
270.	UB1AF	1.8830E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1085E-05
271.	AB6	4.2176E-04	9.9998E-01	1.0000E+00	-1.0416E-07	5.6660E-01	1.1442E-06
272.	FB2	0.0000E+00	9.9996E-01	1.0000E+00	-1.1561E-07	2.7700E-02	0.0000E+00
273.	TP5	0.0000E+00	9.9996E-01	1.0000E+00	-1.2164E-07	8.0120E-02	0.0000E+00
274.	MA11	0.0000E+00	9.9996E-01	1.0000E+00	-1.2471E-07	1.0280E-01	0.0000E+00
275.	ZB7	0.0000E+00	9.9996E-01	1.0000E+00	-1.2470E-07	5.9770E-02	0.0000E+00
276.	MB27	1.5745E-04	9.9995E-01	1.0000E+00	-1.4204E-07	1.1160E-01	4.2716E-07
277.	BE13	0.0000E+00	9.9995E-01	1.0000E+00	-1.4202E-07	5.3200E-05	0.0000E+00
278.	MA7	1.5744E-04	9.9994E-01	1.0000E+00	-1.8750E-07	1.0140E-01	4.2714E-07
279.	DS5	0.0000E+00	9.9994E-01	1.0000E+00	-1.7101E-07	1.0546E-01	0.0000E+00
280.	GC6	0.0000E+00	9.9992E-01	1.0000E+00	-2.6038E-07	1.3650E-01	0.0000E+00
281.	GD8	0.0000E+00	9.9992E-01	1.0000E+00	-2.5929E-07	1.3290E-01	0.0000E+00
282.	GD5	0.0000E+00	9.9991E-01	1.0000E+00	-2.7183E-07	1.2940E-01	0.0000E+00
283.	BB7	6.1254E-05	9.9991E-01	1.0000E+00	-3.1078E-07	2.4260E-01	1.6618E-07
284.	VB5	0.0000E+00	9.9991E-01	1.0000E+00	-2.3308E-07	9.1160E-03	0.0000E+00
285.	OS1	0.0000E+00	9.9991E-01	1.0000E+00	-2.6054E-07	1.0000E-01	0.0000E+00
286.	GC4	0.0000E+00	9.9991E-01	1.0000E+00	-2.7293E-07	1.3290E-01	0.0000E+00
287.	BE85	0.0000E+00	9.9990E-01	1.0000E+00	-2.7457E-07	6.7810E-03	0.0000E+00
288.	PB4	0.0000E+00	9.9988E-01	1.0000E+00	-3.2716E-07	3.4550E-02	0.0000E+00
289.	RF3	0.0000E+00	9.9985E-01	1.0000E+00	-4.1574E-07	7.3460E-04	0.0000E+00
290.	BB6	0.0000E+00	9.9985E-01	1.0000E+00	-4.2794E-07	4.3110E-02	0.0000E+00
291.	AB4	0.0000E+00	9.9985E-01	1.0000E+00	-4.3279E-07	5.3850E-02	0.0000E+00
292.	GD4	1.6090E-04	9.9984E-01	1.0001E+00	-5.8969E-07	2.5240E-01	4.3650E-07
293.	DDAC2	0.0000E+00	9.9984E-01	1.0000E+00	-4.4178E-07	6.9983E-04	0.0000E+00
294.	PR3	0.0000E+00	9.9984E-01	1.0000E+00	-4.4182E-07	8.6088E-03	0.0000E+00
295.	RT3	0.0000E+00	9.9984E-01	1.0000E+00	-4.3828E-07	6.1145E-04	0.0000E+00
296.	BE21	0.0000E+00	9.9984E-01	1.0000E+00	-4.3812E-07	2.2870E-04	0.0000E+00
297.	MB28	0.0000E+00	9.9984E-01	1.0000E+00	-4.3191E-07	1.1050E-02	0.0000E+00
298.	RI5	0.0000E+00	9.9983E-01	1.0000E+00	-4.6326E-07	3.2260E-04	0.0000E+00
299.	RI3	0.0000E+00	9.9983E-01	1.0000E+00	-4.5009E-07	3.2260E-04	0.0000E+00
300.	FC2	0.0000E+00	9.9983E-01	1.0000E+00	-4.6309E-07	3.4460E-03	0.0000E+00
301.	FD2	0.0000E+00	9.9983E-01	1.0000E+00	-4.6309E-07	3.4460E-03	0.0000E+00
302.	V211	0.0000E+00	9.9983E-01	1.0000E+00	-4.6146E-07	1.1240E-04	0.0000E+00
303.	ZB4	0.0000E+00	9.9982E-01	1.0000E+00	-4.8771E-07	8.2130E-03	0.0000E+00
304.	ZA4	0.0000E+00	9.9982E-01	1.0000E+00	-4.8792E-07	8.6464E-03	0.0000E+00
305.	AFA5	0.0000E+00	9.9982E-01	1.0000E+00	-5.2905E-07	5.8710E-02	0.0000E+00
306.	OF2	0.0000E+00	9.9981E-01	1.0000E+00	-5.8332E-07	1.0000E-01	0.0000E+00
307.	RVB2	3.8287E-05	9.9978E-01	1.0000E+00	-6.1591E-07	9.0860E-03	1.0387E-07
308.	PB3	1.2216E-04	9.9974E-01	1.0000E+00	-7.1034E-07	2.0640E-02	3.3140E-07
309.	AE4	0.0000E+00	9.9967E-01	1.0000E+00	-8.8631E-07	1.6184E-03	0.0000E+00
310.	V210	0.0000E+00	9.9967E-01	1.0000E+00	-8.8492E-07	9.4420E-05	0.0000E+00
311.	GC3	7.9996E-04	9.9966E-01	1.0001E+00	-1.1225E-06	1.7760E-01	2.1703E-06
312.	SEI	0.0000E+00	9.9965E-01	1.0000E+00	-9.4974E-07	2.3345E-03	0.0000E+00
313.	RT6	0.0000E+00	9.9965E-01	1.0000E+00	-9.6375E-07	7.4597E-04	0.0000E+00
314.	BE53	0.0000E+00	9.9965E-01	1.0000E+00	-9.3953E-07	8.0490E-05	0.0000E+00
315.	RR8	0.0000E+00	9.9963E-01	1.0000E+00	-1.0036E-06	4.6243E-03	0.0000E+00
316.	V22	0.0000E+00	9.9952E-01	1.0000E+00	-1.3344E-06	3.0030E-02	0.0000E+00
317.	DCAC2	0.0000E+00	9.9951E-01	1.0000E+00	-1.3383E-06	6.9983E-04	0.0000E+00
318.	PI2	0.0000E+00	9.9949E-01	1.0000E+00	-1.3908E-06	1.3804E-02	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
319.	RR9	0.0000E+00	9.9948E-01	1.0000E+00	-1.4181E-06	4.6243E-03	0.0000E+00
320.	AFA3	0.0000E+00	9.9945E-01	1.0000E+00	-1.5430E-06	3.0710E-02	0.0000E+00
321.	UB1B2	0.0000E+00	9.9941E-01	1.0001E+00	-1.7884E-06	1.0760E-01	0.0000E+00
322.	BB10	0.0000E+00	9.9936E-01	1.0000E+00	-1.7349E-06	6.7570E-04	0.0000E+00
323.	PB12	0.0000E+00	9.9932E-01	1.0000E+00	-1.8417E-06	4.0570E-03	0.0000E+00
324.	V221	0.0000E+00	9.9929E-01	1.0000E+00	-1.9420E-06	3.8420E-03	0.0000E+00
325.	V27	0.0000E+00	9.9923E-01	1.0000E+00	-2.1004E-06	3.0910E-03	0.0000E+00
326.	VA2	0.0000E+00	9.9911E-01	1.0000E+00	-2.4497E-06	9.1160E-03	0.0000E+00
327.	MB7	0.0000E+00	9.9908E-01	1.0000E+00	-2.5020E-06	7.0110E-03	0.0000E+00
328.	BC23	0.0000E+00	9.9892E-01	1.0000E+00	-2.9428E-06	7.5100E-03	0.0000E+00
329.	V34	0.0000E+00	9.9885E-01	1.0000E+00	-3.1621E-06	1.5295E-02	0.0000E+00
330.	UB1C2	0.0000E+00	9.9882E-01	1.0001E+00	-3.3476E-06	4.6460E-02	0.0000E+00
331.	GC2	1.3585E-03	9.9877E-01	1.0002E+00	-3.9584E-06	1.5570E-01	3.6855E-06
332.	ZB3	0.0000E+00	9.9876E-01	1.0000E+00	-3.3856E-06	1.0230E-02	0.0000E+00
333.	ZA3	0.0000E+00	9.9876E-01	1.0000E+00	-3.3876E-06	1.0810E-02	0.0000E+00
334.	UB1C4	0.0000E+00	9.9867E-01	1.0000E+00	-3.6186E-06	2.5070E-03	0.0000E+00
335.	BC8	0.0000E+00	9.9858E-01	1.0000E+00	-3.8781E-06	6.2180E-03	0.0000E+00
336.	TB3	0.0000E+00	9.9858E-01	1.0000E+00	-3.8586E-06	1.2166E-03	0.0000E+00
337.	UB1D5	0.0000E+00	9.9856E-01	1.0000E+00	-3.9162E-06	2.5070E-03	0.0000E+00
338.	UB1B3	0.0000E+00	9.9856E-01	1.0000E+00	-3.9174E-06	2.8010E-03	0.0000E+00
339.	RL3	0.0000E+00	9.9853E-01	1.0000E+00	-4.0282E-06	1.0369E-02	0.0000E+00
340.	CH2	7.1261E-05	9.9852E-01	1.0002E+00	-4.5888E-06	1.2296E-01	1.9333E-07
341.	PB2	0.0000E+00	9.9851E-01	1.0000E+00	-4.0626E-06	3.2130E-03	0.0000E+00
342.	BE86	0.0000E+00	9.9849E-01	1.0000E+00	-4.0987E-06	3.4290E-03	0.0000E+00
343.	GC1	1.1500E-04	9.9847E-01	1.0002E+00	-4.7676E-06	1.2940E-01	3.1198E-07
344.	TP2	0.0000E+00	9.9839E-01	1.0001E+00	-4.6776E-06	6.3430E-02	0.0000E+00
345.	RL5	1.3946E-03	9.9838E-01	1.0002E+00	-4.8703E-06	1.0032E-01	3.7833E-06
346.	CI2	0.0000E+00	9.9832E-01	1.0000E+00	-4.6777E-06	2.3533E-02	0.0000E+00
347.	UB1D2	0.0000E+00	9.9824E-01	1.0001E+00	-4.9723E-06	3.7090E-02	0.0000E+00
348.	V226	0.0000E+00	9.9824E-01	1.0000E+00	-4.7797E-06	7.7540E-04	0.0000E+00
349.	S23	1.6585E-04	9.9823E-01	1.0001E+00	-5.1911E-06	7.5510E-02	4.4994E-07
350.	CH3	3.7186E-05	9.9816E-01	1.0003E+00	-5.6975E-06	1.2296E-01	1.0088E-07
351.	TB4	2.9731E-04	9.9809E-01	1.0001E+00	-5.4904E-06	5.6007E-02	8.0658E-07
352.	CP2	0.0000E+00	9.9804E-01	1.0000E+00	-5.3404E-06	1.7895E-03	0.0000E+00
353.	VT2AR1	7.9931E-05	9.9803E-01	1.0002E+00	-5.9442E-06	1.0000E-01	2.1685E-07
354.	AE10	0.0000E+00	9.9801E-01	1.0000E+00	-5.4014E-06	8.0047E-04	0.0000E+00
355.	PD2	0.0000E+00	9.9800E-01	1.0000E+00	-5.4342E-06	1.8824E-03	0.0000E+00
356.	RA1	4.1414E-04	9.9793E-01	1.0000E+00	-5.7331E-06	1.9057E-02	1.1235E-06
357.	PD3	0.0000E+00	9.9790E-01	1.0000E+00	-5.6929E-06	1.1743E-03	0.0000E+00
358.	MB5	0.0000E+00	9.9786E-01	1.0000E+00	-5.8374E-06	7.5630E-03	0.0000E+00
359.	AE9	0.0000E+00	9.9778E-01	1.0000E+00	-6.0223E-06	8.1416E-05	0.0000E+00
360.	CSB2	2.1765E-04	9.9777E-01	1.0002E+00	-6.4715E-06	6.3310E-02	5.9047E-07
361.	MB13	0.0000E+00	9.9765E-01	1.0000E+00	-6.4212E-06	7.0550E-03	0.0000E+00
362.	DCAC3	0.0000E+00	9.9747E-01	1.0000E+00	-6.8735E-06	7.2834E-04	0.0000E+00
363.	VS2	0.0000E+00	9.9730E-01	1.0000E+00	-7.3769E-06	8.8731E-03	0.0000E+00
364.	BA5	0.0000E+00	9.9729E-01	1.0000E+00	-7.3552E-06	6.7570E-04	0.0000E+00
365.	DSLR1	6.5057E-05	9.9723E-01	1.0001E+00	-7.7548E-06	2.9970E-02	1.7650E-07
366.	TT2	0.0000E+00	9.9723E-01	1.0000E+00	-7.5165E-06	7.3004E-05	0.0000E+00
367.	DC2	0.0000E+00	9.9723E-01	1.0000E+00	-7.5226E-06	5.7890E-04	0.0000E+00
368.	VB3	0.0000E+00	9.9720E-01	1.0000E+00	-7.6202E-06	3.5120E-03	0.0000E+00
369.	MB10	0.0000E+00	9.9709E-01	1.0002E+00	-8.5110E-06	7.3870E-02	0.0000E+00
370.	MA5	0.0000E+00	9.9702E-01	1.0000E+00	-8.1384E-06	7.5630E-03	0.0000E+00
371.	BE17	0.0000E+00	9.9698E-01	1.0000E+00	-8.1991E-06	1.8220E-04	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
372.	DDAC3	0.0000E+00	9.9694E-01	1.0000E+00	-8.2983E-06	7.2834E-04	0.0000E+00
373.	V222	0.0000E+00	9.9691E-01	1.0000E+00	-8.4154E-06	3.8460E-03	0.0000E+00
374.	AE3	0.0000E+00	9.9682E-01	1.0000E+00	-8.6376E-06	2.3574E-04	0.0000E+00
375.	PB10	6.7772E-05	9.9677E-01	1.0001E+00	-8.9502E-06	2.0940E-02	1.8386E-07
376.	BE5	0.0000E+00	9.9674E-01	1.0000E+00	-8.8335E-06	2.2870E-04	0.0000E+00
377.	PB6	0.0000E+00	9.9667E-01	1.0000E+00	-9.0546E-06	3.2130E-03	0.0000E+00
378.	VT2BR1	1.0014E-04	9.9648E-01	1.0004E+00	-1.0624E-05	1.0000E-01	2.7169E-07
379.	BB5	0.0000E+00	9.9645E-01	1.0000E+00	-9.6479E-06	5.4520E-04	0.0000E+00
380.	RL2	0.0000E+00	9.9631E-01	1.0000E+00	-1.0119E-05	1.0053E-02	0.0000E+00
381.	AFR1	1.3424E-03	9.9626E-01	1.0004E+00	-1.1267E-05	1.0000E-01	3.6419E-06
382.	DBAC2	0.0000E+00	9.9617E-01	1.0000E+00	-1.0400E-05	6.9983E-04	0.0000E+00
383.	V224	0.0000E+00	9.9607E-01	1.0000E+00	-1.0659E-05	2.4320E-04	0.0000E+00
384.	BB9	0.0000E+00	9.9598E-01	1.0000E+00	-1.0911E-05	6.0140E-04	0.0000E+00
385.	AB9	0.0000E+00	9.9587E-01	1.0000E+00	-1.1205E-05	6.7570E-04	0.0000E+00
386.	PB5	0.0000E+00	9.9585E-01	1.0000E+00	-1.1302E-05	3.2130E-03	0.0000E+00
387.	AB2	0.0000E+00	9.9585E-01	1.0000E+00	-1.1272E-05	5.6940E-04	0.0000E+00
388.	PD5	4.2081E-05	9.9581E-01	1.0001E+00	-1.1723E-05	3.0838E-02	1.1416E-07
389.	CI4	4.0316E-04	9.9577E-01	1.0006E+00	-1.3010E-05	1.1757E-01	1.0937E-06
390.	BC34	0.0000E+00	9.9568E-01	1.0000E+00	-1.1807E-05	6.3260E-03	0.0000E+00
391.	CH6	4.0831E-04	9.9561E-01	1.0006E+00	-1.3570E-05	1.2296E-01	1.1077E-06
392.	DS6	2.6080E-04	9.9541E-01	1.0005E+00	-1.3933E-05	1.0636E-01	7.0753E-07
393.	MB3	0.0000E+00	9.9538E-01	1.0000E+00	-1.2640E-05	7.5200E-03	0.0000E+00
394.	PA3	0.0000E+00	9.9517E-01	1.0000E+00	-1.3154E-05	4.0566E-03	0.0000E+00
395.	PI3	4.5048E-05	9.9502E-01	1.0001E+00	-1.3854E-05	2.5000E-02	1.2221E-07
396.	DAAC2	0.0000E+00	9.9493E-01	1.0000E+00	-1.3767E-05	6.9983E-04	0.0000E+00
397.	DD2	0.0000E+00	9.9486E-01	1.0000E+00	-1.3946E-05	5.7890E-04	0.0000E+00
398.	FA1	4.1433E-05	9.9434E-01	1.0000E+00	-1.5408E-05	3.5320E-03	1.1241E-07
399.	FE2	0.0000E+00	9.9425E-01	1.0000E+00	-1.5628E-05	1.3930E-03	0.0000E+00
400.	BE43	0.0000E+00	9.9396E-01	1.0000E+00	-1.6445E-05	3.3620E-03	0.0000E+00
401.	BC3	0.0000E+00	9.9389E-01	1.0000E+00	-1.6671E-05	6.1870E-03	0.0000E+00
402.	RI4	0.0000E+00	9.9359E-01	1.0000E+00	-1.7387E-05	5.0730E-04	0.0000E+00
403.	BB8	0.0000E+00	9.9293E-01	1.0000E+00	-1.9189E-05	5.6940E-04	0.0000E+00
404.	V36	0.0000E+00	9.9284E-01	1.0000E+00	-1.9440E-05	4.8115E-04	0.0000E+00
405.	RB1	2.9469E-04	9.9276E-01	1.0001E+00	-2.0014E-05	1.8250E-02	7.9948E-07
406.	AE6	0.0000E+00	9.9267E-01	1.0000E+00	-1.9950E-05	3.4298E-03	0.0000E+00
407.	DP7	0.0000E+00	9.9259E-01	1.0001E+00	-2.0294E-05	8.9256E-03	0.0000E+00
408.	AB7	0.0000E+00	9.9131E-01	1.0000E+00	-2.3578E-05	6.0140E-04	0.0000E+00
409.	VT1AR1	4.6684E-04	9.9069E-01	1.0010E+00	-2.8056E-05	1.0000E-01	1.2665E-06
410.	V15	0.0000E+00	9.8972E-01	1.0000E+00	-2.8006E-05	3.8430E-03	0.0000E+00
411.	AFA1	0.0000E+00	9.8896E-01	1.0000E+00	-3.0013E-05	2.3760E-03	0.0000E+00
412.	VT1A2	0.0000E+00	9.8835E-01	1.0000E+00	-3.1614E-05	3.1890E-04	0.0000E+00
413.	SL3	0.0000E+00	9.8827E-01	1.0002E+00	-3.2376E-05	1.6996E-02	0.0000E+00
414.	AM1	0.0000E+00	9.8741E-01	1.0000E+00	-3.4191E-05	1.0000E-03	0.0000E+00
415.	CSB3	2.5642E-03	9.8672E-01	1.0003E+00	-3.6781E-05	2.0840E-02	6.9564E-06
416.	DAAC3	0.0000E+00	9.8624E-01	1.0000E+00	-3.7354E-05	7.2834E-04	0.0000E+00
417.	DA2	0.0000E+00	9.8602E-01	1.0000E+00	-3.7938E-05	5.7890E-04	0.0000E+00
418.	VINV22	0.0000E+00	9.8421E-01	1.0002E+00	-4.3281E-05	1.0530E-02	0.0000E+00
419.	VT2B2	0.0000E+00	9.8421E-01	1.0000E+00	-4.2838E-05	3.1890E-04	0.0000E+00
420.	VF1	0.0000E+00	9.8326E-01	1.0000E+00	-4.5441E-05	6.9392E-04	0.0000E+00
421.	CH1	2.8029E-03	9.8319E-01	1.0019E+00	-5.0770E-05	1.0196E-01	7.6041E-06
422.	FC1	0.0000E+00	9.8278E-01	1.0001E+00	-4.6879E-05	3.4470E-03	0.0000E+00
423.	FD1	0.0000E+00	9.8278E-01	1.0001E+00	-4.6879E-05	3.4470E-03	0.0000E+00
424.	D22	0.0000E+00	9.8261E-01	1.0000E+00	-4.7306E-05	2.6886E-03	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
425.	D12	0.0000E+00	9.8261E-01	1.0000E+00	-4.7312E-05	2.8153E-03	0.0000E+00
426.	ZB2	4.3216E-05	9.8123E-01	1.0002E+00	-5.1369E-05	8.6600E-03	1.1724E-07
427.	ZA2	4.3218E-05	9.8093E-01	1.0002E+00	-5.2210E-05	9.1268E-03	1.1725E-07
428.	CP3	7.5296E-03	9.7921E-01	1.0027E+00	-6.3781E-05	1.1564E-01	2.0427E-05
429.	RS1	1.3296E-02	9.7911E-01	1.0023E+00	-6.3008E-05	1.0047E-01	3.6070E-05
430.	RF1	0.0000E+00	9.7647E-01	1.0000E+00	-6.3873E-05	5.0780E-04	0.0000E+00
431.	IP1	0.0000E+00	9.7620E-01	1.0000E+00	-6.4639E-05	9.1965E-04	0.0000E+00
432.	SU1	0.0000E+00	9.7620E-01	1.0000E+00	-6.4595E-05	2.3186E-04	0.0000E+00
433.	VT1BR1	5.4263E-03	9.7528E-01	1.0027E+00	-7.4516E-05	1.0000E-01	1.4721E-05
434.	CH4	3.5711E-02	9.7443E-01	1.0029E+00	-7.7248E-05	1.0196E-01	9.6883E-05
435.	MR1	8.5655E-03	9.7409E-01	1.0029E+00	-7.8088E-05	1.0000E-01	2.3238E-05
436.	PD4	1.4963E-03	9.7394E-01	1.0010E+00	-7.3497E-05	3.8160E-02	4.0593E-06
437.	MB11	0.0000E+00	9.7022E-01	1.0002E+00	-8.1359E-05	6.9180E-03	0.0000E+00
438.	HH2	4.9133E-03	9.6946E-01	1.0034E+00	-9.2092E-05	1.0030E-01	1.3330E-05
439.	VC2	0.0000E+00	9.6641E-01	1.0003E+00	-9.1934E-05	8.8737E-03	0.0000E+00
440.	PB7	0.0000E+00	9.5814E-01	1.0002E+00	-1.1402E-04	4.0570E-03	0.0000E+00
441.	PE2	0.0000E+00	9.4433E-01	1.0000E+00	-1.5104E-04	1.1448E-04	0.0000E+00
442.	DB2	0.0000E+00	9.4365E-01	1.0000E+00	-1.5296E-04	5.7890E-04	0.0000E+00
443.	RA2	1.1024E-02	9.4073E-01	1.0014E+00	-1.6458E-04	2.3082E-02	2.9907E-05
444.	DBAC3	0.0000E+00	9.3420E-01	1.0000E+00	-1.7864E-04	7.2834E-04	0.0000E+00
445.	PA2	1.1411E-03	9.3258E-01	1.0014E+00	-1.8683E-04	2.0976E-02	3.0958E-06
446.	OT1	4.3385E-02	9.3202E-01	1.0076E+00	-2.0492E-04	1.0000E-01	1.1770E-04
447.	AR2	0.0000E+00	9.2825E-01	1.0004E+00	-1.9578E-04	5.7667E-03	0.0000E+00
448.	CI3	0.0000E+00	9.2792E-01	1.0007E+00	-1.9732E-04	8.9763E-03	0.0000E+00
449.	FW1	0.0000E+00	9.0558E-01	1.0005E+00	-2.5744E-04	5.0000E-03	0.0000E+00
450.	DBAC1	5.5862E-04	9.0439E-01	1.0001E+00	-2.5955E-04	6.9340E-04	1.5155E-06
451.	PB9	0.0000E+00	8.9602E-01	1.0003E+00	-2.8300E-04	3.2130E-03	0.0000E+00
452.	TP1	3.6060E-02	8.7550E-01	1.0084E+00	-3.6046E-04	6.2970E-02	9.7829E-05
453.	RB4	8.5919E-03	8.7220E-01	1.0029E+00	-3.5447E-04	2.1850E-02	2.3309E-05
454.	TP7	0.0000E+00	8.7174E-01	1.0000E+00	-3.4801E-04	1.3890E-04	0.0000E+00
455.	CD1	3.8974E-03	8.6475E-01	1.0011E+00	-3.6990E-04	8.0334E-03	1.0573E-05
456.	RI2	0.0000E+00	8.5907E-01	1.0001E+00	-3.8253E-04	5.0730E-04	0.0000E+00
457.	ZB1	2.0961E-03	8.5744E-01	1.0012E+00	-3.8995E-04	8.2130E-03	5.6867E-06
458.	HH1	7.6344E-02	8.5068E-01	1.0166E+00	-4.5011E-04	1.0000E-01	2.0712E-04
459.	CSB1	5.4548E-03	8.4696E-01	1.0031E+00	-4.2363E-04	1.9940E-02	1.4799E-05
460.	ZA5	2.1458E-03	8.4376E-01	1.0012E+00	-4.2726E-04	7.9249E-03	5.8214E-06
461.	CSA1	5.6722E-03	8.3541E-01	1.0035E+00	-4.5602E-04	2.0843E-02	1.5388E-05
462.	ZB5	1.9535E-03	8.3419E-01	1.0013E+00	-4.5325E-04	7.5410E-03	5.2998E-06
463.	RRB	0.0000E+00	8.2822E-01	1.0001E+00	-4.6624E-04	4.2417E-04	0.0000E+00
464.	CTMU1	8.1073E-02	8.2429E-01	1.0197E+00	-5.3015E-04	1.0082E-01	2.1995E-04
465.	SU3	1.1832E-03	8.0967E-01	1.0016E+00	-5.2072E-04	8.4073E-03	3.2099E-06
466.	S21	3.8000E-03	7.8065E-01	1.0025E+00	-6.0195E-04	1.1430E-02	1.0309E-05
467.	S11	3.9654E-03	7.6407E-01	1.0029E+00	-6.4798E-04	1.2211E-02	1.0758E-05
468.	VB1	2.7986E-03	6.9906E-01	1.0023E+00	-8.2268E-04	7.5950E-03	7.5926E-06
469.	MB9	2.9053E-03	6.9311E-01	1.0022E+00	-8.3846E-04	7.0170E-03	7.8820E-06
470.	TB1	0.0000E+00	6.7982E-01	1.0001E+00	-8.6892E-04	3.2555E-04	0.0000E+00
471.	BC1	1.1447E-03	6.6871E-01	1.0012E+00	-9.0209E-04	3.6910E-03	3.1056E-06
472.	MS1	0.0000E+00	6.6346E-01	1.0001E+00	-9.1322E-04	2.1398E-04	0.0000E+00
473.	PB1	1.4295E-03	6.3664E-01	1.0012E+00	-9.8895E-04	3.2130E-03	3.8782E-06
474.	MA3	2.9054E-03	6.2127E-01	1.0029E+00	-1.0353E-03	7.5200E-03	7.8823E-06
475.	PA1	1.4927E-03	6.1295E-01	1.0012E+00	-1.0534E-03	3.2129E-03	4.0495E-06
476.	RVA1	4.4388E-03	5.4744E-01	1.0041E+00	-1.2390E-03	9.0863E-03	1.2042E-05
477.	CI1	1.6417E-03	5.0325E-01	1.0024E+00	-1.3543E-03	4.8871E-03	4.4538E-06

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
478.	SI1	1.7070E-04	4.9803E-01	1.0005E+00	-1.3632E-03	1.0215E-03	4.6311E-07
479.	DC1	4.9294E-04	4.8987E-01	1.0005E+00	-1.3854E-03	1.0120E-03	1.3373E-06
480.	RI1	0.0000E+00	4.8790E-01	1.0002E+00	-1.3897E-03	3.2260E-04	0.0000E+00
481.	A21	2.7104E-04	4.7707E-01	1.0003E+00	-1.4195E-03	5.8153E-04	7.3531E-07
482.	D11	1.4399E-03	4.6713E-01	1.0017E+00	-1.4503E-03	3.2017E-03	3.9064E-06
483.	D21	1.3305E-03	4.5007E-01	1.0017E+00	-1.4965E-03	3.0750E-03	3.6095E-06
484.	VC1	8.3887E-05	3.9697E-01	1.0004E+00	-1.6371E-03	6.9303E-04	2.2758E-07
485.	CP1	2.7677E-04	2.7670E-01	1.0011E+00	-1.9652E-03	1.4657E-03	7.5085E-07
486.	UB1D1	5.8830E-04	2.7627E-01	1.0017E+00	-1.9680E-03	2.3130E-03	1.5960E-06
487.	UB1C1	5.8822E-04	2.6684E-01	1.0018E+00	-1.9938E-03	2.3960E-03	1.5958E-06
488.	EE1	2.6260E-04	2.5736E-01	1.0010E+00	-2.0175E-03	1.3908E-03	7.1243E-07
489.	FE1	2.6238E-04	2.5720E-01	1.0010E+00	-2.0180E-03	1.3908E-03	7.1182E-07
490.	UB1B1	5.8835E-04	2.5543E-01	1.0019E+00	-2.0250E-03	2.5070E-03	1.5962E-06
491.	UB1A1	5.8827E-04	2.2885E-01	1.0022E+00	-2.0980E-03	2.8010E-03	1.5959E-06
492.	AR1	0.0000E+00	2.2385E-01	1.0002E+00	-2.1063E-03	2.9630E-04	0.0000E+00
493.	DD1	1.6273E-04	1.6594E-01	1.0008E+00	-2.2651E-03	1.0120E-03	4.4147E-07
494.	DCAC1	8.2288E-05	1.2544E-01	1.0006E+00	-2.3743E-03	6.9340E-04	2.2324E-07
495.	DDAC1	7.9564E-05	1.2082E-01	1.0006E+00	-2.3868E-03	6.9340E-04	2.1585E-07
496.	B1U21	7.5993E-05	1.0778E-01	1.0007E+00	-2.4223E-03	7.3542E-04	2.0617E-07
497.	A1U21	7.6026E-05	1.0607E-01	1.0007E+00	-2.4270E-03	7.3542E-04	2.0626E-07
498.	VT1A1	0.0000E+00	2.5625E-02	1.0003E+00	-2.6443E-03	3.1770E-04	0.0000E+00
499.	VINV21	0.0000E+00	2.0923E-02	1.0002E+00	-2.6567E-03	1.9040E-04	0.0000E+00
500.	VT2B1	0.0000E+00	2.0311E-02	1.0003E+00	-2.6587E-03	3.1770E-04	0.0000E+00
501.	OG1	0.0000E+00	2.0151E-02	1.0005E+00	-2.6595E-03	4.6313E-04	0.0000E+00
502.	B31	0.0000E+00	1.7390E-02	1.0004E+00	-2.6669E-03	4.1960E-04	0.0000E+00
503.	A31	0.0000E+00	1.7390E-02	1.0004E+00	-2.6669E-03	4.1950E-04	0.0000E+00
504.	DG1	0.0000E+00	1.3976E-02	1.0004E+00	-2.6760E-03	3.6298E-04	0.0000E+00
505.	VT2A1	0.0000E+00	2.7712E-03	1.0003E+00	-2.7063E-03	3.1890E-04	0.0000E+00
506.	A2U21	0.0000E+00	2.6952E-03	1.0006E+00	-2.7072E-03	5.8153E-04	0.0000E+00
507.	SGCLGS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
508.	RTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
509.	AF1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6562E-06	0.0000E+00
510.	SLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
511.	B1LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
512.	SRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
513.	SES	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
514.	SYCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
515.	AF2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.8286E-06	0.0000E+00
516.	AF4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.4009E-06	0.0000E+00
517.	PRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
518.	SE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0752E-06	0.0000E+00
519.	RTB	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.4121E-06	0.0000E+00
520.	BB2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.8580E-05	0.0000E+00
521.	BBLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
522.	AF3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.8286E-06	0.0000E+00
523.	BE65	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.9360E-05	0.0000E+00
524.	MELTSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
525.	BB1	8.4380E-05	0.0000E+00	9.9994E-01	0.0000E+00	2.6740E-05	2.2892E-07
526.	BA1	8.1089E-05	0.0000E+00	9.9994E-01	0.0000E+00	2.6740E-05	2.1999E-07
527.	OSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
528.	OTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
529.	PE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.0078E-06	0.0000E+00
530.	MSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Achievement Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
531.	V11	4.7708E-04	0.0000E+00	9.9953E-01	0.0000E+00	7.3100E-06	1.2943E-06
532.	B2U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
533.	B1U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
534.	AE7	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.0291E-05	0.0000E+00
535.	AF5	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.9248E-05	0.0000E+00
536.	SYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
537.	BE49	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.9360E-05	0.0000E+00
538.	AF6	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0804E-05	0.0000E+00
539.	B2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
540.	BE9	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.6980E-06	0.0000E+00
541.	GBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
542.	GE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
543.	MELTIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
544.	V219	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3270E-05	0.0000E+00
545.	V220	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.2820E-05	0.0000E+00
546.	HE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
547.	MACROS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
548.	GDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
549.	INTPRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
550.	DP4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3827E-05	0.0000E+00
551.	DHS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
552.	V31	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	5.6297E-07	0.0000E+00
553.	V21	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	7.0910E-06	0.0000E+00
554.	DP2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.1999E-05	0.0000E+00
555.	V25	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.9840E-06	0.0000E+00
556.	DP1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.1494E-06	0.0000E+00
557.	V24	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.9740E-06	0.0000E+00
558.	IYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
559.	GAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
560.	BYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
561.	MELTBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
562.	GCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
563.	CL1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.8220E-06	0.0000E+00
564.	CMS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
565.	LYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
566.	LYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
567.	LYCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
568.	IC1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.0020E-06	0.0000E+00
569.	CCSRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
570.	CAVS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
571.	LOWPRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
572.	SE9	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0752E-06	0.0000E+00
573.	RW1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.3840E-07	0.0000E+00
574.	AB1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6740E-05	0.0000E+00
575.	RHRSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
576.	V35	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.0398E-05	0.0000E+00
577.	FAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
578.	CSIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
579.	EXS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
580.	CT1	0.0000E+00	0.0000E+00	1.0001E+00	-2.7132E-03	9.3318E-05	0.0000E+00
581.	AA1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6740E-05	0.0000E+00
582.	AALS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
583.	SYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Achievement Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
584.	BALS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
585.	AB3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.8580E-05	0.0000E+00
586.	A2U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
587.	V32	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.5407E-06	0.0000E+00
588.	A2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
589.	V14	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3710E-05	0.0000E+00
590.	FCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
591.	FBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
592.	TT1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.8253E-06	0.0000E+00
593.	ABLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
594.	TTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
595.	DSLRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
596.	CSRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
597.	WCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
598.	A1U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
599.	FDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
600.	VS3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.6996E-06	0.0000E+00
601.	A1LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
1.	CTMU1	8.1073E-02	8.2429E-01	1.0197E+00	-5.3015E-04	1.0082E-01	2.1995E-04
2.	HH1	7.6344E-02	8.5068E-01	1.0166E+00	-4.5011E-04	1.0000E-01	2.0712E-04
3.	TP1	3.6060E-02	8.7550E-01	1.0084E+00	-3.6046E-04	6.2970E-02	9.7829E-05
4.	OT1	4.3385E-02	9.3202E-01	1.0076E+00	-2.0492E-04	1.0000E-01	1.1770E-04
5.	RVA1	4.4388E-03	5.4744E-01	1.0041E+00	-1.2390E-03	9.0863E-03	1.2042E-05
6.	CSA1	5.6722E-03	8.3541E-01	1.0035E+00	-4.5602E-04	2.0843E-02	1.5388E-05
7.	HH2	4.9133E-03	9.6946E-01	1.0034E+00	-9.2092E-05	1.0030E-01	1.3330E-05
8.	CSB1	5.4548E-03	8.4696E-01	1.0031E+00	-4.2363E-04	1.9940E-02	1.4799E-05
9.	CH4	3.5711E-02	9.7443E-01	1.0029E+00	-7.7248E-05	1.0196E-01	9.6883E-05
10.	RB4	8.5919E-03	8.7220E-01	1.0029E+00	-3.5447E-04	2.1850E-02	2.3309E-05
11.	S11	3.9654E-03	7.6407E-01	1.0029E+00	-6.4798E-04	1.2211E-02	1.0758E-05
12.	MA3	2.9054E-03	6.2127E-01	1.0029E+00	-1.0353E-03	7.5200E-03	7.8823E-06
13.	MR1	8.5655E-03	9.7409E-01	1.0029E+00	-7.8088E-05	1.0000E-01	2.3238E-05
14.	CP3	7.5296E-03	9.7921E-01	1.0027E+00	-6.3781E-05	1.1564E-01	2.0427E-05
15.	VT1BR1	5.4263E-03	9.7528E-01	1.0027E+00	-7.4516E-05	1.0000E-01	1.4721E-05
16.	S21	3.8000E-03	7.8065E-01	1.0025E+00	-6.0195E-04	1.1430E-02	1.0309E-05
17.	CI1	1.6417E-03	5.0325E-01	1.0024E+00	-1.3543E-03	4.8871E-03	4.4538E-06
18.	RS1	1.3296E-02	9.7911E-01	1.0023E+00	-6.3008E-05	1.0047E-01	3.6070E-05
19.	VB1	2.7986E-03	6.9906E-01	1.0023E+00	-8.2268E-04	7.5950E-03	7.5926E-06
20.	MB9	2.9053E-03	6.9311E-01	1.0022E+00	-8.3846E-04	7.0170E-03	7.8820E-06
21.	UB1A1	5.8827E-04	2.2885E-01	1.0022E+00	-2.0980E-03	2.8010E-03	1.5959E-06
22.	CH1	2.8029E-03	9.8319E-01	1.0019E+00	-5.0770E-05	1.0196E-01	7.6041E-06
23.	UB1B1	5.8835E-04	2.5543E-01	1.0019E+00	-2.0250E-03	2.5070E-03	1.5962E-06
24.	UB1C1	5.8822E-04	2.6684E-01	1.0018E+00	-1.9938E-03	2.3960E-03	1.5958E-06
25.	UB1D1	5.8830E-04	2.7627E-01	1.0017E+00	-1.9680E-03	2.3130E-03	1.5960E-06
26.	D21	1.3305E-03	4.5007E-01	1.0017E+00	-1.4965E-03	3.0750E-03	3.6095E-06
27.	D11	1.4399E-03	4.6713E-01	1.0017E+00	-1.4503E-03	3.2017E-03	3.9064E-06
28.	SU3	1.1832E-03	8.0967E-01	1.0016E+00	-5.2072E-04	8.4073E-03	3.2099E-06
29.	RA2	1.1024E-02	9.4073E-01	1.0014E+00	-1.6458E-04	2.3082E-02	2.9907E-05
30.	PA2	1.1411E-03	9.3258E-01	1.0014E+00	-1.8683E-04	2.0976E-02	3.0958E-06
31.	ZB5	1.9535E-03	8.3419E-01	1.0013E+00	-4.5325E-04	7.5410E-03	5.2998E-06
32.	BC1	1.1447E-03	6.6871E-01	1.0012E+00	-9.0209E-04	3.6910E-03	3.1056E-06
33.	PA1	1.4927E-03	6.1295E-01	1.0012E+00	-1.0534E-03	3.2129E-03	4.0495E-06
34.	PB1	1.4295E-03	6.3664E-01	1.0012E+00	-9.8895E-04	3.2130E-03	3.8782E-06
35.	ZB1	2.0961E-03	8.5744E-01	1.0012E+00	-3.8995E-04	8.2130E-03	5.6867E-06
36.	ZA5	2.1458E-03	8.4376E-01	1.0012E+00	-4.2726E-04	7.9249E-03	5.8214E-06
37.	CD1	3.8974E-03	8.6475E-01	1.0011E+00	-3.6990E-04	8.0334E-03	1.0573E-05
38.	CP1	2.7677E-04	2.7670E-01	1.0011E+00	-1.9652E-03	1.4657E-03	7.5085E-07
39.	FE1	2.6238E-04	2.5720E-01	1.0010E+00	-2.0180E-03	1.3908E-03	7.1182E-07
40.	EE1	2.6260E-04	2.5736E-01	1.0010E+00	-2.0175E-03	1.3908E-03	7.1243E-07
41.	VT1AR1	4.6684E-04	9.9069E-01	1.0010E+00	-2.8056E-05	1.0000E-01	1.2665E-06
42.	PD4	1.4963E-03	9.7394E-01	1.0010E+00	-7.3497E-05	3.8160E-02	4.0593E-06
43.	DD1	1.6273E-04	1.6594E-01	1.0008E+00	-2.2651E-03	1.0120E-03	4.4147E-07
44.	CI3	0.0000E+00	9.2792E-01	1.0007E+00	-1.9732E-04	8.9763E-03	0.0000E+00
45.	A1U21	7.6026E-05	1.0607E-01	1.0007E+00	-2.4270E-03	7.3542E-04	2.0626E-07
46.	B1U21	7.5993E-05	1.0778E-01	1.0007E+00	-2.4223E-03	7.3542E-04	2.0617E-07
47.	DDAC1	7.9564E-05	1.2082E-01	1.0006E+00	-2.3868E-03	6.9340E-04	2.1585E-07
48.	DCAC1	8.2288E-05	1.2544E-01	1.0006E+00	-2.3743E-03	6.9340E-04	2.2324E-07
49.	A2U21	0.0000E+00	2.6952E-03	1.0006E+00	-2.7072E-03	5.8153E-04	0.0000E+00
50.	CH6	4.0831E-04	9.9561E-01	1.0006E+00	-1.3570E-05	1.2296E-01	1.1077E-06
51.	CI4	4.0316E-04	9.9577E-01	1.0006E+00	-1.3010E-05	1.1757E-01	1.0937E-06
52.	FW1	0.0000E+00	9.0558E-01	1.0005E+00	-2.5744E-04	5.0000E-03	0.0000E+00
53.	DS6	2.6080E-04	9.9541E-01	1.0005E+00	-1.3933E-05	1.0636E-01	7.0753E-07

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
54.	OG1	0.0000E+00	2.0151E-02	1.0005E+00	-2.6595E-03	4.6313E-04	0.0000E+00
55.	DC1	4.9294E-04	4.8987E-01	1.0005E+00	-1.3854E-03	1.0120E-03	1.3373E-06
56.	SI1	1.7070E-04	4.9803E-01	1.0005E+00	-1.3632E-03	1.0215E-03	4.6311E-07
57.	AR2	0.0000E+00	9.2825E-01	1.0004E+00	-1.9578E-04	5.7667E-03	0.0000E+00
58.	A31	0.0000E+00	1.7390E-02	1.0004E+00	-2.6669E-03	4.1950E-04	0.0000E+00
59.	B31	0.0000E+00	1.7390E-02	1.0004E+00	-2.6669E-03	4.1960E-04	0.0000E+00
60.	VC1	8.3887E-05	3.9697E-01	1.0004E+00	-1.6371E-03	6.9303E-04	2.2758E-07
61.	VT2BR1	1.0014E-04	9.9648E-01	1.0004E+00	-1.0624E-05	1.0000E-01	2.7169E-07
62.	AFR1	1.3424E-03	9.9626E-01	1.0004E+00	-1.1267E-05	1.0000E-01	3.6419E-06
63.	DG1	0.0000E+00	1.3976E-02	1.0004E+00	-2.6760E-03	3.6298E-04	0.0000E+00
64.	VT2A1	0.0000E+00	2.7712E-03	1.0003E+00	-2.7063E-03	3.1890E-04	0.0000E+00
65.	A21	2.7104E-04	4.7707E-01	1.0003E+00	-1.4195E-03	5.8153E-04	7.3531E-07
66.	CH3	3.7186E-05	9.9816E-01	1.0003E+00	-5.6975E-06	1.2296E-01	1.0088E-07
67.	CSB3	2.5642E-03	9.8672E-01	1.0003E+00	-3.6781E-05	2.0840E-02	6.9564E-06
68.	VT2B1	0.0000E+00	2.0311E-02	1.0003E+00	-2.6587E-03	3.1770E-04	0.0000E+00
69.	VT1A1	0.0000E+00	2.5625E-02	1.0003E+00	-2.6443E-03	3.1770E-04	0.0000E+00
70.	VC2	0.0000E+00	9.6641E-01	1.0003E+00	-9.1934E-05	8.8737E-03	0.0000E+00
71.	PB9	0.0000E+00	8.9602E-01	1.0003E+00	-2.8300E-04	3.2130E-03	0.0000E+00
72.	ZA2	4.3218E-05	9.8093E-01	1.0002E+00	-5.2210E-05	9.1268E-03	1.1725E-07
73.	CSB2	2.1765E-04	9.9777E-01	1.0002E+00	-6.4715E-06	6.3310E-02	5.9047E-07
74.	ZB2	4.3216E-05	9.8123E-01	1.0002E+00	-5.1369E-05	8.6600E-03	1.1724E-07
75.	MB10	0.0000E+00	9.9709E-01	1.0002E+00	-8.5110E-06	7.3870E-02	0.0000E+00
76.	RI1	0.0000E+00	4.8790E-01	1.0002E+00	-1.3897E-03	3.2260E-04	0.0000E+00
77.	MB11	0.0000E+00	9.7022E-01	1.0002E+00	-8.1359E-05	6.9180E-03	0.0000E+00
78.	SL3	0.0000E+00	9.8827E-01	1.0002E+00	-3.2376E-05	1.6996E-02	0.0000E+00
79.	GC1	1.1500E-04	9.9847E-01	1.0002E+00	-4.7676E-06	1.2940E-01	3.1198E-07
80.	CH2	7.1261E-05	9.9852E-01	1.0002E+00	-4.5888E-06	1.2296E-01	1.9333E-07
81.	VT2AR1	7.9931E-05	9.9803E-01	1.0002E+00	-5.9442E-06	1.0000E-01	2.1685E-07
82.	VINV22	0.0000E+00	9.8421E-01	1.0002E+00	-4.3281E-05	1.0530E-02	0.0000E+00
83.	RL5	1.3946E-03	9.9838E-01	1.0002E+00	-4.8703E-06	1.0032E-01	3.7833E-06
84.	GC2	1.3585E-03	9.9877E-01	1.0002E+00	-3.9584E-06	1.5570E-01	3.6855E-06
85.	PB7	0.0000E+00	9.5814E-01	1.0002E+00	-1.1402E-04	4.0570E-03	0.0000E+00
86.	VINV21	0.0000E+00	2.0923E-02	1.0002E+00	-2.6567E-03	1.9040E-04	0.0000E+00
87.	AR1	0.0000E+00	2.2385E-01	1.0002E+00	-2.1063E-03	2.9630E-04	0.0000E+00
88.	PD5	4.2081E-05	9.9581E-01	1.0001E+00	-1.1723E-05	3.0838E-02	1.1416E-07
89.	TB4	2.9731E-04	9.9809E-01	1.0001E+00	-5.4904E-06	5.6007E-02	8.0658E-07
90.	TB1	0.0000E+00	6.7982E-01	1.0001E+00	-8.6892E-04	3.2555E-04	0.0000E+00
91.	UB1C2	0.0000E+00	9.9882E-01	1.0001E+00	-3.3476E-06	4.6460E-02	0.0000E+00
92.	RB1	2.9469E-04	9.9276E-01	1.0001E+00	-2.0014E-05	1.8250E-02	7.9948E-07
93.	UB1B2	0.0000E+00	9.9941E-01	1.0001E+00	-1.7884E-06	1.0760E-01	0.0000E+00
94.	FD1	0.0000E+00	9.8278E-01	1.0001E+00	-4.6879E-05	3.4470E-03	0.0000E+00
95.	FC1	0.0000E+00	9.8278E-01	1.0001E+00	-4.6879E-05	3.4470E-03	0.0000E+00
96.	RRB	0.0000E+00	8.2822E-01	1.0001E+00	-4.6624E-04	4.2417E-04	0.0000E+00
97.	RI2	0.0000E+00	8.5907E-01	1.0001E+00	-3.8253E-04	5.0730E-04	0.0000E+00
98.	DP7	0.0000E+00	9.9259E-01	1.0001E+00	-2.0294E-05	8.9256E-03	0.0000E+00
99.	PI3	4.5048E-05	9.9502E-01	1.0001E+00	-1.3854E-05	2.5000E-02	1.2221E-07
100.	PB10	6.7772E-05	9.9677E-01	1.0001E+00	-8.9502E-06	2.0940E-02	1.8386E-07
101.	CT1	0.0000E+00	0.0000E+00	1.0001E+00	-2.7132E-03	9.3318E-05	0.0000E+00
102.	UB1D2	0.0000E+00	9.9824E-01	1.0001E+00	-4.9723E-06	3.7090E-02	0.0000E+00
103.	TP2	0.0000E+00	9.9839E-01	1.0001E+00	-4.6776E-06	6.3430E-02	0.0000E+00
104.	MS1	0.0000E+00	6.6346E-01	1.0001E+00	-9.1322E-04	2.1398E-04	0.0000E+00
105.	S23	1.6585E-04	9.9823E-01	1.0001E+00	-5.1911E-06	7.5510E-02	4.4994E-07
106.	GD4	1.6090E-04	9.9984E-01	1.0001E+00	-5.8969E-07	2.5240E-01	4.3650E-07

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
107.	DBAC1	5.5862E-04	9.0439E-01	1.0001E+00	-2.5955E-04	6.9340E-04	1.5155E-06
108.	DSLR1	6.5057E-05	9.9723E-01	1.0001E+00	-7.7548E-06	2.9970E-02	1.7650E-07
109.	GC3	7.9996E-04	9.9966E-01	1.0001E+00	-1.1225E-06	1.7760E-01	2.1703E-06
110.	DS5	0.0000E+00	9.9994E-01	1.0000E+00	-1.7101E-07	1.0546E-01	0.0000E+00
111.	GC6	0.0000E+00	9.9992E-01	1.0000E+00	-2.6038E-07	1.3650E-01	0.0000E+00
112.	GD8	0.0000E+00	9.9992E-01	1.0000E+00	-2.5929E-07	1.3290E-01	0.0000E+00
113.	MA7	1.5744E-04	9.9994E-01	1.0000E+00	-1.8750E-07	1.0140E-01	4.2714E-07
114.	BB7	6.1254E-05	9.9991E-01	1.0000E+00	-3.1078E-07	2.4260E-01	1.6618E-07
115.	BE13	0.0000E+00	9.9995E-01	1.0000E+00	-1.4202E-07	5.3200E-05	0.0000E+00
116.	GD5	0.0000E+00	9.9991E-01	1.0000E+00	-2.7183E-07	1.2940E-01	0.0000E+00
117.	MB27	1.5745E-04	9.9995E-01	1.0000E+00	-1.4204E-07	1.1160E-01	4.2716E-07
118.	BE21	0.0000E+00	9.9984E-01	1.0000E+00	-4.3812E-07	2.2870E-04	0.0000E+00
119.	RT3	0.0000E+00	9.9984E-01	1.0000E+00	-4.3828E-07	6.1145E-04	0.0000E+00
120.	MB28	0.0000E+00	9.9984E-01	1.0000E+00	-4.3191E-07	1.1050E-02	0.0000E+00
121.	PR3	0.0000E+00	9.9984E-01	1.0000E+00	-4.4182E-07	8.6088E-03	0.0000E+00
122.	DDAC2	0.0000E+00	9.9984E-01	1.0000E+00	-4.4178E-07	6.9983E-04	0.0000E+00
123.	FC2	0.0000E+00	9.9983E-01	1.0000E+00	-4.6309E-07	3.4460E-03	0.0000E+00
124.	RI5	0.0000E+00	9.9983E-01	1.0000E+00	-4.6326E-07	3.2260E-04	0.0000E+00
125.	RI3	0.0000E+00	9.9983E-01	1.0000E+00	-4.5009E-07	3.2260E-04	0.0000E+00
126.	VB5	0.0000E+00	9.9991E-01	1.0000E+00	-2.3308E-07	9.1160E-03	0.0000E+00
127.	GC4	0.0000E+00	9.9991E-01	1.0000E+00	-2.7293E-07	1.3290E-01	0.0000E+00
128.	BE85	0.0000E+00	9.9990E-01	1.0000E+00	-2.7457E-07	6.7810E-03	0.0000E+00
129.	OS1	0.0000E+00	9.9991E-01	1.0000E+00	-2.6054E-07	1.0000E-01	0.0000E+00
130.	AB4	0.0000E+00	9.9985E-01	1.0000E+00	-4.3279E-07	5.3850E-02	0.0000E+00
131.	BB6	0.0000E+00	9.9985E-01	1.0000E+00	-4.2794E-07	4.3110E-02	0.0000E+00
132.	PB4	0.0000E+00	9.9988E-01	1.0000E+00	-3.2716E-07	3.4550E-02	0.0000E+00
133.	RF3	0.0000E+00	9.9985E-01	1.0000E+00	-4.1574E-07	7.3460E-04	0.0000E+00
134.	FD2	0.0000E+00	9.9983E-01	1.0000E+00	-4.6309E-07	3.4460E-03	0.0000E+00
135.	MB3	0.0000E+00	9.9538E-01	1.0000E+00	-1.2640E-05	7.5200E-03	0.0000E+00
136.	BC34	0.0000E+00	9.9568E-01	1.0000E+00	-1.1807E-05	6.3260E-03	0.0000E+00
137.	V32	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.5407E-06	0.0000E+00
138.	PA3	0.0000E+00	9.9517E-01	1.0000E+00	-1.3154E-05	4.0566E-03	0.0000E+00
139.	V14	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3710E-05	0.0000E+00
140.	A2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
141.	AB2	0.0000E+00	9.9585E-01	1.0000E+00	-1.1272E-05	5.6940E-04	0.0000E+00
142.	BE43	0.0000E+00	9.9396E-01	1.0000E+00	-1.6445E-05	3.3620E-03	0.0000E+00
143.	FE2	0.0000E+00	9.9425E-01	1.0000E+00	-1.5628E-05	1.3930E-03	0.0000E+00
144.	BC3	0.0000E+00	9.9389E-01	1.0000E+00	-1.6671E-05	6.1870E-03	0.0000E+00
145.	DAAC2	0.0000E+00	9.9493E-01	1.0000E+00	-1.3767E-05	6.9983E-04	0.0000E+00
146.	DD2	0.0000E+00	9.9486E-01	1.0000E+00	-1.3946E-05	5.7890E-04	0.0000E+00
147.	FA1	4.1433E-05	9.9434E-01	1.0000E+00	-1.5408E-05	3.5320E-03	1.1241E-07
148.	ZB7	0.0000E+00	9.9996E-01	1.0000E+00	-1.2470E-07	5.9770E-02	0.0000E+00
149.	AB6	4.2176E-04	9.9998E-01	1.0000E+00	-1.0416E-07	5.6660E-01	1.1442E-06
150.	FB2	0.0000E+00	9.9996E-01	1.0000E+00	-1.1561E-07	2.7700E-02	0.0000E+00
151.	BB9	0.0000E+00	9.9598E-01	1.0000E+00	-1.0911E-05	6.0140E-04	0.0000E+00
152.	TTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
153.	MA11	0.0000E+00	9.9996E-01	1.0000E+00	-1.2471E-07	1.0280E-01	0.0000E+00
154.	TP5	0.0000E+00	9.9996E-01	1.0000E+00	-1.2164E-07	8.0120E-02	0.0000E+00
155.	PB5	0.0000E+00	9.9585E-01	1.0000E+00	-1.1302E-05	3.2130E-03	0.0000E+00
156.	FBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
157.	TT1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.8253E-06	0.0000E+00
158.	FCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
159.	TP7	0.0000E+00	8.7174E-01	1.0000E+00	-3.4801E-04	1.3890E-04	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
160.	AB9	0.0000E+00	9.9587E-01	1.0000E+00	-1.1205E-05	6.7570E-04	0.0000E+00
161.	ABLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
162.	RI4	0.0000E+00	9.9359E-01	1.0000E+00	-1.7387E-05	5.0730E-04	0.0000E+00
163.	PD3	0.0000E+00	9.9790E-01	1.0000E+00	-5.6929E-06	1.1743E-03	0.0000E+00
164.	RA1	4.1414E-04	9.9793E-01	1.0000E+00	-5.7331E-06	1.9057E-02	1.1235E-06
165.	MB5	0.0000E+00	9.9786E-01	1.0000E+00	-5.8374E-06	7.5630E-03	0.0000E+00
166.	PD2	0.0000E+00	9.9800E-01	1.0000E+00	-5.4342E-06	1.8824E-03	0.0000E+00
167.	AE10	0.0000E+00	9.9801E-01	1.0000E+00	-5.4014E-06	8.0047E-04	0.0000E+00
168.	DCAC3	0.0000E+00	9.9747E-01	1.0000E+00	-6.8735E-06	7.2834E-04	0.0000E+00
169.	AE9	0.0000E+00	9.9778E-01	1.0000E+00	-6.0223E-06	8.1416E-05	0.0000E+00
170.	MB13	0.0000E+00	9.9765E-01	1.0000E+00	-6.4212E-06	7.0550E-03	0.0000E+00
171.	VS2	0.0000E+00	9.9730E-01	1.0000E+00	-7.3769E-06	8.8731E-03	0.0000E+00
172.	PB2	0.0000E+00	9.9851E-01	1.0000E+00	-4.0626E-06	3.2130E-03	0.0000E+00
173.	BE86	0.0000E+00	9.9849E-01	1.0000E+00	-4.0987E-06	3.4290E-03	0.0000E+00
174.	RL3	0.0000E+00	9.9853E-01	1.0000E+00	-4.0282E-06	1.0369E-02	0.0000E+00
175.	CP2	0.0000E+00	9.9804E-01	1.0000E+00	-5.3404E-06	1.7895E-03	0.0000E+00
176.	DSLRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
177.	CI2	0.0000E+00	9.9832E-01	1.0000E+00	-4.6777E-06	2.3533E-02	0.0000E+00
178.	V226	0.0000E+00	9.9824E-01	1.0000E+00	-4.7797E-06	7.7540E-04	0.0000E+00
179.	UB1B3	0.0000E+00	9.9856E-01	1.0000E+00	-3.9174E-06	2.8010E-03	0.0000E+00
180.	PB6	0.0000E+00	9.9667E-01	1.0000E+00	-9.0546E-06	3.2130E-03	0.0000E+00
181.	V224	0.0000E+00	9.9607E-01	1.0000E+00	-1.0659E-05	2.4320E-04	0.0000E+00
182.	BE5	0.0000E+00	9.9674E-01	1.0000E+00	-8.8335E-06	2.2870E-04	0.0000E+00
183.	AE3	0.0000E+00	9.9682E-01	1.0000E+00	-8.6376E-06	2.3574E-04	0.0000E+00
184.	CSRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
185.	BB5	0.0000E+00	9.9645E-01	1.0000E+00	-9.6479E-06	5.4520E-04	0.0000E+00
186.	RL2	0.0000E+00	9.9631E-01	1.0000E+00	-1.0119E-05	1.0053E-02	0.0000E+00
187.	BA5	0.0000E+00	9.9729E-01	1.0000E+00	-7.3552E-06	6.7570E-04	0.0000E+00
188.	DC2	0.0000E+00	9.9723E-01	1.0000E+00	-7.5226E-06	5.7890E-04	0.0000E+00
189.	VB3	0.0000E+00	9.9720E-01	1.0000E+00	-7.6202E-06	3.5120E-03	0.0000E+00
190.	TT2	0.0000E+00	9.9723E-01	1.0000E+00	-7.5165E-06	7.3004E-05	0.0000E+00
191.	V222	0.0000E+00	9.9691E-01	1.0000E+00	-8.4154E-06	3.8460E-03	0.0000E+00
192.	DDAC3	0.0000E+00	9.9694E-01	1.0000E+00	-8.2983E-06	7.2834E-04	0.0000E+00
193.	MA5	0.0000E+00	9.9702E-01	1.0000E+00	-8.1384E-06	7.5630E-03	0.0000E+00
194.	BE17	0.0000E+00	9.9698E-01	1.0000E+00	-8.1991E-06	1.8220E-04	0.0000E+00
195.	V211	0.0000E+00	9.9983E-01	1.0000E+00	-4.6146E-07	1.1240E-04	0.0000E+00
196.	RT6	0.0000E+00	9.9965E-01	1.0000E+00	-9.6375E-07	7.4597E-04	0.0000E+00
197.	BE53	0.0000E+00	9.9965E-01	1.0000E+00	-9.3953E-07	8.0490E-05	0.0000E+00
198.	SEI	0.0000E+00	9.9965E-01	1.0000E+00	-9.4974E-07	2.3345E-03	0.0000E+00
199.	V210	0.0000E+00	9.9967E-01	1.0000E+00	-8.8492E-07	9.4420E-05	0.0000E+00
200.	DCAC2	0.0000E+00	9.9951E-01	1.0000E+00	-1.3383E-06	6.9983E-04	0.0000E+00
201.	RR8	0.0000E+00	9.9963E-01	1.0000E+00	-1.0036E-06	4.6243E-03	0.0000E+00
202.	V22	0.0000E+00	9.9952E-01	1.0000E+00	-1.3344E-06	3.0030E-02	0.0000E+00
203.	PI2	0.0000E+00	9.9949E-01	1.0000E+00	-1.3908E-06	1.3804E-02	0.0000E+00
204.	ZA4	0.0000E+00	9.9982E-01	1.0000E+00	-4.8792E-07	8.6464E-03	0.0000E+00
205.	AFA5	0.0000E+00	9.9982E-01	1.0000E+00	-5.2905E-07	5.8710E-02	0.0000E+00
206.	ZB4	0.0000E+00	9.9982E-01	1.0000E+00	-4.8771E-07	8.2130E-03	0.0000E+00
207.	AE4	0.0000E+00	9.9967E-01	1.0000E+00	-8.8631E-07	1.6184E-03	0.0000E+00
208.	PB3	1.2216E-04	9.9974E-01	1.0000E+00	-7.1034E-07	2.0640E-02	3.3140E-07
209.	OF2	0.0000E+00	9.9981E-01	1.0000E+00	-5.8332E-07	1.0000E-01	0.0000E+00
210.	RVB2	3.8287E-05	9.9978E-01	1.0000E+00	-6.1591E-07	9.0860E-03	1.0387E-07
211.	UB1D5	0.0000E+00	9.9856E-01	1.0000E+00	-3.9162E-06	2.5070E-03	0.0000E+00
212.	ZB3	0.0000E+00	9.9876E-01	1.0000E+00	-3.3856E-06	1.0230E-02	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
213.	ZA3	0.0000E+00	9.9876E-01	1.0000E+00	-3.3876E-06	1.0810E-02	0.0000E+00
214.	V34	0.0000E+00	9.9885E-01	1.0000E+00	-3.1621E-06	1.5295E-02	0.0000E+00
215.	BC23	0.0000E+00	9.9892E-01	1.0000E+00	-2.9428E-06	7.5100E-03	0.0000E+00
216.	TB3	0.0000E+00	9.9858E-01	1.0000E+00	-3.8586E-06	1.2166E-03	0.0000E+00
217.	UB1C4	0.0000E+00	9.9867E-01	1.0000E+00	-3.6186E-06	2.5070E-03	0.0000E+00
218.	BC8	0.0000E+00	9.9858E-01	1.0000E+00	-3.8781E-06	6.2180E-03	0.0000E+00
219.	RR9	0.0000E+00	9.9948E-01	1.0000E+00	-1.4181E-06	4.6243E-03	0.0000E+00
220.	BB10	0.0000E+00	9.9936E-01	1.0000E+00	-1.7349E-06	6.7570E-04	0.0000E+00
221.	PB12	0.0000E+00	9.9932E-01	1.0000E+00	-1.8417E-06	4.0570E-03	0.0000E+00
222.	AFA3	0.0000E+00	9.9945E-01	1.0000E+00	-1.5430E-06	3.0710E-02	0.0000E+00
223.	MB7	0.0000E+00	9.9908E-01	1.0000E+00	-2.5020E-06	7.0110E-03	0.0000E+00
224.	VA2	0.0000E+00	9.9911E-01	1.0000E+00	-2.4497E-06	9.1160E-03	0.0000E+00
225.	V221	0.0000E+00	9.9929E-01	1.0000E+00	-1.9420E-06	3.8420E-03	0.0000E+00
226.	V27	0.0000E+00	9.9923E-01	1.0000E+00	-2.1004E-06	3.0910E-03	0.0000E+00
227.	DBAC2	0.0000E+00	9.9617E-01	1.0000E+00	-1.0400E-05	6.9983E-04	0.0000E+00
228.	V24	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.9740E-06	0.0000E+00
229.	DP1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.1494E-06	0.0000E+00
230.	IYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
231.	GAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
232.	DP2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.1999E-05	0.0000E+00
233.	V25	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.9840E-06	0.0000E+00
234.	V21	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	7.0910E-06	0.0000E+00
235.	CMS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
236.	CL1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.8220E-06	0.0000E+00
237.	LYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
238.	BYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
239.	MELTBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
240.	GCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
241.	LYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
242.	V219	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3270E-05	0.0000E+00
243.	MELTIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
244.	V220	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.2820E-05	0.0000E+00
245.	HE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
246.	GBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
247.	GE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
248.	V31	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	5.6297E-07	0.0000E+00
249.	DHS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
250.	DP4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3827E-05	0.0000E+00
251.	MACROS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
252.	GDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
253.	INTPRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
254.	BE9	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.6980E-06	0.0000E+00
255.	SYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
256.	AALS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
257.	BALS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
258.	AB3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.8580E-05	0.0000E+00
259.	EXS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
260.	AA1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6740E-05	0.0000E+00
261.	CSIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
262.	DAAC3	0.0000E+00	9.8624E-01	1.0000E+00	-3.7354E-05	7.2834E-04	0.0000E+00
263.	DA2	0.0000E+00	9.8602E-01	1.0000E+00	-3.7938E-05	5.7890E-04	0.0000E+00
264.	AM1	0.0000E+00	9.8741E-01	1.0000E+00	-3.4191E-05	1.0000E-03	0.0000E+00
265.	D22	0.0000E+00	9.8261E-01	1.0000E+00	-4.7306E-05	2.6886E-03	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
266.	VF1	0.0000E+00	9.8326E-01	1.0000E+00	-4.5441E-05	6.9392E-04	0.0000E+00
267.	VT2B2	0.0000E+00	9.8421E-01	1.0000E+00	-4.2838E-05	3.1890E-04	0.0000E+00
268.	LYCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
269.	CAVS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
270.	CCSRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
271.	LOWPRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
272.	MU1	6.4906E-04	1.0000E+00	1.0000E+00	1.0492E-08	4.4090E-01	1.7609E-06
273.	D12	0.0000E+00	9.8261E-01	1.0000E+00	-4.7312E-05	2.8153E-03	0.0000E+00
274.	IC1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.0020E-06	0.0000E+00
275.	FAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
276.	V35	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.0398E-05	0.0000E+00
277.	RHRSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
278.	SE9	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0752E-06	0.0000E+00
279.	RW1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.3840E-07	0.0000E+00
280.	AB1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6740E-05	0.0000E+00
281.	VT1A2	0.0000E+00	9.8835E-01	1.0000E+00	-3.1614E-05	3.1890E-04	0.0000E+00
282.	SLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
283.	AF1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6562E-06	0.0000E+00
284.	IP1	0.0000E+00	9.7620E-01	1.0000E+00	-6.4639E-05	9.1965E-04	0.0000E+00
285.	B1LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
286.	SGCLGS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
287.	RTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
288.	A2U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
289.	AF2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.8286E-06	0.0000E+00
290.	SYCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
291.	AF4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.4009E-06	0.0000E+00
292.	SRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
293.	SES	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
294.	RF1	0.0000E+00	9.7647E-01	1.0000E+00	-6.3873E-05	5.0780E-04	0.0000E+00
295.	PRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
296.	DBAC3	0.0000E+00	9.3420E-01	1.0000E+00	-1.7864E-04	7.2834E-04	0.0000E+00
297.	AE6	0.0000E+00	9.9267E-01	1.0000E+00	-1.9950E-05	3.4298E-03	0.0000E+00
298.	AB7	0.0000E+00	9.9131E-01	1.0000E+00	-2.3578E-05	6.0140E-04	0.0000E+00
299.	DB2	0.0000E+00	9.4365E-01	1.0000E+00	-1.5296E-04	5.7890E-04	0.0000E+00
300.	BB8	0.0000E+00	9.9293E-01	1.0000E+00	-1.9189E-05	5.6940E-04	0.0000E+00
301.	V36	0.0000E+00	9.9284E-01	1.0000E+00	-1.9440E-05	4.8115E-04	0.0000E+00
302.	SU1	0.0000E+00	9.7620E-01	1.0000E+00	-6.4595E-05	2.3186E-04	0.0000E+00
303.	FDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
304.	VS3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.6996E-06	0.0000E+00
305.	V15	0.0000E+00	9.8972E-01	1.0000E+00	-2.8006E-05	3.8430E-03	0.0000E+00
306.	PE2	0.0000E+00	9.4433E-01	1.0000E+00	-1.5104E-04	1.1448E-04	0.0000E+00
307.	A1LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
308.	B2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
309.	AFA1	0.0000E+00	9.8896E-01	1.0000E+00	-3.0013E-05	2.3760E-03	0.0000E+00
310.	MSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
311.	B2U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
312.	B1U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
313.	OTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
314.	PE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.0078E-06	0.0000E+00
315.	OSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
316.	AF6	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0804E-05	0.0000E+00
317.	BE49	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.9360E-05	0.0000E+00
318.	AE7	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.0291E-05	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
319.	AF5	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.9248E-05	0.0000E+00
320.	SYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
321.	A1U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
322.	AF3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.8286E-06	0.0000E+00
323.	BBLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
324.	BE65	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.9360E-05	0.0000E+00
325.	BB2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.8580E-05	0.0000E+00
326.	SE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0752E-06	0.0000E+00
327.	WCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
328.	RTB	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.4121E-06	0.0000E+00
329.	MELTSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
330.	RT9	6.2197E-05	1.0002E+00	9.9998E-01	6.7448E-07	1.0016E-01	1.6874E-07
331.	DS9	8.7558E-05	1.0002E+00	9.9998E-01	6.3759E-07	1.0000E-01	2.3754E-07
332.	EE2	8.1753E-05	1.0119E+00	9.9998E-01	3.2271E-05	1.3908E-03	2.2179E-07
333.	BB14	3.4731E-04	1.0000E+00	9.9998E-01	6.8624E-08	8.1440E-01	9.4223E-07
334.	AE2	3.0177E-04	1.0002E+00	9.9998E-01	4.8826E-07	1.1120E-01	8.1870E-07
335.	CH5	1.6832E-02	1.0002E+00	9.9997E-01	5.6389E-07	1.2296E-01	4.5663E-05
336.	GB3	4.1433E-05	1.0003E+00	9.9996E-01	8.2349E-07	1.3650E-01	1.1241E-07
337.	V13	1.7008E-04	1.0119E+00	9.9996E-01	3.2308E-05	3.0920E-03	4.6141E-07
338.	BB1	8.4380E-05	0.0000E+00	9.9994E-01	0.0000E+00	2.6740E-05	2.2892E-07
339.	BA1	8.1089E-05	0.0000E+00	9.9994E-01	0.0000E+00	2.6740E-05	2.1999E-07
340.	OS2	4.6005E-04	1.0005E+00	9.9994E-01	1.5108E-06	1.0000E-01	1.2481E-06
341.	RVB3	4.5238E-04	1.0011E+00	9.9994E-01	3.0746E-06	5.4830E-02	1.2273E-06
342.	FB1	1.2867E-04	1.0200E+00	9.9993E-01	5.4393E-05	3.4470E-03	3.4909E-07
343.	VS1	3.7479E-04	1.0988E+00	9.9993E-01	2.6816E-04	6.9239E-04	1.0168E-06
344.	MU5	1.1410E-04	1.0006E+00	9.9993E-01	1.7005E-06	1.0841E-01	3.0954E-07
345.	ZB10	1.9351E-04	1.0013E+00	9.9992E-01	3.7676E-06	5.5980E-02	5.2499E-07
346.	VINV12	1.0285E-04	1.1451E+00	9.9990E-01	3.9398E-04	6.7640E-04	2.7903E-07
347.	BE4	1.0058E-04	1.0000E+00	9.9990E-01	2.8176E-07	9.6850E-01	2.7288E-07
348.	BA3	1.0374E-04	1.1681E+00	9.9990E-01	4.5637E-04	6.0140E-04	2.8143E-07
349.	DE2	1.0258E-04	1.5784E+00	9.9990E-01	1.5695E-03	1.7602E-04	2.7829E-07
350.	RB3	1.1940E-04	1.0016E+00	9.9990E-01	4.5059E-06	6.0470E-02	3.2394E-07
351.	BE10	1.0539E-04	1.0637E+00	9.9989E-01	1.7297E-04	1.6480E-03	2.8593E-07
352.	RR3	1.0663E-04	1.0009E+00	9.9989E-01	2.6496E-06	1.0918E-01	2.8928E-07
353.	B2U21	6.8743E-04	1.1865E+00	9.9989E-01	5.0639E-04	5.8153E-04	1.8649E-06
354.	BE34	1.2695E-04	1.0164E+00	9.9989E-01	4.4846E-05	6.9180E-03	3.4442E-07
355.	VINV11	2.9985E-04	1.6217E+00	9.9988E-01	1.6871E-03	1.9240E-04	8.1347E-07
356.	BC2	1.3899E-04	1.0318E+00	9.9988E-01	8.6584E-05	3.6870E-03	3.7707E-07
357.	V33	1.4536E-04	1.5283E+00	9.9987E-01	1.4337E-03	2.5274E-04	3.9436E-07
358.	LCL1	1.5313E-04	1.0323E+00	9.9987E-01	8.8021E-05	3.8880E-03	4.1543E-07
359.	BE90	1.3792E-04	1.1705E+00	9.9986E-01	4.6299E-04	7.9950E-04	3.7418E-07
360.	VT1B1	4.5460E-04	1.5041E+00	9.9984E-01	1.3679E-03	3.1890E-04	1.2333E-06
361.	REC5	1.6090E-04	1.0023E+00	9.9984E-01	6.7444E-06	6.4720E-02	4.3650E-07
362.	TP3	1.0857E-03	1.0021E+00	9.9983E-01	6.2470E-06	7.2270E-02	2.9455E-06
363.	OB1	7.4750E-04	1.0013E+00	9.9983E-01	3.9884E-06	1.1765E-01	2.0279E-06
364.	RH2	1.8456E-04	1.0014E+00	9.9982E-01	4.4219E-06	1.1323E-01	5.0069E-07
365.	MB1	1.9022E-04	1.0251E+00	9.9981E-01	6.8679E-05	7.5140E-03	5.1606E-07
366.	AC8	1.9786E-04	1.2197E+00	9.9980E-01	5.9644E-04	8.9420E-04	5.3679E-07
367.	BC28	1.9786E-04	1.0014E+00	9.9980E-01	4.2068E-06	1.2760E-01	5.3679E-07
368.	RT2	2.0599E-04	2.2383E+00	9.9980E-01	3.3600E-03	1.6534E-04	5.5884E-07
369.	RVB1	7.7202E-03	1.0253E+00	9.9978E-01	6.9234E-05	8.6670E-03	2.0944E-05
370.	EB7	5.6559E-04	1.0022E+00	9.9976E-01	6.6186E-06	1.0000E-01	1.5344E-06
371.	BC22	4.0868E-04	1.0621E+00	9.9975E-01	1.6924E-04	3.9620E-03	1.1087E-06

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
372.	MB8	2.5755E-04	1.0032E+00	9.9974E-01	9.4524E-06	7.3920E-02	6.9872E-07
373.	PD1	1.1229E-03	1.2846E+00	9.9973E-01	7.7294E-04	9.5564E-04	3.0462E-06
374.	BE33	3.2020E-04	1.0407E+00	9.9972E-01	1.1115E-04	6.7800E-03	8.6869E-07
375.	V12	3.2615E-04	1.0820E+00	9.9968E-01	2.2344E-04	3.8430E-03	8.8483E-07
376.	GD1	5.9806E-04	1.0025E+00	9.9965E-01	7.6262E-06	1.2560E-01	1.6225E-06
377.	VB2	4.7255E-04	1.0476E+00	9.9964E-01	1.3007E-04	7.5650E-03	1.2820E-06
378.	PR4	4.8970E-04	1.0144E+00	9.9963E-01	4.0106E-05	2.5234E-02	1.3285E-06
379.	TB2	5.3972E-04	1.0065E+00	9.9963E-01	1.8760E-05	5.3944E-02	1.4642E-06
380.	MDE1	1.6091E-03	1.3244E+00	9.9961E-01	8.8101E-04	1.2150E-03	4.3654E-06
381.	SR1	7.2251E-04	1.0110E+00	9.9960E-01	3.0935E-05	3.4944E-02	1.9601E-06
382.	MA1	4.4409E-04	1.0577E+00	9.9956E-01	1.5783E-04	7.5140E-03	1.2048E-06
383.	GD2	1.7315E-03	1.0025E+00	9.9955E-01	7.9569E-06	1.5470E-01	4.6975E-06
384.	SU2	6.5947E-04	2.5643E+00	9.9953E-01	4.2451E-03	2.9848E-04	1.7891E-06
385.	V11	4.7708E-04	0.0000E+00	9.9953E-01	0.0000E+00	7.3100E-06	1.2943E-06
386.	BE41	4.6599E-04	1.0695E+00	9.9953E-01	1.8979E-04	6.6530E-03	1.2642E-06
387.	AC3	1.3463E-03	1.0042E+00	9.9951E-01	1.2660E-05	1.0520E-01	3.6524E-06
388.	DAAC1	1.1511E-03	1.7906E+00	9.9945E-01	2.1464E-03	6.9340E-04	3.1230E-06
389.	MB12	6.4388E-04	1.0080E+00	9.9936E-01	2.3403E-05	7.4640E-02	1.7468E-06
390.	WC1	7.7152E-04	1.0058E+00	9.9936E-01	1.7462E-05	1.0000E-01	2.0931E-06
391.	RR6	6.6971E-04	1.0050E+00	9.9933E-01	1.5426E-05	1.1778E-01	1.8169E-06
392.	PRA	6.8714E-04	1.0915E+00	9.9931E-01	2.5005E-04	7.4482E-03	1.8642E-06
393.	GD3	1.4666E-03	1.0037E+00	9.9929E-01	1.1916E-05	1.6140E-01	3.9787E-06
394.	PR2	7.5656E-04	1.2326E+00	9.9926E-01	6.3298E-04	3.1810E-03	2.0525E-06
395.	BA4	7.6102E-04	1.0061E+00	9.9924E-01	1.8540E-05	1.1050E-01	2.0646E-06
396.	AA2	8.0822E-04	2.1836E+00	9.9920E-01	3.2132E-03	6.7570E-04	2.1927E-06
397.	V1R1	9.7331E-04	1.0088E+00	9.9903E-01	2.6405E-05	1.0000E-01	2.6405E-06
398.	MB4	9.9957E-04	1.1337E+00	9.9900E-01	3.6542E-04	7.4210E-03	2.7118E-06
399.	VA1	7.3629E-03	1.1319E+00	9.9899E-01	3.6052E-04	7.5650E-03	1.9975E-05
400.	V37	1.3388E-03	1.0252E+00	9.9895E-01	7.1291E-05	4.0089E-02	3.6320E-06
401.	VNV2R1	1.4694E-03	1.0096E+00	9.9894E-01	2.8808E-05	1.0000E-01	3.9864E-06
402.	REC4	1.1425E-03	1.0292E+00	9.9886E-01	8.2431E-05	3.7600E-02	3.0994E-06
403.	CE1	2.4589E-03	1.8365E+00	9.9883E-01	2.2726E-03	1.3908E-03	6.6708E-06
404.	MA4	1.4641E-03	1.1647E+00	9.9877E-01	4.5023E-04	7.4210E-03	3.9721E-06
405.	CE2	1.4623E-03	2.0029E+00	9.9860E-01	2.7245E-03	1.3930E-03	3.9672E-06
406.	REC2	1.4196E-03	1.0363E+00	9.9858E-01	1.0243E-04	3.7600E-02	3.8513E-06
407.	B21	2.0118E-03	3.5138E+00	9.9854E-01	6.8238E-03	5.8153E-04	5.4579E-06
408.	RR7	1.4886E-03	1.0107E+00	9.9851E-01	3.3167E-05	1.2176E-01	4.0384E-06
409.	RD2	1.4992E-03	1.0122E+00	9.9850E-01	3.7255E-05	1.0917E-01	4.0672E-06
410.	DS2	1.5866E-03	1.0135E+00	9.9841E-01	4.0816E-05	1.0546E-01	4.3045E-06
411.	PI1	1.6691E-03	1.6224E+00	9.9837E-01	1.6928E-03	2.6076E-03	4.5283E-06
412.	SR4	1.8406E-03	1.0016E+00	9.9836E-01	8.9196E-06	4.9980E-01	4.9934E-06
413.	RB6	2.3899E-03	1.0209E+00	9.9830E-01	6.1412E-05	7.4960E-02	6.4836E-06
414.	DB1	2.7560E-03	2.7807E+00	9.9820E-01	4.8360E-03	1.0120E-03	7.4769E-06
415.	AE5	1.9351E-03	1.2766E+00	9.9811E-01	7.5563E-04	6.7815E-03	5.2499E-06
416.	A11	2.9771E-03	4.0592E+00	9.9775E-01	8.3056E-03	7.3542E-04	8.0768E-06
417.	DA1	3.3513E-03	3.3275E+00	9.9764E-01	6.3208E-03	1.0120E-03	9.0920E-06
418.	REC3	2.4983E-03	1.0252E+00	9.9750E-01	7.5042E-05	9.0320E-02	6.7778E-06
419.	REC1	3.2315E-03	1.0827E+00	9.9677E-01	2.3316E-04	3.7600E-02	8.7668E-06
420.	RT4	3.5674E-03	8.8450E+00	9.9644E-01	2.1293E-02	4.5407E-04	9.6782E-06
421.	BE1	3.7862E-03	2.1338E+01	9.9629E-01	5.5187E-02	1.8220E-04	1.0272E-05
422.	DE1	3.9082E-03	2.2272E+01	9.9626E-01	5.7719E-02	1.7602E-04	1.0603E-05
423.	GB2	4.8446E-03	1.0229E+00	9.9567E-01	7.3815E-05	1.5920E-01	1.3143E-05
424.	S22	6.4805E-03	1.3919E+00	9.9516E-01	1.0763E-03	1.2210E-02	1.7581E-05

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
425.	MF1	6.3534E-03	1.2293E+00	9.9443E-01	6.3718E-04	2.3713E-02	1.7236E-05
426.	BC33	6.4302E-03	2.5432E+00	9.9425E-01	4.2024E-03	3.7150E-03	1.7445E-05
427.	BC21	6.1187E-03	1.0562E+00	9.9409E-01	1.6852E-04	9.5160E-02	1.6600E-05
428.	GA1	7.5953E-03	1.0383E+00	9.9395E-01	1.2031E-04	1.3650E-01	2.0606E-05
429.	RH1	6.2751E-03	1.0534E+00	9.9374E-01	1.6189E-04	1.0486E-01	1.7024E-05
430.	GB1	7.2477E-03	1.0449E+00	9.9312E-01	1.4038E-04	1.3290E-01	1.9663E-05
431.	AC1	8.0914E-03	3.1175E+01	9.9208E-01	8.1885E-02	2.6250E-04	2.1952E-05
432.	RL4	1.8308E-02	1.0719E+00	9.9201E-01	2.1688E-04	1.0000E-01	4.9668E-05
433.	RR4	8.9594E-03	1.0731E+00	9.9104E-01	2.2263E-04	1.0918E-01	2.4306E-05
434.	VNV1R1	1.4526E-02	1.0885E+00	9.9017E-01	2.6679E-04	1.0000E-01	3.9407E-05
435.	BE2	9.9166E-03	1.2559E+00	9.9009E-01	7.2118E-04	3.7270E-02	2.6903E-05
436.	AE1	1.0353E-02	5.5206E+01	9.8974E-01	1.4709E-01	1.8919E-04	2.8086E-05
437.	RB5	1.3488E-02	1.4455E+00	9.8947E-01	1.2373E-03	2.3080E-02	3.6592E-05
438.	MU2	1.3605E-01	1.0139E+00	9.8905E-01	6.7351E-05	4.4090E-01	3.6909E-04
439.	EB1	1.3489E-02	1.0961E+00	9.8859E-01	2.9158E-04	1.0618E-01	3.6594E-05
440.	MU6	9.6704E-02	1.0101E+00	9.8772E-01	6.0656E-05	5.4931E-01	2.6235E-04
441.	RL1	2.2365E-02	2.3585E+00	9.8620E-01	3.7228E-03	1.0053E-02	6.0674E-05
442.	RD1	1.4126E-02	1.1203E+00	9.8587E-01	3.6473E-04	1.0507E-01	3.8322E-05
443.	SL1	3.1177E-02	1.0825E+00	9.8552E-01	2.6307E-04	1.4934E-01	8.4580E-05
444.	TPR1	3.3686E-02	1.0028E+00	9.8503E-01	4.8115E-05	8.4400E-01	9.1388E-05
445.	DS4	1.7515E-02	1.1324E+00	9.8439E-01	4.0156E-04	1.0546E-01	4.7518E-05
446.	PL1	7.9165E-02	1.0080E+00	9.8428E-01	6.4410E-05	6.6200E-01	2.1477E-04
447.	OGR11	1.7390E-02	1.0480E+00	9.8355E-01	1.7496E-04	2.5500E-01	4.7179E-05
448.	BE3	2.0855E-02	1.1467E+00	9.8168E-01	4.4765E-04	1.1100E-01	5.6579E-05
449.	EB3	2.4978E-02	1.1581E+00	9.8122E-01	4.7983E-04	1.0619E-01	6.7763E-05
450.	B11	2.4192E-02	3.2950E+01	9.7649E-01	8.6742E-02	7.3542E-04	6.5631E-05
451.	RT1	2.4049E-02	1.5346E+02	9.7607E-01	4.1369E-01	1.5696E-04	6.5245E-05
452.	CCSR3	2.5858E-02	1.2301E+00	9.7443E-01	6.9372E-04	1.0000E-01	7.0151E-05
453.	MU4	2.0637E-01	1.0229E+00	9.7216E-01	1.3754E-04	5.4906E-01	5.5987E-04
454.	PR1	2.8640E-02	6.8829E+00	9.7145E-01	1.6037E-02	4.8296E-03	7.7699E-05
455.	ZA1	3.4519E-02	4.5575E+00	9.6897E-01	9.7355E-03	8.6459E-03	9.3647E-05
456.	OF1	3.1865E-02	1.2866E+00	9.6816E-01	8.6383E-04	1.0000E-01	8.6449E-05
457.	AC2	4.1012E-02	1.3528E+00	9.5966E-01	1.0666E-03	1.0260E-01	1.1126E-04
458.	RT8	8.3675E-02	1.7025E+00	9.2181E-01	2.1179E-03	1.0016E-01	2.2701E-04
459.	CCPR1	1.0237E-01	1.7052E+00	9.2165E-01	2.1256E-03	1.0000E-01	2.7772E-04
460.	OS3	8.7408E-02	1.7220E+00	9.1978E-01	2.1764E-03	1.0000E-01	2.3713E-04
461.	SEH	8.4029E-02	1.7333E+00	9.1600E-01	2.2172E-03	1.0278E-01	2.2796E-04
462.	DS8	9.1348E-02	1.8206E+00	9.0882E-01	2.4737E-03	1.0000E-01	2.4782E-04
463.	RR5	1.1148E-01	1.9096E+00	8.8852E-01	2.7700E-03	1.0918E-01	3.0243E-04
464.	ZB6	1.1708E-01	2.8869E+00	8.8312E-01	5.4361E-03	5.8330E-02	3.1763E-04
465.	MU3	1.2327E-01	2.0146E+00	8.7695E-01	3.0865E-03	1.0816E-01	3.3443E-04
466.	SED	2.1396E-01	2.8668E+00	7.8615E-01	5.6447E-03	1.0278E-01	5.8046E-04
467.	RR1	3.3826E-01	4.0131E+00	6.6174E-01	9.0922E-03	1.0093E-01	9.1767E-04
468.	DEF	6.4208E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7419E-04
469.	MUF	5.9304E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6089E-04
470.	SGCLGF	6.7500E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8312E-04
471.	FEF	6.2795E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7036E-04
472.	ZAF	1.1279E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0600E-04
473.	PRF	1.1231E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0468E-04
474.	DAACF	1.1164E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0288E-04
475.	MELTSF	8.0045E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1716E-04
476.	TPF	6.9664E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8899E-04
477.	SYCF	7.2321E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9620E-04

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
478.	MELTF	1.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7129E-03
479.	B1LF	8.0020E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1709E-04
480.	VT1BF	7.8529E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1304E-04
481.	TPRF	6.9664E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8899E-04
482.	DAF	1.9186E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.2050E-06
483.	PBF	2.3472E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.3679E-05
484.	BEF	2.6980E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3195E-05
485.	CCSRF	4.0040E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0863E-04
486.	PDF	3.4742E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.4254E-05
487.	VINV1F	5.6349E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5287E-04
488.	CCPRF	2.5429E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.8986E-05
489.	B2LF	5.9050E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6020E-04
490.	CIF	8.5903E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3305E-04
491.	BCF	1.0282E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7893E-04
492.	BYAF	1.1508E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.1220E-04
493.	MAF	1.0597E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.8748E-04
494.	MFF	2.8873E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.8331E-05
495.	ZBF	2.9699E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.0573E-05
496.	DBACF	2.9141E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.9057E-05
497.	BALF	5.5374E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5023E-04
498.	BBLF	4.6420E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2593E-05
499.	DSLRF	3.3797E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.1688E-07
500.	VT2BF	4.5260E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2279E-05
501.	BBF	3.9570E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0735E-05
502.	VSF	3.9997E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0851E-06
503.	LYAF	1.9404E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.2642E-07
504.	GBF	1.2867E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4909E-07
505.	LYNF	3.5114E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.5262E-07
506.	A2U2LF	3.1453E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.5330E-06
507.	B1U2F	4.4500E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2073E-05
508.	B2U2F	4.4500E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2073E-05
509.	DCACF	3.7402E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0147E-05
510.	ABLF	3.1453E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.5330E-06
511.	A1U2LF	3.2213E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.7392E-06
512.	IYBF	1.9962E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4155E-06
513.	DHF	2.7712E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.5182E-06
514.	SRF	8.8017E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3879E-06
515.	VT2AF	2.7712E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.5182E-06
516.	SLF	2.5563E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.9350E-06
517.	ABF	2.2735E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.1678E-06
518.	DBF	1.0748E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9160E-06
519.	SYAF	1.2681E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4403E-06
520.	SYBF	3.9676E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0764E-07
521.	RLF	1.2296E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.3359E-07
522.	RHF	1.1940E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2394E-07
523.	GAF	4.1433E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1241E-07
524.	A2U2F	2.6952E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3120E-06
525.	A1U2F	2.6952E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3120E-06
526.	DDACF	2.8523E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.7381E-06
527.	UB1AF	1.8830E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1085E-05
528.	LYCF	7.1784E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9475E-05
529.	HHF	7.7153E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0931E-05
530.	SYNF	6.4166E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7408E-05

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
531.	UB1DF	1.8721E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0788E-05
532.	V1F	5.6884E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5432E-05
533.	AALF	1.1960E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2448E-05
534.	VT1AF	1.3976E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.7916E-05
535.	V1RF	5.6884E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5432E-05
536.	DGF	1.3976E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.7916E-05
537.	RSF	1.3304E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.6094E-05
538.	UB1BF	1.8721E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0788E-05
539.	B1U2LF	4.7180E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2800E-05
540.	LOWPRF	1.8657E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0615E-05
541.	SIF	3.0711E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.3318E-04
542.	AAF	1.0191E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7646E-05
543.	B3F	1.7390E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7179E-05
544.	MELTLF	7.7236E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0954E-05
545.	AEF	9.0551E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.4566E-05
546.	CMF	3.3106E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.9814E-04
547.	PAF	2.1717E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8917E-05
548.	OGF	2.0151E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4668E-05
549.	EEF	2.1645E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8721E-05
550.	VINV2F	5.1374E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3938E-05
551.	CEF	2.1645E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8721E-05
552.	UB1CF	1.8830E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1085E-05
553.	PEF	1.9059E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1705E-05
554.	B2U2LF	5.3294E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4458E-05
555.	CDF	1.8795E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0990E-05
556.	A2LF	1.2158E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2985E-05
557.	FWF	1.6127E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.3752E-05
558.	A1F	1.0999E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9839E-05
559.	A1LF	1.4937E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0524E-05
560.	A3F	1.7390E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7179E-05
561.	CTMUF	2.0151E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4668E-05
562.	OBF	1.2340E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.3476E-05
563.	BYBF	1.1677E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.1679E-05
564.	A2F	1.0999E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9839E-05
565.	RVAF	5.7085E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5487E-04
566.	RAF	4.3933E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1919E-03
567.	CSBF	4.3141E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1704E-03
568.	S1F	4.3933E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1919E-03
569.	RQF	6.4514E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7502E-03
570.	TBF	6.4391E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7469E-03
571.	RECF	9.9155E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.6900E-03
572.	DPF	8.7196E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3656E-03
573.	CSIF	4.2974E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1659E-03
574.	INTPRF	9.1292E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.4767E-03
575.	DSNN	7.6116E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0650E-03
576.	B1F	5.4337E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4741E-04
577.	BAF	5.3391E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4485E-04
578.	B2F	5.4337E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4741E-04
579.	OTF	4.4624E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2106E-04
580.	CSRF	4.8713E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3216E-03
581.	MSF	6.3920E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7341E-03
582.	V3F	2.2147E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.0083E-05
583.	CSAF	5.6327E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5281E-03

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Risk Reduction Worth

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
584.	S2F	3.0537E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2844E-04
585.	CHF	4.2942E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1650E-03
586.	MBF	1.4227E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8597E-04
587.	SEF	3.4518E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.3646E-04
588.	RDF	1.4241E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8634E-04
589.	MELTBF	1.2675E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4388E-04
590.	RBF	3.0537E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2844E-04
591.	CAVF	3.4466E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.3505E-04
592.	RRF	3.6453E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.8894E-04
593.	IYAF	7.8348E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1255E-03
594.	RVBF	1.2108E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2849E-04
595.	MELTIF	7.8548E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1310E-03
596.	ARF	1.5210E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.1264E-04
597.	RHRSF	8.6007E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3333E-03
598.	VBF	3.0497E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2736E-04
599.	ACF	2.9333E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.9578E-04
600.	VCF	2.1853E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.9287E-04
601.	VAF	1.4987E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0659E-04

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
1.	RT1	2.4049E-02	1.5346E+02	9.7607E-01	4.1369E-01	1.5696E-04	6.5245E-05
2.	AE1	1.0353E-02	5.5206E+01	9.8974E-01	1.4709E-01	1.8919E-04	2.8086E-05
3.	B11	2.4192E-02	3.2950E+01	9.7649E-01	8.6742E-02	7.3542E-04	6.5631E-05
4.	AC1	8.0914E-03	3.1175E+01	9.9208E-01	8.1885E-02	2.6250E-04	2.1952E-05
5.	DE1	3.9082E-03	2.2272E+01	9.9626E-01	5.7719E-02	1.7602E-04	1.0603E-05
6.	BE1	3.7862E-03	2.1338E+01	9.9629E-01	5.5187E-02	1.8220E-04	1.0272E-05
7.	RT4	3.5674E-03	8.8450E+00	9.9644E-01	2.1293E-02	4.5407E-04	9.6782E-06
8.	PR1	2.8640E-02	6.8829E+00	9.7145E-01	1.6037E-02	4.8296E-03	7.7699E-05
9.	ZA1	3.4519E-02	4.5575E+00	9.6897E-01	9.7355E-03	8.6459E-03	9.3647E-05
10.	RR1	3.3826E-01	4.0131E+00	6.6174E-01	9.0922E-03	1.0093E-01	9.1767E-04
11.	A11	2.9771E-03	4.0592E+00	9.9775E-01	8.3056E-03	7.3542E-04	8.0768E-06
12.	B21	2.0118E-03	3.5138E+00	9.9854E-01	6.8238E-03	5.8153E-04	5.4579E-06
13.	DA1	3.3513E-03	3.3275E+00	9.9764E-01	6.3208E-03	1.0120E-03	9.0920E-06
14.	SED	2.1396E-01	2.8668E+00	7.8615E-01	5.6447E-03	1.0278E-01	5.8046E-04
15.	ZB6	1.1708E-01	2.8869E+00	8.8312E-01	5.4361E-03	5.8330E-02	3.1763E-04
16.	DB1	2.7560E-03	2.7807E+00	9.9820E-01	4.8360E-03	1.0120E-03	7.4769E-06
17.	SU2	6.5947E-04	2.5643E+00	9.9953E-01	4.2451E-03	2.9848E-04	1.7891E-06
18.	BC33	6.4302E-03	2.5432E+00	9.9425E-01	4.2024E-03	3.7150E-03	1.7445E-05
19.	RL1	2.2365E-02	2.3585E+00	9.8620E-01	3.7228E-03	1.0053E-02	6.0674E-05
20.	RT2	2.0599E-04	2.2383E+00	9.9980E-01	3.3600E-03	1.6534E-04	5.5884E-07
21.	AA2	8.0822E-04	2.1836E+00	9.9920E-01	3.2132E-03	6.7570E-04	2.1927E-06
22.	MU3	1.2327E-01	2.0146E+00	8.7695E-01	3.0865E-03	1.0816E-01	3.3443E-04
23.	RR5	1.1148E-01	1.9096E+00	8.8852E-01	2.7700E-03	1.0918E-01	3.0243E-04
24.	CE2	1.4623E-03	2.0029E+00	9.9860E-01	2.7245E-03	1.3930E-03	3.9672E-06
25.	DS8	9.1348E-02	1.8206E+00	9.0882E-01	2.4737E-03	1.0000E-01	2.4782E-04
26.	CE1	2.4589E-03	1.8365E+00	9.9883E-01	2.2726E-03	1.3908E-03	6.6708E-06
27.	SEH	8.4029E-02	1.7333E+00	9.1600E-01	2.2172E-03	1.0278E-01	2.2796E-04
28.	OS3	8.7408E-02	1.7220E+00	9.1978E-01	2.1764E-03	1.0000E-01	2.3713E-04
29.	DAAC1	1.1511E-03	1.7906E+00	9.9945E-01	2.1464E-03	6.9340E-04	3.1230E-06
30.	CCPR1	1.0237E-01	1.7052E+00	9.2165E-01	2.1256E-03	1.0000E-01	2.7772E-04
31.	RT8	8.3675E-02	1.7025E+00	9.2181E-01	2.1179E-03	1.0016E-01	2.2701E-04
32.	PI1	1.6691E-03	1.6224E+00	9.9837E-01	1.6928E-03	2.6076E-03	4.5283E-06
33.	VINV11	2.9985E-04	1.6217E+00	9.9988E-01	1.6871E-03	1.9240E-04	8.1347E-07
34.	DE2	1.0258E-04	1.5784E+00	9.9990E-01	1.5695E-03	1.7602E-04	2.7829E-07
35.	V33	1.4536E-04	1.5283E+00	9.9987E-01	1.4337E-03	2.5274E-04	3.9436E-07
36.	VT1B1	4.5460E-04	1.5041E+00	9.9984E-01	1.3679E-03	3.1890E-04	1.2333E-06
37.	RB5	1.3488E-02	1.4455E+00	9.8947E-01	1.2373E-03	2.3080E-02	3.6592E-05
38.	S22	6.4805E-03	1.3919E+00	9.9516E-01	1.0763E-03	1.2210E-02	1.7581E-05
39.	AC2	4.1012E-02	1.3528E+00	9.5966E-01	1.0666E-03	1.0260E-01	1.1126E-04
40.	MDE1	1.6091E-03	1.3244E+00	9.9961E-01	8.8101E-04	1.2150E-03	4.3654E-06
41.	OF1	3.1865E-02	1.2866E+00	9.6816E-01	8.6383E-04	1.0000E-01	8.6449E-05
42.	PD1	1.1229E-03	1.2846E+00	9.9973E-01	7.7294E-04	9.5564E-04	3.0462E-06
43.	AE5	1.9351E-03	1.2766E+00	9.9811E-01	7.5563E-04	6.7815E-03	5.2499E-06
44.	BE2	9.9166E-03	1.2559E+00	9.9009E-01	7.2118E-04	3.7270E-02	2.6903E-05
45.	CCSR3	2.5858E-02	1.2301E+00	9.7443E-01	6.9372E-04	1.0000E-01	7.0151E-05
46.	MF1	6.3534E-03	1.2293E+00	9.9443E-01	6.3718E-04	2.3713E-02	1.7236E-05
47.	PR2	7.5656E-04	1.2326E+00	9.9926E-01	6.3298E-04	3.1810E-03	2.0525E-06
48.	AC8	1.9786E-04	1.2197E+00	9.9980E-01	5.9644E-04	8.9420E-04	5.3679E-07
49.	B2U21	6.8743E-04	1.1865E+00	9.9989E-01	5.0639E-04	5.8153E-04	1.8649E-06
50.	EB3	2.4978E-02	1.1581E+00	9.8122E-01	4.7983E-04	1.0619E-01	6.7763E-05
51.	BE90	1.3792E-04	1.1705E+00	9.9986E-01	4.6299E-04	7.9950E-04	3.7418E-07
52.	BA3	1.0374E-04	1.1681E+00	9.9990E-01	4.5637E-04	6.0140E-04	2.8143E-07
53.	MA4	1.4641E-03	1.1647E+00	9.9877E-01	4.5023E-04	7.4210E-03	3.9721E-06

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
54.	BE3	2.0855E-02	1.1467E+00	9.8168E-01	4.4765E-04	1.1100E-01	5.6579E-05
55.	DS4	1.7515E-02	1.1324E+00	9.8439E-01	4.0156E-04	1.0546E-01	4.7518E-05
56.	VINV12	1.0285E-04	1.1451E+00	9.9990E-01	3.9398E-04	6.7640E-04	2.7903E-07
57.	MB4	9.9957E-04	1.1337E+00	9.9900E-01	3.6542E-04	7.4210E-03	2.7118E-06
58.	RD1	1.4126E-02	1.1203E+00	9.8587E-01	3.6473E-04	1.0507E-01	3.8322E-05
59.	VA1	7.3629E-03	1.1319E+00	9.9899E-01	3.6052E-04	7.5650E-03	1.9975E-05
60.	EB1	1.3489E-02	1.0961E+00	9.8859E-01	2.9158E-04	1.0618E-01	3.6594E-05
61.	VS1	3.7479E-04	1.0988E+00	9.9993E-01	2.6816E-04	6.9239E-04	1.0168E-06
62.	VNV1R1	1.4526E-02	1.0885E+00	9.9017E-01	2.6679E-04	1.0000E-01	3.9407E-05
63.	SL1	3.1177E-02	1.0825E+00	9.8552E-01	2.6307E-04	1.4934E-01	8.4580E-05
64.	PRA	6.8714E-04	1.0915E+00	9.9931E-01	2.5005E-04	7.4482E-03	1.8642E-06
65.	REC1	3.2315E-03	1.0827E+00	9.9677E-01	2.3316E-04	3.7600E-02	8.7668E-06
66.	V12	3.2615E-04	1.0820E+00	9.9968E-01	2.2344E-04	3.8430E-03	8.8483E-07
67.	RR4	8.9594E-03	1.0731E+00	9.9104E-01	2.2263E-04	1.0918E-01	2.4306E-05
68.	RL4	1.8308E-02	1.0719E+00	9.9201E-01	2.1688E-04	1.0000E-01	4.9668E-05
69.	BE41	4.6599E-04	1.0695E+00	9.9953E-01	1.8979E-04	6.6530E-03	1.2642E-06
70.	OGR11	1.7390E-02	1.0480E+00	9.8355E-01	1.7496E-04	2.5500E-01	4.7179E-05
71.	BE10	1.0539E-04	1.0637E+00	9.9989E-01	1.7297E-04	1.6480E-03	2.8593E-07
72.	BC22	4.0868E-04	1.0621E+00	9.9975E-01	1.6924E-04	3.9620E-03	1.1087E-06
73.	BC21	6.1187E-03	1.0562E+00	9.9409E-01	1.6852E-04	9.5160E-02	1.6600E-05
74.	RH1	6.2751E-03	1.0534E+00	9.9374E-01	1.6189E-04	1.0486E-01	1.7024E-05
75.	MA1	4.4409E-04	1.0577E+00	9.9956E-01	1.5783E-04	7.5140E-03	1.2048E-06
76.	GB1	7.2477E-03	1.0449E+00	9.9312E-01	1.4038E-04	1.3290E-01	1.9663E-05
77.	MU4	2.0637E-01	1.0229E+00	9.7216E-01	1.3754E-04	5.4906E-01	5.5987E-04
78.	VB2	4.7255E-04	1.0476E+00	9.9964E-01	1.3007E-04	7.5650E-03	1.2820E-06
79.	GA1	7.5953E-03	1.0383E+00	9.9395E-01	1.2031E-04	1.3650E-01	2.0606E-05
80.	BE33	3.2020E-04	1.0407E+00	9.9972E-01	1.1115E-04	6.7800E-03	8.6869E-07
81.	REC2	1.4196E-03	1.0363E+00	9.9858E-01	1.0243E-04	3.7600E-02	3.8513E-06
82.	LCL1	1.5313E-04	1.0323E+00	9.9987E-01	8.8021E-05	3.8880E-03	4.1543E-07
83.	BC2	1.3899E-04	1.0318E+00	9.9988E-01	8.6584E-05	3.6870E-03	3.7707E-07
84.	REC4	1.1425E-03	1.0292E+00	9.9886E-01	8.2431E-05	3.7600E-02	3.0994E-06
85.	REC3	2.4983E-03	1.0252E+00	9.9750E-01	7.5042E-05	9.0320E-02	6.7778E-06
86.	GB2	4.8446E-03	1.0229E+00	9.9567E-01	7.3815E-05	1.5920E-01	1.3143E-05
87.	V37	1.3388E-03	1.0252E+00	9.9895E-01	7.1291E-05	4.0089E-02	3.6320E-06
88.	RVB1	7.7202E-03	1.0253E+00	9.9978E-01	6.9234E-05	8.6670E-03	2.0944E-05
89.	MB1	1.9022E-04	1.0251E+00	9.9981E-01	6.8679E-05	7.5140E-03	5.1606E-07
90.	MU2	1.3605E-01	1.0139E+00	9.8905E-01	6.7351E-05	4.4090E-01	3.6909E-04
91.	PL1	7.9165E-02	1.0080E+00	9.8428E-01	6.4410E-05	6.6200E-01	2.1477E-04
92.	RB6	2.3899E-03	1.0209E+00	9.9830E-01	6.1412E-05	7.4960E-02	6.4836E-06
93.	MU6	9.6704E-02	1.0101E+00	9.8772E-01	6.0656E-05	5.4931E-01	2.6235E-04
94.	FB1	1.2867E-04	1.0200E+00	9.9993E-01	5.4393E-05	3.4470E-03	3.4909E-07
95.	TPR1	3.3686E-02	1.0028E+00	9.8503E-01	4.8115E-05	8.4400E-01	9.1388E-05
96.	BE34	1.2695E-04	1.0164E+00	9.9989E-01	4.4846E-05	6.9180E-03	3.4442E-07
97.	DS2	1.5866E-03	1.0135E+00	9.9841E-01	4.0816E-05	1.0546E-01	4.3045E-06
98.	PR4	4.8970E-04	1.0144E+00	9.9963E-01	4.0106E-05	2.5234E-02	1.3285E-06
99.	RD2	1.4992E-03	1.0122E+00	9.9850E-01	3.7255E-05	1.0917E-01	4.0672E-06
100.	RR7	1.4886E-03	1.0107E+00	9.9851E-01	3.3167E-05	1.2176E-01	4.0384E-06
101.	V13	1.7008E-04	1.0119E+00	9.9996E-01	3.2308E-05	3.0920E-03	4.6141E-07
102.	EE2	8.1753E-05	1.0119E+00	9.9998E-01	3.2271E-05	1.3908E-03	2.2179E-07
103.	SR1	7.2251E-04	1.0110E+00	9.9960E-01	3.0935E-05	3.4944E-02	1.9601E-06
104.	VNV2R1	1.4694E-03	1.0096E+00	9.9894E-01	2.8808E-05	1.0000E-01	3.9864E-06
105.	V1R1	9.7331E-04	1.0088E+00	9.9903E-01	2.6405E-05	1.0000E-01	2.6405E-06
106.	MB12	6.4388E-04	1.0080E+00	9.9936E-01	2.3403E-05	7.4640E-02	1.7468E-06

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
107.	TB2	5.3972E-04	1.0065E+00	9.9963E-01	1.8760E-05	5.3944E-02	1.4642E-06
108.	BA4	7.6102E-04	1.0061E+00	9.9924E-01	1.8540E-05	1.1050E-01	2.0646E-06
109.	WC1	7.7152E-04	1.0058E+00	9.9936E-01	1.7462E-05	1.0000E-01	2.0931E-06
110.	RR6	6.6971E-04	1.0050E+00	9.9933E-01	1.5426E-05	1.1778E-01	1.8169E-06
111.	AC3	1.3463E-03	1.0042E+00	9.9951E-01	1.2660E-05	1.0520E-01	3.6524E-06
112.	GD3	1.4666E-03	1.0037E+00	9.9929E-01	1.1916E-05	1.6140E-01	3.9787E-06
113.	MB8	2.5755E-04	1.0032E+00	9.9974E-01	9.4524E-06	7.3920E-02	6.9872E-07
114.	SR4	1.8406E-03	1.0016E+00	9.9836E-01	8.9196E-06	4.9980E-01	4.9934E-06
115.	GD2	1.7315E-03	1.0025E+00	9.9955E-01	7.9569E-06	1.5470E-01	4.6975E-06
116.	GD1	5.9806E-04	1.0025E+00	9.9965E-01	7.6262E-06	1.2560E-01	1.6225E-06
117.	REC5	1.6090E-04	1.0023E+00	9.9984E-01	6.7444E-06	6.4720E-02	4.3650E-07
118.	EB7	5.6559E-04	1.0022E+00	9.9976E-01	6.6186E-06	1.0000E-01	1.5344E-06
119.	TP3	1.0857E-03	1.0021E+00	9.9983E-01	6.2470E-06	7.2270E-02	2.9455E-06
120.	RB3	1.1940E-04	1.0016E+00	9.9990E-01	4.5059E-06	6.0470E-02	3.2394E-07
121.	RH2	1.8456E-04	1.0014E+00	9.9982E-01	4.4219E-06	1.1323E-01	5.0069E-07
122.	BC28	1.9786E-04	1.0014E+00	9.9980E-01	4.2068E-06	1.2760E-01	5.3679E-07
123.	OB1	7.4750E-04	1.0013E+00	9.9983E-01	3.9884E-06	1.1765E-01	2.0279E-06
124.	ZB10	1.9351E-04	1.0013E+00	9.9992E-01	3.7676E-06	5.5980E-02	5.2499E-07
125.	RVB3	4.5238E-04	1.0011E+00	9.9994E-01	3.0746E-06	5.4830E-02	1.2273E-06
126.	RR3	1.0663E-04	1.0009E+00	9.9989E-01	2.6496E-06	1.0918E-01	2.8928E-07
127.	MU5	1.1410E-04	1.0006E+00	9.9993E-01	1.7005E-06	1.0841E-01	3.0954E-07
128.	OS2	4.6005E-04	1.0005E+00	9.9994E-01	1.5108E-06	1.0000E-01	1.2481E-06
129.	GB3	4.1433E-05	1.0003E+00	9.9996E-01	8.2349E-07	1.3650E-01	1.1241E-07
130.	RT9	6.2197E-05	1.0002E+00	9.9998E-01	6.7448E-07	1.0016E-01	1.6874E-07
131.	DS9	8.7558E-05	1.0002E+00	9.9998E-01	6.3759E-07	1.0000E-01	2.3754E-07
132.	CH5	1.6832E-02	1.0002E+00	9.9997E-01	5.6389E-07	1.2296E-01	4.5663E-05
133.	AE2	3.0177E-04	1.0002E+00	9.9998E-01	4.8826E-07	1.1120E-01	8.1870E-07
134.	BE4	1.0058E-04	1.0000E+00	9.9990E-01	2.8176E-07	9.6850E-01	2.7288E-07
135.	BB14	3.4731E-04	1.0000E+00	9.9998E-01	6.8624E-08	8.1440E-01	9.4223E-07
136.	MU1	6.4906E-04	1.0000E+00	1.0000E+00	1.0492E-08	4.4090E-01	1.7609E-06
137.	SGCLGS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
138.	MELTSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
139.	RTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
140.	B1LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
141.	AF4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.4009E-06	0.0000E+00
142.	SYCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
143.	AF2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.8286E-06	0.0000E+00
144.	SRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
145.	A2U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
146.	SES	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
147.	SE9	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0752E-06	0.0000E+00
148.	RHRSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
149.	RW1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.3840E-07	0.0000E+00
150.	FAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
151.	V35	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.0398E-05	0.0000E+00
152.	AF1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6562E-06	0.0000E+00
153.	BB1	8.4380E-05	0.0000E+00	9.9994E-01	0.0000E+00	2.6740E-05	2.2892E-07
154.	BA1	8.1089E-05	0.0000E+00	9.9994E-01	0.0000E+00	2.6740E-05	2.1999E-07
155.	AB1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6740E-05	0.0000E+00
156.	SLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
157.	WCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
158.	SYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
159.	AF5	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.9248E-05	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
160.	A1U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
161.	BE49	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.9360E-05	0.0000E+00
162.	AE7	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.0291E-05	0.0000E+00
163.	AF6	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0804E-05	0.0000E+00
164.	SE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.0752E-06	0.0000E+00
165.	BB2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.8580E-05	0.0000E+00
166.	AF3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.8286E-06	0.0000E+00
167.	BBLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
168.	BE65	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.9360E-05	0.0000E+00
169.	PRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
170.	B2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
171.	A1LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
172.	MSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
173.	FDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
174.	VS3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.6996E-06	0.0000E+00
175.	OSS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
176.	PE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.0078E-06	0.0000E+00
177.	OTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
178.	B2U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
179.	B1U2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
180.	RTB	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.4121E-06	0.0000E+00
181.	IC1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.0020E-06	0.0000E+00
182.	HHF	7.7153E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0931E-05
183.	LYCF	7.1784E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9475E-05
184.	SYNF	6.4166E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7408E-05
185.	DDACF	2.8523E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.7381E-06
186.	UB1AF	1.8830E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1085E-05
187.	A1U2F	2.6952E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3120E-06
188.	V1RF	5.6884E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5432E-05
189.	VT1AF	1.3976E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.7916E-05
190.	UB1DF	1.8721E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0788E-05
191.	V1F	5.6884E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5432E-05
192.	AALF	1.1960E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2448E-05
193.	DGF	1.3976E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.7916E-05
194.	ABF	2.2735E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.1678E-06
195.	SLF	2.5563E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.9350E-06
196.	DBF	1.0748E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9160E-06
197.	SRF	8.8017E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3879E-06
198.	VT2AF	2.7712E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.5182E-06
199.	A2U2F	2.6952E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3120E-06
200.	GAF	4.1433E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1241E-07
201.	RHF	1.1940E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2394E-07
202.	SYAF	1.2681E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4403E-06
203.	SYBF	3.9676E-05	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0764E-07
204.	RLF	1.2296E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.3359E-07
205.	DHF	2.7712E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.5182E-06
206.	UB1CF	1.8830E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1085E-05
207.	CEF	2.1645E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8721E-05
208.	PEF	1.9059E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.1705E-05
209.	EEF	2.1645E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8721E-05
210.	VINV2F	5.1374E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3938E-05
211.	OGF	2.0151E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4668E-05
212.	A1F	1.0999E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9839E-05

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
213.	FWF	1.6127E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.3752E-05
214.	B2U2LF	5.3294E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4458E-05
215.	CDF	1.8795E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0990E-05
216.	A2LF	1.2158E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2985E-05
217.	RSF	1.3304E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.6094E-05
218.	SIF	3.0711E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.3318E-04
219.	LOWPRF	1.8657E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0615E-05
220.	AAF	1.0191E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7646E-05
221.	UB1BF	1.8721E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.0788E-05
222.	B1U2LF	4.7180E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2800E-05
223.	PAF	2.1717E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.8917E-05
224.	CMF	3.3106E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.9814E-04
225.	AEF	9.0551E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.4566E-05
226.	B3F	1.7390E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7179E-05
227.	MELTLF	7.7236E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0954E-05
228.	V11	4.7708E-04	0.0000E+00	9.9953E-01	0.0000E+00	7.3100E-06	1.2943E-06
229.	DAF	1.9186E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.2050E-06
230.	TPRF	6.9664E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8899E-04
231.	PBF	2.3472E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.3679E-05
232.	B1LF	8.0020E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1709E-04
233.	VT1BF	7.8529E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1304E-04
234.	MELTF	1.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7129E-03
235.	CCPRF	2.5429E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.8986E-05
236.	VINV1F	5.6349E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5287E-04
237.	BEF	2.6980E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.3195E-05
238.	CCSRF	4.0040E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0863E-04
239.	PDF	3.4742E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.4254E-05
240.	B2LF	5.9050E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6020E-04
241.	FEF	6.2795E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7036E-04
242.	SGCLGF	6.7500E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8312E-04
243.	ZAF	1.1279E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0600E-04
244.	DEF	6.4208E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7419E-04
245.	MUF	5.9304E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.6089E-04
246.	SYCF	7.2321E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.9620E-04
247.	TPF	6.9664E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.8899E-04
248.	MELTSF	8.0045E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1716E-04
249.	PRF	1.1231E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0468E-04
250.	DAACF	1.1164E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.0288E-04
251.	IYBF	1.9962E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4155E-06
252.	LYNF	3.5114E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.5262E-07
253.	GBF	1.2867E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4909E-07
254.	A2U2LF	3.1453E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.5330E-06
255.	VSF	3.9997E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0851E-06
256.	LYAF	1.9404E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.2642E-07
257.	BBF	3.9570E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0735E-05
258.	A1U2LF	3.2213E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.7392E-06
259.	ABLF	3.1453E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.5330E-06
260.	B1U2F	4.4500E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2073E-05
261.	B2U2F	4.4500E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2073E-05
262.	DCACF	3.7402E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.0147E-05
263.	CIF	8.5903E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3305E-04
264.	MFF	2.8873E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.8331E-05
265.	MAF	1.0597E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.8748E-04

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
266.	ZBF	2.9699E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.0573E-05
267.	BCF	1.0282E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.7893E-04
268.	BYAF	1.1508E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.1220E-04
269.	VT2BF	4.5260E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2279E-05
270.	DSLRF	3.3797E-04	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.1688E-07
271.	BBLF	4.6420E-03	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2593E-05
272.	DBACF	2.9141E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.9057E-05
273.	BALF	5.5374E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5023E-04
274.	A1LF	1.4937E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0524E-05
275.	FBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
276.	TT1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	3.8253E-06	0.0000E+00
277.	TTS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
278.	A2LS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
279.	MELTIF	7.8548E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1310E-03
280.	FCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
281.	ABLS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
282.	CTMUF	2.0151E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.4668E-05
283.	A3F	1.7390E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.7179E-05
284.	V14	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3710E-05	0.0000E+00
285.	V32	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.5407E-06	0.0000E+00
286.	RVBF	1.2108E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.2849E-04
287.	IYAF	7.8348E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.1255E-03
288.	V25	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.9840E-06	0.0000E+00
289.	V21	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	7.0910E-06	0.0000E+00
290.	DP2	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.1999E-05	0.0000E+00
291.	CL1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	4.8220E-06	0.0000E+00
292.	CMS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
293.	DSLRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
294.	CSRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
295.	V24	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.9740E-06	0.0000E+00
296.	GAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
297.	IYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
298.	DP1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.1494E-06	0.0000E+00
299.	LYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
300.	S1F	4.3933E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1919E-03
301.	DSNN	7.6116E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.0650E-03
302.	RQF	6.4514E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7502E-03
303.	RAF	4.3933E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1919E-03
304.	CSBF	4.3141E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1704E-03
305.	MBF	1.4227E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8597E-04
306.	CHF	4.2942E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1650E-03
307.	CSIF	4.2974E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.1659E-03
308.	TBF	6.4391E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7469E-03
309.	RECF	9.9155E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.6900E-03
310.	DPF	8.7196E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3656E-03
311.	RRF	3.6453E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.8894E-04
312.	A2F	1.0999E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.9839E-05
313.	BYBF	1.1677E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.1679E-05
314.	CAVF	3.4466E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.3505E-04
315.	S2F	3.0537E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2844E-04
316.	OBF	1.2340E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.3476E-05
317.	SEF	3.4518E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	9.3646E-04
318.	RDF	1.4241E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.8634E-04

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
319.	MELTBF	1.2675E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	3.4388E-04
320.	B1F	5.4337E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4741E-04
321.	RBF	3.0537E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2844E-04
322.	RVAF	5.7085E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5487E-04
323.	INTPRF	9.1292E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.4767E-03
324.	ACF	2.9333E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	7.9578E-04
325.	VBF	3.0497E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	8.2736E-04
326.	SYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
327.	RHRSF	8.6007E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	2.3333E-03
328.	BE9	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	6.6980E-06	0.0000E+00
329.	BALS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
330.	VCF	2.1853E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	5.9287E-04
331.	AALS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
332.	AB3	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.8580E-05	0.0000E+00
333.	DHS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
334.	DP4	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3827E-05	0.0000E+00
335.	V31	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	5.6297E-07	0.0000E+00
336.	INTPRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
337.	ARF	1.5210E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.1264E-04
338.	MACROS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
339.	GDS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
340.	GE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
341.	V3F	2.2147E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	6.0083E-05
342.	LYCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
343.	CSAF	5.6327E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.5281E-03
344.	MSF	6.3920E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.7341E-03
345.	LOWPRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
346.	CAVS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
347.	CCSRS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
348.	EXS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
349.	CSIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
350.	BAF	5.3391E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4485E-04
351.	AA1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	2.6740E-05	0.0000E+00
352.	CSRF	4.8713E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.3216E-03
353.	VAF	1.4987E-01	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	4.0659E-04
354.	B2F	5.4337E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.4741E-04
355.	OTF	4.4624E-02	1.0000E+00	0.0000E+00	0.0000E+00	1.0000E+00	1.2106E-04
356.	BYAS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
357.	MELTIS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
358.	V219	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.3270E-05	0.0000E+00
359.	V220	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	1.2820E-05	0.0000E+00
360.	GCS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
361.	MELTBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
362.	LYBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
363.	GBS	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
364.	HE1	0.0000E+00	0.0000E+00	1.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
365.	AB6	4.2176E-04	9.9998E-01	1.0000E+00	-1.0416E-07	5.6660E-01	1.1442E-06
366.	FB2	0.0000E+00	9.9996E-01	1.0000E+00	-1.1561E-07	2.7700E-02	0.0000E+00
367.	TP5	0.0000E+00	9.9996E-01	1.0000E+00	-1.2164E-07	8.0120E-02	0.0000E+00
368.	ZB7	0.0000E+00	9.9996E-01	1.0000E+00	-1.2470E-07	5.9770E-02	0.0000E+00
369.	MA11	0.0000E+00	9.9996E-01	1.0000E+00	-1.2471E-07	1.0280E-01	0.0000E+00
370.	BE13	0.0000E+00	9.9995E-01	1.0000E+00	-1.4202E-07	5.3200E-05	0.0000E+00
371.	MB27	1.5745E-04	9.9995E-01	1.0000E+00	-1.4204E-07	1.1160E-01	4.2716E-07

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
372.	DS5	0.0000E+00	9.9994E-01	1.0000E+00	-1.7101E-07	1.0546E-01	0.0000E+00
373.	MA7	1.5744E-04	9.9994E-01	1.0000E+00	-1.8750E-07	1.0140E-01	4.2714E-07
374.	VB5	0.0000E+00	9.9991E-01	1.0000E+00	-2.3308E-07	9.1160E-03	0.0000E+00
375.	GD8	0.0000E+00	9.9992E-01	1.0000E+00	-2.5929E-07	1.3290E-01	0.0000E+00
376.	GC6	0.0000E+00	9.9992E-01	1.0000E+00	-2.6038E-07	1.3650E-01	0.0000E+00
377.	OS1	0.0000E+00	9.9991E-01	1.0000E+00	-2.6054E-07	1.0000E-01	0.0000E+00
378.	GD5	0.0000E+00	9.9991E-01	1.0000E+00	-2.7183E-07	1.2940E-01	0.0000E+00
379.	GC4	0.0000E+00	9.9991E-01	1.0000E+00	-2.7293E-07	1.3290E-01	0.0000E+00
380.	BE85	0.0000E+00	9.9990E-01	1.0000E+00	-2.7457E-07	6.7810E-03	0.0000E+00
381.	BB7	6.1254E-05	9.9991E-01	1.0000E+00	-3.1078E-07	2.4260E-01	1.6618E-07
382.	PB4	0.0000E+00	9.9988E-01	1.0000E+00	-3.2716E-07	3.4550E-02	0.0000E+00
383.	RF3	0.0000E+00	9.9985E-01	1.0000E+00	-4.1574E-07	7.3460E-04	0.0000E+00
384.	BB6	0.0000E+00	9.9985E-01	1.0000E+00	-4.2794E-07	4.3110E-02	0.0000E+00
385.	MB28	0.0000E+00	9.9984E-01	1.0000E+00	-4.3191E-07	1.1050E-02	0.0000E+00
386.	AB4	0.0000E+00	9.9985E-01	1.0000E+00	-4.3279E-07	5.3850E-02	0.0000E+00
387.	BE21	0.0000E+00	9.9984E-01	1.0000E+00	-4.3812E-07	2.2870E-04	0.0000E+00
388.	RT3	0.0000E+00	9.9984E-01	1.0000E+00	-4.3828E-07	6.1145E-04	0.0000E+00
389.	DDAC2	0.0000E+00	9.9984E-01	1.0000E+00	-4.4178E-07	6.9983E-04	0.0000E+00
390.	PR3	0.0000E+00	9.9984E-01	1.0000E+00	-4.4182E-07	8.6088E-03	0.0000E+00
391.	RI3	0.0000E+00	9.9983E-01	1.0000E+00	-4.5009E-07	3.2260E-04	0.0000E+00
392.	V211	0.0000E+00	9.9983E-01	1.0000E+00	-4.6146E-07	1.1240E-04	0.0000E+00
393.	FC2	0.0000E+00	9.9983E-01	1.0000E+00	-4.6309E-07	3.4460E-03	0.0000E+00
394.	FD2	0.0000E+00	9.9983E-01	1.0000E+00	-4.6309E-07	3.4460E-03	0.0000E+00
395.	RI5	0.0000E+00	9.9983E-01	1.0000E+00	-4.6326E-07	3.2260E-04	0.0000E+00
396.	ZB4	0.0000E+00	9.9982E-01	1.0000E+00	-4.8771E-07	8.2130E-03	0.0000E+00
397.	ZA4	0.0000E+00	9.9982E-01	1.0000E+00	-4.8792E-07	8.6464E-03	0.0000E+00
398.	AFA5	0.0000E+00	9.9982E-01	1.0000E+00	-5.2905E-07	5.8710E-02	0.0000E+00
399.	OF2	0.0000E+00	9.9981E-01	1.0000E+00	-5.8332E-07	1.0000E-01	0.0000E+00
400.	GD4	1.6090E-04	9.9984E-01	1.0001E+00	-5.8969E-07	2.5240E-01	4.3650E-07
401.	RVB2	3.8287E-05	9.9978E-01	1.0000E+00	-6.1591E-07	9.0860E-03	1.0387E-07
402.	PB3	1.2216E-04	9.9974E-01	1.0000E+00	-7.1034E-07	2.0640E-02	3.3140E-07
403.	V210	0.0000E+00	9.9967E-01	1.0000E+00	-8.8492E-07	9.4420E-05	0.0000E+00
404.	AE4	0.0000E+00	9.9967E-01	1.0000E+00	-8.8631E-07	1.6184E-03	0.0000E+00
405.	BE53	0.0000E+00	9.9965E-01	1.0000E+00	-9.3953E-07	8.0490E-05	0.0000E+00
406.	SEI	0.0000E+00	9.9965E-01	1.0000E+00	-9.4974E-07	2.3345E-03	0.0000E+00
407.	RT6	0.0000E+00	9.9965E-01	1.0000E+00	-9.6375E-07	7.4597E-04	0.0000E+00
408.	RR8	0.0000E+00	9.9963E-01	1.0000E+00	-1.0036E-06	4.6243E-03	0.0000E+00
409.	GC3	7.9996E-04	9.9966E-01	1.0001E+00	-1.1225E-06	1.7760E-01	2.1703E-06
410.	V22	0.0000E+00	9.9952E-01	1.0000E+00	-1.3344E-06	3.0030E-02	0.0000E+00
411.	DCAC2	0.0000E+00	9.9951E-01	1.0000E+00	-1.3383E-06	6.9983E-04	0.0000E+00
412.	PI2	0.0000E+00	9.9949E-01	1.0000E+00	-1.3908E-06	1.3804E-02	0.0000E+00
413.	RR9	0.0000E+00	9.9948E-01	1.0000E+00	-1.4181E-06	4.6243E-03	0.0000E+00
414.	AFA3	0.0000E+00	9.9945E-01	1.0000E+00	-1.5430E-06	3.0710E-02	0.0000E+00
415.	BB10	0.0000E+00	9.9936E-01	1.0000E+00	-1.7349E-06	6.7570E-04	0.0000E+00
416.	UB1B2	0.0000E+00	9.9941E-01	1.0001E+00	-1.7884E-06	1.0760E-01	0.0000E+00
417.	PB12	0.0000E+00	9.9932E-01	1.0000E+00	-1.8417E-06	4.0570E-03	0.0000E+00
418.	V221	0.0000E+00	9.9929E-01	1.0000E+00	-1.9420E-06	3.8420E-03	0.0000E+00
419.	V27	0.0000E+00	9.9923E-01	1.0000E+00	-2.1004E-06	3.0910E-03	0.0000E+00
420.	VA2	0.0000E+00	9.9911E-01	1.0000E+00	-2.4497E-06	9.1160E-03	0.0000E+00
421.	MB7	0.0000E+00	9.9908E-01	1.0000E+00	-2.5020E-06	7.0110E-03	0.0000E+00
422.	BC23	0.0000E+00	9.9892E-01	1.0000E+00	-2.9428E-06	7.5100E-03	0.0000E+00
423.	V34	0.0000E+00	9.9885E-01	1.0000E+00	-3.1621E-06	1.5295E-02	0.0000E+00
424.	UB1C2	0.0000E+00	9.9882E-01	1.0001E+00	-3.3476E-06	4.6460E-02	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
425.	ZB3	0.0000E+00	9.9876E-01	1.0000E+00	-3.3856E-06	1.0230E-02	0.0000E+00
426.	ZA3	0.0000E+00	9.9876E-01	1.0000E+00	-3.3876E-06	1.0810E-02	0.0000E+00
427.	UB1C4	0.0000E+00	9.9867E-01	1.0000E+00	-3.6186E-06	2.5070E-03	0.0000E+00
428.	TB3	0.0000E+00	9.9858E-01	1.0000E+00	-3.8586E-06	1.2166E-03	0.0000E+00
429.	BC8	0.0000E+00	9.9858E-01	1.0000E+00	-3.8781E-06	6.2180E-03	0.0000E+00
430.	UB1D5	0.0000E+00	9.9856E-01	1.0000E+00	-3.9162E-06	2.5070E-03	0.0000E+00
431.	UB1B3	0.0000E+00	9.9856E-01	1.0000E+00	-3.9174E-06	2.8010E-03	0.0000E+00
432.	GC2	1.3585E-03	9.9877E-01	1.0002E+00	-3.9584E-06	1.5570E-01	3.6855E-06
433.	RL3	0.0000E+00	9.9853E-01	1.0000E+00	-4.0282E-06	1.0369E-02	0.0000E+00
434.	PB2	0.0000E+00	9.9851E-01	1.0000E+00	-4.0626E-06	3.2130E-03	0.0000E+00
435.	BE86	0.0000E+00	9.9849E-01	1.0000E+00	-4.0987E-06	3.4290E-03	0.0000E+00
436.	CH2	7.1261E-05	9.9852E-01	1.0002E+00	-4.5888E-06	1.2296E-01	1.9333E-07
437.	TP2	0.0000E+00	9.9839E-01	1.0001E+00	-4.6776E-06	6.3430E-02	0.0000E+00
438.	CI2	0.0000E+00	9.9832E-01	1.0000E+00	-4.6777E-06	2.3533E-02	0.0000E+00
439.	GC1	1.1500E-04	9.9847E-01	1.0002E+00	-4.7676E-06	1.2940E-01	3.1198E-07
440.	V226	0.0000E+00	9.9824E-01	1.0000E+00	-4.7797E-06	7.7540E-04	0.0000E+00
441.	RL5	1.3946E-03	9.9838E-01	1.0002E+00	-4.8703E-06	1.0032E-01	3.7833E-06
442.	UB1D2	0.0000E+00	9.9824E-01	1.0001E+00	-4.9723E-06	3.7090E-02	0.0000E+00
443.	S23	1.6585E-04	9.9823E-01	1.0001E+00	-5.1911E-06	7.5510E-02	4.4994E-07
444.	CP2	0.0000E+00	9.9804E-01	1.0000E+00	-5.3404E-06	1.7895E-03	0.0000E+00
445.	AE10	0.0000E+00	9.9801E-01	1.0000E+00	-5.4014E-06	8.0047E-04	0.0000E+00
446.	PD2	0.0000E+00	9.9800E-01	1.0000E+00	-5.4342E-06	1.8824E-03	0.0000E+00
447.	TB4	2.9731E-04	9.9809E-01	1.0001E+00	-5.4904E-06	5.6007E-02	8.0658E-07
448.	PD3	0.0000E+00	9.9790E-01	1.0000E+00	-5.6929E-06	1.1743E-03	0.0000E+00
449.	CH3	3.7186E-05	9.9816E-01	1.0003E+00	-5.6975E-06	1.2296E-01	1.0088E-07
450.	RA1	4.1414E-04	9.9793E-01	1.0000E+00	-5.7331E-06	1.9057E-02	1.1235E-06
451.	MB5	0.0000E+00	9.9786E-01	1.0000E+00	-5.8374E-06	7.5630E-03	0.0000E+00
452.	VT2AR1	7.9931E-05	9.9803E-01	1.0002E+00	-5.9442E-06	1.0000E-01	2.1685E-07
453.	AE9	0.0000E+00	9.9778E-01	1.0000E+00	-6.0223E-06	8.1416E-05	0.0000E+00
454.	MB13	0.0000E+00	9.9765E-01	1.0000E+00	-6.4212E-06	7.0550E-03	0.0000E+00
455.	CSB2	2.1765E-04	9.9777E-01	1.0002E+00	-6.4715E-06	6.3310E-02	5.9047E-07
456.	DCAC3	0.0000E+00	9.9747E-01	1.0000E+00	-6.8735E-06	7.2834E-04	0.0000E+00
457.	BA5	0.0000E+00	9.9729E-01	1.0000E+00	-7.3552E-06	6.7570E-04	0.0000E+00
458.	VS2	0.0000E+00	9.9730E-01	1.0000E+00	-7.3769E-06	8.8731E-03	0.0000E+00
459.	TT2	0.0000E+00	9.9723E-01	1.0000E+00	-7.5165E-06	7.3004E-05	0.0000E+00
460.	DC2	0.0000E+00	9.9723E-01	1.0000E+00	-7.5226E-06	5.7890E-04	0.0000E+00
461.	VB3	0.0000E+00	9.9720E-01	1.0000E+00	-7.6202E-06	3.5120E-03	0.0000E+00
462.	DSLR1	6.5057E-05	9.9723E-01	1.0001E+00	-7.7548E-06	2.9970E-02	1.7650E-07
463.	MA5	0.0000E+00	9.9702E-01	1.0000E+00	-8.1384E-06	7.5630E-03	0.0000E+00
464.	BE17	0.0000E+00	9.9698E-01	1.0000E+00	-8.1991E-06	1.8220E-04	0.0000E+00
465.	DDAC3	0.0000E+00	9.9694E-01	1.0000E+00	-8.2983E-06	7.2834E-04	0.0000E+00
466.	V222	0.0000E+00	9.9691E-01	1.0000E+00	-8.4154E-06	3.8460E-03	0.0000E+00
467.	MB10	0.0000E+00	9.9709E-01	1.0002E+00	-8.5110E-06	7.3870E-02	0.0000E+00
468.	AE3	0.0000E+00	9.9682E-01	1.0000E+00	-8.6376E-06	2.3574E-04	0.0000E+00
469.	BE5	0.0000E+00	9.9674E-01	1.0000E+00	-8.8335E-06	2.2870E-04	0.0000E+00
470.	PB10	6.7772E-05	9.9677E-01	1.0001E+00	-8.9502E-06	2.0940E-02	1.8386E-07
471.	PB6	0.0000E+00	9.9667E-01	1.0000E+00	-9.0546E-06	3.2130E-03	0.0000E+00
472.	BB5	0.0000E+00	9.9645E-01	1.0000E+00	-9.6479E-06	5.4520E-04	0.0000E+00
473.	RL2	0.0000E+00	9.9631E-01	1.0000E+00	-1.0119E-05	1.0053E-02	0.0000E+00
474.	DBAC2	0.0000E+00	9.9617E-01	1.0000E+00	-1.0400E-05	6.9983E-04	0.0000E+00
475.	VT2BR1	1.0014E-04	9.9648E-01	1.0004E+00	-1.0624E-05	1.0000E-01	2.7169E-07
476.	V224	0.0000E+00	9.9607E-01	1.0000E+00	-1.0659E-05	2.4320E-04	0.0000E+00
477.	BB9	0.0000E+00	9.9598E-01	1.0000E+00	-1.0911E-05	6.0140E-04	0.0000E+00

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
478.	AB9	0.0000E+00	9.9587E-01	1.0000E+00	-1.1205E-05	6.7570E-04	0.0000E+00
479.	AFR1	1.3424E-03	9.9626E-01	1.0004E+00	-1.1267E-05	1.0000E-01	3.6419E-06
480.	AB2	0.0000E+00	9.9585E-01	1.0000E+00	-1.1272E-05	5.6940E-04	0.0000E+00
481.	PB5	0.0000E+00	9.9585E-01	1.0000E+00	-1.1302E-05	3.2130E-03	0.0000E+00
482.	PD5	4.2081E-05	9.9581E-01	1.0001E+00	-1.1723E-05	3.0838E-02	1.1416E-07
483.	BC34	0.0000E+00	9.9568E-01	1.0000E+00	-1.1807E-05	6.3260E-03	0.0000E+00
484.	MB3	0.0000E+00	9.9538E-01	1.0000E+00	-1.2640E-05	7.5200E-03	0.0000E+00
485.	CI4	4.0316E-04	9.9577E-01	1.0006E+00	-1.3010E-05	1.1757E-01	1.0937E-06
486.	PA3	0.0000E+00	9.9517E-01	1.0000E+00	-1.3154E-05	4.0566E-03	0.0000E+00
487.	CH6	4.0831E-04	9.9561E-01	1.0006E+00	-1.3570E-05	1.2296E-01	1.1077E-06
488.	DAAC2	0.0000E+00	9.9493E-01	1.0000E+00	-1.3767E-05	6.9983E-04	0.0000E+00
489.	PI3	4.5048E-05	9.9502E-01	1.0001E+00	-1.3854E-05	2.5000E-02	1.2221E-07
490.	DS6	2.6080E-04	9.9541E-01	1.0005E+00	-1.3933E-05	1.0636E-01	7.0753E-07
491.	DD2	0.0000E+00	9.9486E-01	1.0000E+00	-1.3946E-05	5.7890E-04	0.0000E+00
492.	FA1	4.1433E-05	9.9434E-01	1.0000E+00	-1.5408E-05	3.5320E-03	1.1241E-07
493.	FE2	0.0000E+00	9.9425E-01	1.0000E+00	-1.5628E-05	1.3930E-03	0.0000E+00
494.	BE43	0.0000E+00	9.9396E-01	1.0000E+00	-1.6445E-05	3.3620E-03	0.0000E+00
495.	BC3	0.0000E+00	9.9389E-01	1.0000E+00	-1.6671E-05	6.1870E-03	0.0000E+00
496.	RI4	0.0000E+00	9.9359E-01	1.0000E+00	-1.7387E-05	5.0730E-04	0.0000E+00
497.	BB8	0.0000E+00	9.9293E-01	1.0000E+00	-1.9189E-05	5.6940E-04	0.0000E+00
498.	V36	0.0000E+00	9.9284E-01	1.0000E+00	-1.9440E-05	4.8115E-04	0.0000E+00
499.	AE6	0.0000E+00	9.9267E-01	1.0000E+00	-1.9950E-05	3.4298E-03	0.0000E+00
500.	RB1	2.9469E-04	9.9276E-01	1.0001E+00	-2.0014E-05	1.8250E-02	7.9948E-07
501.	DP7	0.0000E+00	9.9259E-01	1.0001E+00	-2.0294E-05	8.9256E-03	0.0000E+00
502.	AB7	0.0000E+00	9.9131E-01	1.0000E+00	-2.3578E-05	6.0140E-04	0.0000E+00
503.	V15	0.0000E+00	9.8972E-01	1.0000E+00	-2.8006E-05	3.8430E-03	0.0000E+00
504.	VT1AR1	4.6684E-04	9.9069E-01	1.0010E+00	-2.8056E-05	1.0000E-01	1.2665E-06
505.	AFA1	0.0000E+00	9.8896E-01	1.0000E+00	-3.0013E-05	2.3760E-03	0.0000E+00
506.	VT1A2	0.0000E+00	9.8835E-01	1.0000E+00	-3.1614E-05	3.1890E-04	0.0000E+00
507.	SL3	0.0000E+00	9.8827E-01	1.0002E+00	-3.2376E-05	1.6996E-02	0.0000E+00
508.	AM1	0.0000E+00	9.8741E-01	1.0000E+00	-3.4191E-05	1.0000E-03	0.0000E+00
509.	CSB3	2.5642E-03	9.8672E-01	1.0003E+00	-3.6781E-05	2.0840E-02	6.9564E-06
510.	DAAC3	0.0000E+00	9.8624E-01	1.0000E+00	-3.7354E-05	7.2834E-04	0.0000E+00
511.	DA2	0.0000E+00	9.8602E-01	1.0000E+00	-3.7938E-05	5.7890E-04	0.0000E+00
512.	VT2B2	0.0000E+00	9.8421E-01	1.0000E+00	-4.2838E-05	3.1890E-04	0.0000E+00
513.	VINV22	0.0000E+00	9.8421E-01	1.0002E+00	-4.3281E-05	1.0530E-02	0.0000E+00
514.	VF1	0.0000E+00	9.8326E-01	1.0000E+00	-4.5441E-05	6.9392E-04	0.0000E+00
515.	FC1	0.0000E+00	9.8278E-01	1.0001E+00	-4.6879E-05	3.4470E-03	0.0000E+00
516.	FD1	0.0000E+00	9.8278E-01	1.0001E+00	-4.6879E-05	3.4470E-03	0.0000E+00
517.	D22	0.0000E+00	9.8261E-01	1.0000E+00	-4.7306E-05	2.6886E-03	0.0000E+00
518.	D12	0.0000E+00	9.8261E-01	1.0000E+00	-4.7312E-05	2.8153E-03	0.0000E+00
519.	CH1	2.8029E-03	9.8319E-01	1.0019E+00	-5.0770E-05	1.0196E-01	7.6041E-06
520.	ZB2	4.3216E-05	9.8123E-01	1.0002E+00	-5.1369E-05	8.6600E-03	1.1724E-07
521.	ZA2	4.3218E-05	9.8093E-01	1.0002E+00	-5.2210E-05	9.1268E-03	1.1725E-07
522.	RS1	1.3296E-02	9.7911E-01	1.0023E+00	-6.3008E-05	1.0047E-01	3.6070E-05
523.	CP3	7.5296E-03	9.7921E-01	1.0027E+00	-6.3781E-05	1.1564E-01	2.0427E-05
524.	RF1	0.0000E+00	9.7647E-01	1.0000E+00	-6.3873E-05	5.0780E-04	0.0000E+00
525.	SU1	0.0000E+00	9.7620E-01	1.0000E+00	-6.4595E-05	2.3186E-04	0.0000E+00
526.	IP1	0.0000E+00	9.7620E-01	1.0000E+00	-6.4639E-05	9.1965E-04	0.0000E+00
527.	PD4	1.4963E-03	9.7394E-01	1.0010E+00	-7.3497E-05	3.8160E-02	4.0593E-06
528.	VT1BR1	5.4263E-03	9.7528E-01	1.0027E+00	-7.4516E-05	1.0000E-01	1.4721E-05
529.	CH4	3.5711E-02	9.7443E-01	1.0029E+00	-7.7248E-05	1.0196E-01	9.6883E-05
530.	MR1	8.5655E-03	9.7409E-01	1.0029E+00	-7.8088E-05	1.0000E-01	2.3238E-05

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
531.	MB11	0.0000E+00	9.7022E-01	1.0002E+00	-8.1359E-05	6.9180E-03	0.0000E+00
532.	VC2	0.0000E+00	9.6641E-01	1.0003E+00	-9.1934E-05	8.8737E-03	0.0000E+00
533.	HH2	4.9133E-03	9.6946E-01	1.0034E+00	-9.2092E-05	1.0030E-01	1.3330E-05
534.	PB7	0.0000E+00	9.5814E-01	1.0002E+00	-1.1402E-04	4.0570E-03	0.0000E+00
535.	PE2	0.0000E+00	9.4433E-01	1.0000E+00	-1.5104E-04	1.1448E-04	0.0000E+00
536.	DB2	0.0000E+00	9.4365E-01	1.0000E+00	-1.5296E-04	5.7890E-04	0.0000E+00
537.	RA2	1.1024E-02	9.4073E-01	1.0014E+00	-1.6458E-04	2.3082E-02	2.9907E-05
538.	DBAC3	0.0000E+00	9.3420E-01	1.0000E+00	-1.7864E-04	7.2834E-04	0.0000E+00
539.	PA2	1.1411E-03	9.3258E-01	1.0014E+00	-1.8683E-04	2.0976E-02	3.0958E-06
540.	AR2	0.0000E+00	9.2825E-01	1.0004E+00	-1.9578E-04	5.7667E-03	0.0000E+00
541.	CI3	0.0000E+00	9.2792E-01	1.0007E+00	-1.9732E-04	8.9763E-03	0.0000E+00
542.	OT1	4.3385E-02	9.3202E-01	1.0076E+00	-2.0492E-04	1.0000E-01	1.1770E-04
543.	FW1	0.0000E+00	9.0558E-01	1.0005E+00	-2.5744E-04	5.0000E-03	0.0000E+00
544.	DBAC1	5.5862E-04	9.0439E-01	1.0001E+00	-2.5955E-04	6.9340E-04	1.5155E-06
545.	PB9	0.0000E+00	8.9602E-01	1.0003E+00	-2.8300E-04	3.2130E-03	0.0000E+00
546.	TP7	0.0000E+00	8.7174E-01	1.0000E+00	-3.4801E-04	1.3890E-04	0.0000E+00
547.	RB4	8.5919E-03	8.7220E-01	1.0029E+00	-3.5447E-04	2.1850E-02	2.3309E-05
548.	TP1	3.6060E-02	8.7550E-01	1.0084E+00	-3.6046E-04	6.2970E-02	9.7829E-05
549.	CD1	3.8974E-03	8.6475E-01	1.0011E+00	-3.6990E-04	8.0334E-03	1.0573E-05
550.	RI2	0.0000E+00	8.5907E-01	1.0001E+00	-3.8253E-04	5.0730E-04	0.0000E+00
551.	ZB1	2.0961E-03	8.5744E-01	1.0012E+00	-3.8995E-04	8.2130E-03	5.6867E-06
552.	CSB1	5.4548E-03	8.4696E-01	1.0031E+00	-4.2363E-04	1.9940E-02	1.4799E-05
553.	ZA5	2.1458E-03	8.4376E-01	1.0012E+00	-4.2726E-04	7.9249E-03	5.8214E-06
554.	HH1	7.6344E-02	8.5068E-01	1.0166E+00	-4.5011E-04	1.0000E-01	2.0712E-04
555.	ZB5	1.9535E-03	8.3419E-01	1.0013E+00	-4.5325E-04	7.5410E-03	5.2998E-06
556.	CSA1	5.6722E-03	8.3541E-01	1.0035E+00	-4.5602E-04	2.0843E-02	1.5388E-05
557.	RRB	0.0000E+00	8.2822E-01	1.0001E+00	-4.6624E-04	4.2417E-04	0.0000E+00
558.	SU3	1.1832E-03	8.0967E-01	1.0016E+00	-5.2072E-04	8.4073E-03	3.2099E-06
559.	CTMU1	8.1073E-02	8.2429E-01	1.0197E+00	-5.3015E-04	1.0082E-01	2.1995E-04
560.	S21	3.8000E-03	7.8065E-01	1.0025E+00	-6.0195E-04	1.1430E-02	1.0309E-05
561.	S11	3.9654E-03	7.6407E-01	1.0029E+00	-6.4798E-04	1.2211E-02	1.0758E-05
562.	VB1	2.7986E-03	6.9906E-01	1.0023E+00	-8.2268E-04	7.5950E-03	7.5926E-06
563.	MB9	2.9053E-03	6.9311E-01	1.0022E+00	-8.3846E-04	7.0170E-03	7.8820E-06
564.	TB1	0.0000E+00	6.7982E-01	1.0001E+00	-8.6892E-04	3.2555E-04	0.0000E+00
565.	BC1	1.1447E-03	6.6871E-01	1.0012E+00	-9.0209E-04	3.6910E-03	3.1056E-06
566.	MS1	0.0000E+00	6.6346E-01	1.0001E+00	-9.1322E-04	2.1398E-04	0.0000E+00
567.	PB1	1.4295E-03	6.3664E-01	1.0012E+00	-9.8895E-04	3.2130E-03	3.8782E-06
568.	MA3	2.9054E-03	6.2127E-01	1.0029E+00	-1.0353E-03	7.5200E-03	7.8823E-06
569.	PA1	1.4927E-03	6.1295E-01	1.0012E+00	-1.0534E-03	3.2129E-03	4.0495E-06
570.	RVA1	4.4388E-03	5.4744E-01	1.0041E+00	-1.2390E-03	9.0863E-03	1.2042E-05
571.	CI1	1.6417E-03	5.0325E-01	1.0024E+00	-1.3543E-03	4.8871E-03	4.4538E-06
572.	SI1	1.7070E-04	4.9803E-01	1.0005E+00	-1.3632E-03	1.0215E-03	4.6311E-07
573.	DC1	4.9294E-04	4.8987E-01	1.0005E+00	-1.3854E-03	1.0120E-03	1.3373E-06
574.	RI1	0.0000E+00	4.8790E-01	1.0002E+00	-1.3897E-03	3.2260E-04	0.0000E+00
575.	A21	2.7104E-04	4.7707E-01	1.0003E+00	-1.4195E-03	5.8153E-04	7.3531E-07
576.	D11	1.4399E-03	4.6713E-01	1.0017E+00	-1.4503E-03	3.2017E-03	3.9064E-06
577.	D21	1.3305E-03	4.5007E-01	1.0017E+00	-1.4965E-03	3.0750E-03	3.6095E-06
578.	VC1	8.3887E-05	3.9697E-01	1.0004E+00	-1.6371E-03	6.9303E-04	2.2758E-07
579.	CP1	2.7677E-04	2.7670E-01	1.0011E+00	-1.9652E-03	1.4657E-03	7.5085E-07
580.	UB1D1	5.8830E-04	2.7627E-01	1.0017E+00	-1.9680E-03	2.3130E-03	1.5960E-06
581.	UB1C1	5.8822E-04	2.6684E-01	1.0018E+00	-1.9938E-03	2.3960E-03	1.5958E-06
582.	EE1	2.6260E-04	2.5736E-01	1.0010E+00	-2.0175E-03	1.3908E-03	7.1243E-07
583.	FE1	2.6238E-04	2.5720E-01	1.0010E+00	-2.0180E-03	1.3908E-03	7.1182E-07

MODEL Name: WBNHA

Split Fraction Importance for Group : MELT

Sorted by Derivative Importance

Group Frequency = 2.7129E-03

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.....	SF Name...	Importance.....	Achievement..	Reduction...	Derivative..	SF Value.....	Frequency.....
584.	UB1B1	5.8835E-04	2.5543E-01	1.0019E+00	-2.0250E-03	2.5070E-03	1.5962E-06
585.	UB1A1	5.8827E-04	2.2885E-01	1.0022E+00	-2.0980E-03	2.8010E-03	1.5959E-06
586.	AR1	0.0000E+00	2.2385E-01	1.0002E+00	-2.1063E-03	2.9630E-04	0.0000E+00
587.	DD1	1.6273E-04	1.6594E-01	1.0008E+00	-2.2651E-03	1.0120E-03	4.4147E-07
588.	DCAC1	8.2288E-05	1.2544E-01	1.0006E+00	-2.3743E-03	6.9340E-04	2.2324E-07
589.	DDAC1	7.9564E-05	1.2082E-01	1.0006E+00	-2.3868E-03	6.9340E-04	2.1585E-07
590.	B1U21	7.5993E-05	1.0778E-01	1.0007E+00	-2.4223E-03	7.3542E-04	2.0617E-07
591.	A1U21	7.6026E-05	1.0607E-01	1.0007E+00	-2.4270E-03	7.3542E-04	2.0626E-07
592.	VT1A1	0.0000E+00	2.5625E-02	1.0003E+00	-2.6443E-03	3.1770E-04	0.0000E+00
593.	VINV21	0.0000E+00	2.0923E-02	1.0002E+00	-2.6567E-03	1.9040E-04	0.0000E+00
594.	VT2B1	0.0000E+00	2.0311E-02	1.0003E+00	-2.6587E-03	3.1770E-04	0.0000E+00
595.	OG1	0.0000E+00	2.0151E-02	1.0005E+00	-2.6595E-03	4.6313E-04	0.0000E+00
596.	A31	0.0000E+00	1.7390E-02	1.0004E+00	-2.6669E-03	4.1950E-04	0.0000E+00
597.	B31	0.0000E+00	1.7390E-02	1.0004E+00	-2.6669E-03	4.1960E-04	0.0000E+00
598.	DG1	0.0000E+00	1.3976E-02	1.0004E+00	-2.6760E-03	3.6298E-04	0.0000E+00
599.	VT2A1	0.0000E+00	2.7712E-03	1.0003E+00	-2.7063E-03	3.1890E-04	0.0000E+00
600.	A2U21	0.0000E+00	2.6952E-03	1.0006E+00	-2.7072E-03	5.8153E-04	0.0000E+00
601.	CT1	0.0000E+00	0.0000E+00	1.0001E+00	-2.7132E-03	9.3318E-05	0.0000E+00

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MELT    1 X     =SEQ512+SEQ513+SEQ514+SEQ515+SEQ516+SEQ517+SEQ518+X      $
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MELT    1 X      =SEQ547+SEQ548+SEQ549+SEQ550+SEQ551+SEQ552+SEQ553+X      $
MELT    1 X      =SEQ554+SEQ555+SEQ556+SEQ557+SEQ558+SEQ559+SEQ560+X      $
MELT    1 X      =SEQ561+SEQ562+SEQ563+SEQ564+SEQ565+SEQ566+SEQ567+X      $
MELT    1 X      =SEQ568+SEQ569+SEQ570+SEQ571+SEQ572+SEQ573+SEQ574+X      $
MELT    1 X      =SEQ575+SEQ576+SEQ577+SEQ578+SEQ579+SEQ580+SEQ581+X      $
MELT    1 X      =SEQ582+SEQ583+SEQ584+SEQ585+SEQ586+SEQ587+SEQ588+X      $
MELT    1 X      =SEQ589+SEQ590+SEQ591+SEQ592+SEQ593+SEQ594+SEQ595+X      $
MELT    1 X      =SEQ596+SEQ597+SEQ598+SEQ599+SEQ600+SEQ601+SEQ602+X      $
MELT    1 X      =SEQ603+SEQ604+SEQ605+SEQ606+SEQ607+SEQ608+SEQ609+X      $
MELT    1 X      =SEQ610+SEQ611+SEQ612+SEQ613+SEQ614+SEQ615+SEQ616+X      $
MELT    1 X      =SEQ617+SEQ618+SEQ619+SEQ620+SEQ621+SEQ622+SEQ623+X      $
MELT    1 X      =SEQ624+SEQ625+SEQ626+SEQ627+SEQ628+SEQ629+SEQ630+X      $
MELT    1 X      =SEQ631+SEQ632+SEQ633+SEQ634+SEQ635+SEQ636+SEQ637+X      $
MELT    1 X      =SEQ638+SEQ639+SEQ640+SEQ641+SEQ642+SEQ643+SEQ644+X      $
MELT    1 X      =SEQ645+SEQ646+SEQ647+SEQ648+SEQ649+SEQ650+SEQ651+X      $
MELT    1 X      =SEQ652+SEQ653+SEQ654+SEQ655+SEQ656+SEQ657+SEQ658+X      $
MELT    1 X      =SEQ659+SEQ660+SEQ661+SEQ662+SEQ663+SEQ664               $
MELT    2 SEQ001=CCSTL*(1-MU4)*(1-CTMU1)*(1-TP1)*SED                      $
MELT    3 SEQ002=ERCWTL*(1-CTMU1)*(1-TP1)                                 $
MELT    4 SEQ003=CCSTL*MU4*(1-CTMU1)*(1-TP1)*SED                          $
MELT    5 SEQ004=CCSTL*CCPR1*(1-MU4)*(1-CTMU1)*(1-TP1)                    $
MELT    6 SEQ005=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X     $
MELT    6 X      =(1-V37)*(1-TP3)*(1-DS6)*(1-PI3)*(1-CI4)*REC1            $
MELT    7 SEQ006=SLOCAN*(1-MU2)*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*X      $
MELT    7 X      =(1-CSA1)*RR1                                            $
MELT    8 SEQ007=CCSTL*CCPR1*MU4*(1-CTMU1)*(1-TP1)                        $
MELT    9 SEQ008=CCSA*MU4*(1-CTMU1)*(1-TP1)*SED*RB5*(1-CSB3)*(1-CH5)      $
MELT   10 SEQ009=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*(1-CSA1)*X $
MELT   10 X      =RR1                                                     $
MELT   11 SEQ010=CCSTL*(1-MU4)*(1-CTMU1)*(1-TP1)*VA1                      $
MELT   12 SEQ011=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*RABX2*(1-CSA1)           $
MELT   13 SEQ012=CCSA*MU4*(1-CTMU1)*(1-TP1)*SED*S22*(1-RB5)*(1-CSB3)*X   $
MELT   13 X      =(1-CH5)                                                 $
MELT   14 SEQ013=CCSA*(1-MU4)*(1-CTMU1)*(1-TP1)*SED*(1-RB5)*(1-CSB3)*X   $
MELT   14 X      =RR5*(1-CH5)                                             $
MELT   15 SEQ014=FLPH1B*CE2*(1-CTMU1)*(1-TP1)                             $
MELT   16 SEQ015=CCSTL*MU4*(1-CTMU1)*(1-TP1)*VA1                          $
MELT   17 SEQ016=CCSA*MU4*(1-CTMU1)*(1-TP1)*SED*(1-RB5)*(1-CSB3)*RR5*X   $
MELT   17 X      =(1-CH5)                                                 $
MELT   18 SEQ017=LOSP*OGR11*DG3*(1-GB2)*(1-DSLR1)*(1-TP3)*X       $
MELT   18 X      =(1-RVB3)*REC2                                           $
MELT   19 SEQ018=LOSP*OGR11*DGSYS*(1-TP3)*(1-DS6)*(1-PI3)*X     $
MELT   19 X      =(1-CI4)*REC5                                            $
MELT   20 SEQ019=CCSA*MU4*(1-CTMU1)*(1-TP1)*SED*(1-RB5)*(1-CSB3)*RVB1*X  $
MELT   20 X      =(1-CH5)                                                 $
MELT   21 SEQ020=LBSD*CE1*(1-PD4)*(1-MU6)*(1-CTMU1)*(1-TP1)               $
MELT   22 SEQ021=FLPH1A*MDE1*(1-CTMU1)*(1-TP1)                            $
MELT   23 SEQ022=LOSP*OGR11*DG3*(1-GD4)*(1-DSLR1)*(1-TP3)*X       $
MELT   23 X      =(1-DS6)*(1-PI3)*(1-CI4)*REC2                            $
MELT   24 SEQ023=LBSD*CE1*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)                   $
MELT   25 SEQ024=LOSP*OGR11*DG3*(1-GC3)*(1-DSLR1)*(1-PA2)*X       $
MELT   25 X      =(1-TP3)*(1-DS6)*(1-PI3)*(1-CI4)*REC2                    $
MELT   26 SEQ025=TTIE*(1-MU4)*(1-CTMU1)*RT1*PL1*EB1*(1-RA2)*(1-RB4)*X    $
MELT   26 X      =(1-CSA1)                                                $
MELT   27 SEQ026=PLMFW*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-SR1)*EB1*X   $
MELT   27 X      =(1-RA2)*(1-RB4)*(1-CSA1)                                $
MELT   28 SEQ027=LVBB1*(1-CTMU1)*TP1*TPR1*MB4*(1-RB5)*(1-CSB3)*(1-CH2)   $
MELT   29 SEQ028=TTIE*MU4*(1-CTMU1)*RT1*PL1*EB1*(1-RA2)*(1-RB4)*X        $
MELT   29 X      =(1-CSA1)                                                $
MELT   30 SEQ029=PLMFW*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-SR1)*EB1*X       $
MELT   30 X      =(1-RA2)*(1-RB4)*(1-CSA1)                                $
MELT   31 SEQ030=LBSD*A11*(1-PD4)*(1-CTMU1)*(1-TP3)*(1-DS6)*(1-PI3)*X    $
MELT   31 X      =(1-CI4)                                                 $
MELT   32 SEQ031=LOSP*(1-OGR11)*BUSD*(1-TP3)*(1-DS6)*X        $
MELT   32 X      =(1-PI3)*(1-CI4)                                         $
MELT   33 SEQ032=PLMFW*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*SR1*(1-EB1)*X   $
MELT   33 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                        $
MELT   34 SEQ033=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*AE5*X        $
MELT   34 X      =(1-DSLR1)*V37*(1-MU4)*(1-TP1)                           $
MELT   35 SEQ034=FLPH1B*A11*(1-CTMU1)*(1-TP3)*(1-RVB3)                    $
MELT   36 SEQ035=SGTR*MU3*(1-CTMU1)*(1-SL1)*DS8*(1-RA2)*(1-RB4)           $
MELT   37 SEQ036=LOSP*OGR11*DG2*(1-GB2)*(1-GC2)*(1-PA2)*(1-V37)*X     $
MELT   37 X      =TP3*TPR1*(1-TB4)*(1-RVB3)*REC3                          $
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MELT   38 SEQ037=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X    $
MELT   38 X      =(1-V37)*TP3*TPR1*(1-CI4)*REC3                       $
MELT   39 SEQ038=LASD*B11*(1-PD5)*(1-CTMU1)*(1-TP3)*(1-DS6)*(1-PI3)*X  $
MELT   39 X      =(1-CI4)                                             $
MELT   40 SEQ039=PLMFW*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*SR1*(1-EB1)*X    $
MELT   40 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                    $
MELT   41 SEQ040=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*AE5*X     $
MELT   41 X      =(1-DSLR1)*V37*MU4*(1-TP1)                           $
MELT   42 SEQ041=LOSP*OGR11*(1-GA1)*GB1*(1-GC2)*DC1*(1-GD2)*(1-V37)*X  $
MELT   42 X      =(1-TB4)*(1-OB1)*(1-RA2)*(1-CSA1)                    $
MELT   43 SEQ042=RTIE*AEBE1*(1-CTMU1)*(1-TP1)                         $
MELT   44 SEQ043=CCSA*BC33*(1-MU4)*(1-CTMU1)*(1-TP1)*SED              $
MELT   45 SEQ044=SGTR*MU3*(1-CTMU1)*SL1*DS4*(1-RA2)*(1-RB4)           $
MELT   46 SEQ045=LOSP*OGR11*(1-GA1)*DG2*(1-GD3)*(1-V37)*TP1*TPR1*X   $
MELT   46 X      =(1-TB4)*(1-OB1)*(1-RA2)*(1-CSA1)*REC3               $
MELT   47 SEQ046=CCSA*BC33*MU4*(1-CTMU1)*(1-TP1)*SED                  $
MELT   48 SEQ047=PLMFW*AEBE1*(1-CTMU1)*(1-TP1)                        $
MELT   49 SEQ048=PLMFW*(1-MU4)*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*X    $
MELT   49 X      =(1-RA2)*(1-RB4)*(1-CSA1)                            $
MELT   50 SEQ049=ERCWB*CE2*(1-CTMU1)*(1-TP1)                          $
MELT   51 SEQ050=TTIE*AEBE1*(1-CTMU1)*(1-TP1)                         $
MELT   52 SEQ051=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X    $
MELT   52 X      =(1-V37)*(1-TP3)*(1-DS6)*(1-PI3)*CI4*REC1            $
MELT   53 SEQ052=LOSP*(1-OGR11)*BUSB*(1-AB6)*(1-BB7)*(1-PD5)*X       $
MELT   53 X      =(1-TP3)*(1-DS6)*(1-PI3)*(1-CI4)                     $
MELT   54 SEQ053=SLOCAI*(1-MU2)*(1-CTMU1)*(1-TP1)*SEH*(1-RA2)*(1-RB4)*X  $
MELT   54 X      =(1-CSA1)*RR1                                        $
MELT   55 SEQ054=TTIE*(1-MU4)*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*X     $
MELT   55 X      =(1-RA2)*(1-RB4)*(1-CSA1)                            $
MELT   56 SEQ055=LVBB2*(1-PD5)*(1-MU4)*(1-CTMU1)*TP1*TPR1*MA4*(1-RA2)*X  $
MELT   56 X      =(1-CSA1)*(1-CH3)                                    $
MELT   57 SEQ056=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X    $
MELT   57 X      =(1-V37)*(1-TP3)*DS6*(1-CI4)*REC1                    $
MELT   58 SEQ057=CCSTL*CE1*(1-MU4)*(1-CTMU1)*(1-TP1)                  $
MELT   59 SEQ058=PLMFW*MU4*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*(1-RA2)*X  $
MELT   59 X      =(1-RB4)*(1-CSA1)                                    $
MELT   60 SEQ059=TTIE*MU4*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*(1-RA2)*X  $
MELT   60 X      =(1-RB4)*(1-CSA1)                                    $
MELT   61 SEQ060=LVBB1*PB1*(1-CTMU1)*TP1*TPR1*(1-RB5)*(1-CSB3)*(1-CH2)  $
MELT   62 SEQ061=LVBB2*(1-PD5)*MU4*(1-CTMU1)*TP1*TPR1*MA4*(1-RA2)*X   $
MELT   62 X      =(1-CSA1)*(1-CH3)                                    $
MELT   63 SEQ062=CCSTL*CE1*MU4*(1-CTMU1)*(1-TP1)                      $
MELT   64 SEQ063=LDCAC*DA1*(1-CTMU1)*MB1*(1-RB5)*(1-CSB3)*(1-CH2)     $
MELT   65 SEQ064=SLOCAN*(1-MU2)*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*X   $
MELT   65 X      =(1-CSA1)*SU2                                        $
MELT   66 SEQ065=CCSTL*(1-MU4)*(1-CTMU1)*TP1*TPR1*SED                 $
MELT   67 SEQ066=SLOCAI*MU2*(1-CTMU1)*(1-TP1)*SEH*(1-RA2)*(1-RB4)*X   $
MELT   67 X      =(1-CSA1)*RR1                                        $
MELT   68 SEQ067=CCSA*BC33*CCPR1*(1-MU4)*(1-CTMU1)*(1-TP1)            $
MELT   69 SEQ068=ERCWTL*(1-CTMU1)*TP1*TPR1                            $
MELT   70 SEQ069=CCSTL*A11*(1-CTMU1)*(1-TP3)*(1-RVB3)                 $
MELT   71 SEQ070=RTIE*B11*CE1*(1-PD4)*(1-MU6)*(1-CTMU1)*(1-TP1)       $
MELT   72 SEQ071=SGTR*DA1*(1-CTMU1)*DS4*(1-RB5)                       $
MELT   73 SEQ072=FLPH1A*B11*(1-PD4)*(1-MU6)*(1-CTMU1)*(1-TP1)         $
MELT   74 SEQ073=RTIE*B11*CE1*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)           $
MELT   75 SEQ074=ERCWA*MDE1*(1-CTMU1)*(1-TP1)                         $
MELT   76 SEQ075=CCSTL*MU4*(1-CTMU1)*TP1*TPR1*SED                     $
MELT   77 SEQ076=CCSA*BC33*CCPR1*MU4*(1-CTMU1)*(1-TP1)                $
MELT   78 SEQ077=FLPH1A*B11*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)             $
MELT   79 SEQ078=SLOCAN*(1-MU2)*(1-CTMU1)*(1-TP1)*(1-RA2)*RB4*(1-CSA1)*X $
MELT   79 X      =RR4                                                 $
MELT   80 SEQ079=LLOCA*(1-MU4)*(1-CTMU1)*(1-CSA1)*RH1                 $
MELT   81 SEQ080=MLOCA*(1-MU4)*(1-CTMU1)*RR1*(1-CSA1)                 $
MELT   82 SEQ081=SLOCAN*(1-MU2)*(1-CTMU1)*(1-TP1)*RA2*(1-RB6)*(1-CSA1)*X $
MELT   82 X      =RR5                                                 $
MELT   83 SEQ082=PLMFW*B11*CE1*(1-PD4)*(1-MU6)*(1-CTMU1)*(1-TP1)      $
MELT   84 SEQ083=LBSD*(1-PD4)*AC2*(1-MU6)*(1-CTMU1)*(1-TP1)*SED       $
MELT   85 SEQ084=LOSP*OGR11*DG2*(1-GB2)*(1-GC2)*(1-PA2)*(1-V37)*X    $
MELT   85 X      =(1-TP3)*TB4*(1-RVB3)*REC4                           $
MELT   86 SEQ085=SGTR*DA1*(1-CTMU1)*(1-DS4)*RB5                       $
MELT   87 SEQ086=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*(1-CSA1)*X $
MELT   87 X      =SU2                                                 $
MELT   88 SEQ087=TTIE*B11*CE1*(1-PD4)*(1-MU6)*(1-CTMU1)*(1-TP1)      $
MELT   89 SEQ088=LOSP*OGR11*GA1*(1-GB2)*(1-GC2)*(1-GD2)*BE41*(1-DSLR1)*X $
MELT   89 X      =(1-PA2)*TP3*TPR1*(1-RVB3)                           $
MELT   90 SEQ089=PLMFW*B11*CE1*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)          $
MELT   91 SEQ090=LBSD*(1-PD4)*AC2*MU6*(1-CTMU1)*(1-TP1)*SED           $
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MELT   92 SEQ091=LOSP*OGR11*(1-GA1)*GB1*(1-GC2)*(1-GD2)*AE5*(1-DSLR1)*X  $
MELT   92 X      =TP1*TPR1                                                $
MELT   93 SEQ092=SGTR*TD31*(1-MU3)*(1-CTMU1)*(1-SL1)                 $
MELT   94 SEQ093=LLOCA*MU4*(1-CTMU1)*(1-CSA1)*RH1                        $
MELT   95 SEQ094=MLOCA*MU4*(1-CTMU1)*RR1*(1-CSA1)                        $
MELT   96 SEQ095=TTIE*B11*CE1*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)              $
MELT   97 SEQ096=LVBB1*(1-CTMU1)*RT2*PL1*(1-TP1)*(1-EB1)*(1-RB5)*X       $
MELT   97 X      =(1-CSB3)*(1-CH2)                                       $
MELT   98 SEQ097=RTIE*A11*B11*(1-PD4)*(1-CTMU1)*(1-TP3)*(1-DS6)*X        $
MELT   98 X      =(1-PI3)*(1-CI4)                                        $
MELT   99 SEQ098=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*(1-RA2)*RB4*(1-CSA1)*RR4   $
MELT  100 SEQ099=SLOCAI*MU2*(1-CTMU1)*(1-TP1)*SEH*RABX2*(1-CSA1)       $
MELT  101 SEQ100=SGTR*MU3*(1-CTMU1)*SL1*(1-DS4)*(1-RA2)*(1-RB4)*RD1      $
MELT  102 SEQ101=SLOCAI*TD31*(1-CTMU1)*(1-TP1)                       $
MELT  103 SEQ102=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*RA2*(1-RB6)*(1-CSA1)*RR5   $
MELT  104 SEQ103=ERCWB*A11*(1-CTMU1)*(1-TP3)*(1-RVB3)                    $
MELT  105 SEQ104=CCSTL*CCPR1*(1-MU4)*(1-CTMU1)*TP1*TPR1                  $
MELT  106 SEQ105=RTIE*DA1*(1-CTMU1)*TP1*TPR1*MB4*(1-RB5)*(1-CSB3)*X      $
MELT  106 X      =(1-CH2)                                                $
MELT  107 SEQ106=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*AE5*BE34*X   $
MELT  107 X      =(1-TP1)*(1-DS6)*(1-PI3)*(1-CI4)                        $
MELT  108 SEQ107=LBSD*BE3*(1-PD4)*(1-MU6)*(1-CTMU1)*(1-TP1)*SED          $
MELT  109 SEQ108=LVBB2*(1-PD5)*PA1*(1-MU4)*(1-CTMU1)*TP1*TPR1*(1-RA2)*X  $
MELT  109 X      =(1-CSA1)*(1-CH3)                                       $
MELT  110 SEQ109=LASD*BC2*(1-CTMU1)*(1-TP3)*TB2*(1-RVB3)                 $
MELT  111 SEQ110=LASD*DE1*(1-CTMU1)*(1-TP3)*(1-RVB3)                     $
MELT  112 SEQ111=PLMFW*A11*B11*(1-PD4)*(1-CTMU1)*(1-TP3)*(1-DS6)*X       $
MELT  112 X      =(1-PI3)*(1-CI4)                                        $
MELT  113 SEQ112=FLPH1B*CCSR3*(1-MU4)*(1-CTMU1)*(1-TP1)*SED              $
MELT  114 SEQ113=SLOCAN*(1-MU2)*(1-CTMU1)*TP1*TPR1*(1-RA2)*(1-RB4)*X     $
MELT  114 X      =(1-CSA1)*RR1                                           $
MELT  115 SEQ114=LBSD*BE3*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)*SED              $
MELT  116 SEQ115=LOSP*OGR11*DG3*(1-GB2)*(1-DSLR1)*TP3*TPR1*X     $
MELT  116 X      =(1-RVB3)*REC3                                          $
MELT  117 SEQ116=CCSTL*CCPR1*MU4*(1-CTMU1)*TP1*TPR1                      $
MELT  118 SEQ117=TTIE*A11*B11*(1-PD4)*(1-CTMU1)*(1-TP3)*(1-DS6)*X        $
MELT  118 X      =(1-PI3)*(1-CI4)                                        $
MELT  119 SEQ118=LBSD*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)*VA1*TB2*(1-RA2)*X    $
MELT  119 X      =(1-CSA1)*(1-CH6)                                       $
MELT  120 SEQ119=LDCAC*DB1*(1-PD5)*(1-MU4)*(1-CTMU1)*MA1*(1-RA2)*X       $
MELT  120 X      =(1-CSA1)*(1-CH3)                                       $
MELT  121 SEQ120=RTIE*TD31*(1-MU4)*(1-CTMU1)*(1-TP1)*SED             $
MELT  122 SEQ121=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*(1-RA2)*RB4*(1-CSA1)*X     $
MELT  122 X      =RVA1                                                   $
MELT  123 SEQ122=SGTR*DA1*(1-CTMU1)*(1-DS4)*(1-RB5)*RD2                  $
MELT  124 SEQ123=LOSP*OGR11*DG3*(1-GD4)*(1-DSLR1)*TP3*TPR1*X     $
MELT  124 X      =(1-CI4)*REC3                                           $
MELT  125 SEQ124=LOSP*(1-OGR11)*BUSA*(1-BB14)*(1-PD5)*(1-TP3)*X   $
MELT  125 X      =(1-DS6)*(1-PI3)*(1-CI4)                                $
MELT  126 SEQ125=LVBB2*(1-PD5)*PA1*MU4*(1-CTMU1)*TP1*TPR1*(1-RA2)*X      $
MELT  126 X      =(1-CSA1)*(1-CH3)                                       $
MELT  127 SEQ126=LOSP*(1-OGR11)*BUSA*(1-AB6)*(1-PD5)*(1-TP3)*X    $
MELT  127 X      =(1-DS6)*(1-PI3)*(1-CI4)                                $
MELT  128 SEQ127=LOSP*OGR11*DG2*(1-GB2)*(1-GC2)*(1-PA2)*V37*X        $
MELT  128 X      =(1-TP3)*(1-RVB3)*REC4                                  $
MELT  129 SEQ128=LOSP*OGR11*DG3*(1-GC3)*(1-DSLR1)*(1-PA2)*TP3*X  $
MELT  129 X      =TPR1*(1-CI4)*REC3                                      $
MELT  130 SEQ129=LOSP*OGR11*(1-GA1)*GB1*(1-GC2)*(1-GD2)*AE5*(1-DSLR1)*X  $
MELT  130 X      =(1-TP1)*REC4                                           $
MELT  131 SEQ130=PLMFW*DA1*(1-CTMU1)*TP1*TPR1*MB4*(1-RB5)*(1-CSB3)*X     $
MELT  131 X      =(1-CH2)                                                $
MELT  132 SEQ131=LOSP*OGR11*DG2*(1-GB2)*(1-GD3)*(1-DSLR1)*V37*X      $
MELT  132 X      =(1-TP3)*(1-RVB3)*REC4                                  $
MELT  133 SEQ132=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*RA2*(1-RB6)*(1-CSA1)*X     $
MELT  133 X      =RVB1                                                   $
MELT  134 SEQ133=FLPH1A*DE2*(1-CTMU1)*(1-TP1)                            $
MELT  135 SEQ134=FLPH1B*CCSR3*MU4*(1-CTMU1)*(1-TP1)*SED                  $
MELT  136 SEQ135=CCSTL*(1-MU4)*CTMU1*(1-TP1)*SED                         $
MELT  137 SEQ136=LBSD*(1-PD4)*AC2*CCPR1*(1-MU6)*(1-CTMU1)*(1-TP1)        $
MELT  138 SEQ137=LLOCA*(1-MU4)*(1-CTMU1)*LCL1*(1-CSA1)                   $
MELT  139 SEQ138=ERCWTL*CTMU1*(1-TP1)                                    $
MELT  140 SEQ139=CCSA*MU4*(1-CTMU1)*TP1*TPR1*SED*RB5*(1-CSB3)*(1-CH5)    $
MELT  141 SEQ140=TTIE*DA1*(1-CTMU1)*TP1*TPR1*MB4*(1-RB5)*(1-CSB3)*X      $
MELT  141 X      =(1-CH2)                                                $
MELT  142 SEQ141=RTIE*CE1*DE1*(1-V37)*(1-CTMU1)*(1-TP1)                  $
MELT  143 SEQ142=LRCP*(1-MU4)*(1-CTMU1)*RT1*PL1*EB1*(1-RA2)*(1-RB4)*X    $
MELT  143 X      =(1-CSA1)                                               $
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MELT  144 SEQ143=LDCAC*DB1*(1-PD5)*MU4*(1-CTMU1)*MA1*(1-RA2)*(1-CSA1)*X  $
MELT  144 X      =(1-CH3)                                                 $
MELT  145 SEQ144=LOSP*OGR11*(1-GA1)*DG3*(1-DSLR1)*TP1*TPR1*X      $
MELT  145 X      =(1-OB1)*REC3                                            $
MELT  146 SEQ145=RTIE*TD31*MU4*(1-CTMU1)*(1-TP1)*SED                 $
MELT  147 SEQ146=LBSD*(1-PD4)*AC2*CCPR1*MU6*(1-CTMU1)*(1-TP1)            $
MELT  148 SEQ147=CCSA*BC33*(1-MU4)*(1-CTMU1)*(1-TP1)*VA1                 $
MELT  149 SEQ148=CCSA*DB1*(1-PD5)*(1-MU4)*(1-CTMU1)*(1-TP1)*SED          $
MELT  150 SEQ149=LOSP*OGR11*GA1*(1-GB2)*(1-GC2)*(1-GD2)*BE41*(1-DSLR1)*X $
MELT  150 X      =(1-PA2)*(1-TP3)*(1-RVB3)*REC4                           $
MELT  151 SEQ150=LDCAC*DA1*PB1*(1-CTMU1)*(1-RB5)*(1-CSB3)*(1-CH2)        $
MELT  152 SEQ151=PLMFW*TD31*(1-MU4)*(1-CTMU1)*(1-TP1)*SED            $
MELT  153 SEQ152=LOSP*OGR11*DGSYS*(1-TP3)*(1-DS6)*(1-PI3)*X    $
MELT  153 X      =CI4*REC5                                                $
MELT  154 SEQ153=ISI*TD31*(1-MU4)*(1-CTMU1)*(1-TP1)                  $
MELT  155 SEQ154=CCSTL*MU4*CTMU1*(1-TP1)*SED                              $
MELT  156 SEQ155=LLOCA*MU4*(1-CTMU1)*LCL1*(1-CSA1)                        $
MELT  157 SEQ156=SLOCAN*MU2*(1-CTMU1)*TP1*TPR1*(1-RA2)*(1-RB4)*X          $
MELT  157 X      =(1-CSA1)*RR1                                            $
MELT  158 SEQ157=LOSP*OGR11*(1-GA1)*BUSD*(1-GB1)*(1-GC1)*X        $
MELT  158 X      =(1-GD1)*(1-TP3)*(1-DS6)*(1-PI3)*(1-CI4)            $
MELT  159 SEQ158=TTIE*TD31*(1-MU4)*(1-CTMU1)*(1-TP1)*SED             $
MELT  160 SEQ159=FLPH1B*MU4*(1-CTMU1)*(1-TP1)*VA1*TB2*(1-RA2)*(1-CSA1)*X $
MELT  160 X      =(1-CH6)                                                 $
MELT  161 SEQ160=PLMFW*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*MA3*(1-MB10)*X  $
MELT  161 X      =(1-AFA3)*(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)       $
MELT  162 SEQ161=PLMFW*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*MB9*(1-AFA3)*X  $
MELT  162 X      =(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                $
MELT  163 SEQ162=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X    $
MELT  163 X      =V37*(1-TP3)*(1-DS6)*(1-PI3)*(1-CI4)*REC1                $
MELT  164 SEQ163=LRCP*MU4*(1-CTMU1)*RT1*PL1*EB1*(1-RA2)*(1-RB4)*X        $
MELT  164 X      =(1-CSA1)                                                $
MELT  165 SEQ164=LOSP*OGR11*DGSYS*(1-TP3)*DS6*(1-CI4)*REC5     $
MELT  166 SEQ165=CCSA*BC33*MU4*(1-CTMU1)*(1-TP1)*VA1                      $
MELT  167 SEQ166=CCSA*DB1*(1-PD5)*MU4*(1-CTMU1)*(1-TP1)*SED               $
MELT  168 SEQ167=FLPH1A*V33*(1-MU4)*(1-CTMU1)*(1-TP1)                     $
MELT  169 SEQ168=PLMFW*CE1*DE1*(1-V37)*(1-CTMU1)*(1-TP1)                  $
MELT  170 SEQ169=EXMFW*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-SR1)*EB1*X   $
MELT  170 X      =(1-RA2)*(1-RB4)*(1-CSA1)                                $
MELT  171 SEQ170=PLMFW*TD31*MU4*(1-CTMU1)*(1-TP1)*SED                 $
MELT  172 SEQ171=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*GD1*AE5*(1-DSLR1)*X  $
MELT  172 X      =(1-MU6)*TP1*TPR1                                        $
MELT  173 SEQ172=LOSP*(1-OGR11)*A11*BE41*(1-TP3)*(1-RVB3)                 $
MELT  174 SEQ173=ISI*TD31*MU4*(1-CTMU1)*(1-TP1)                      $
MELT  175 SEQ174=LOSP*OGR11*DG3*(1-GD4)*(1-DSLR1)*(1-TP3)*X       $
MELT  175 X      =(1-DS6)*(1-PI3)*CI4*REC2                                $
MELT  176 SEQ175=TLMFW*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-SR1)*EB1*X   $
MELT  176 X      =(1-RA2)*(1-RB4)*(1-CSA1)                                $
MELT  177 SEQ176=LVBB1*DB1*(1-PD5)*(1-CTMU1)*TP1*TPR1                     $
MELT  178 SEQ177=LVBB2*DA1*(1-PD5)*(1-CTMU1)*TP1*TPR1                     $
MELT  179 SEQ178=LDAAC*ZB6*OS3*(1-PA2)*(1-MU6)*(1-CTMU1)*(1-MF1)*OF1*X   $
MELT  179 X      =(1-CP3)                                                 $
MELT  180 SEQ179=TTIE*CE1*DE1*(1-V37)*(1-CTMU1)*(1-TP1)                   $
MELT  181 SEQ180=LOSP*OGR11*DG3*(1-GC3)*(1-DSLR1)*(1-PA2)*X       $
MELT  181 X      =(1-TP3)*(1-DS6)*(1-PI3)*CI4*REC2                        $
MELT  182 SEQ181=SGTR*B11*(1-PD4)*AC2*(1-MU5)*(1-CTMU1)*(1-SL1)           $
MELT  183 SEQ182=MLOCA*(1-MU4)*(1-CTMU1)*RABX1*(1-CSA1)              $
MELT  184 SEQ183=TTIE*TD31*MU4*(1-CTMU1)*(1-TP1)*SED                 $
MELT  185 SEQ184=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*GD1*AE5*(1-DSLR1)*X  $
MELT  185 X      =MU6*TP1*TPR1                                            $
MELT  186 SEQ185=PLMFW*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*MA3*(1-MB10)*X      $
MELT  186 X      =(1-AFA3)*(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)       $
MELT  187 SEQ186=PLMFW*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*MB9*(1-AFA3)*X      $
MELT  187 X      =(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                $
MELT  188 SEQ187=LVBB2*(1-PD5)*(1-MU4)*(1-CTMU1)*RT2*PL1*(1-TP1)*X        $
MELT  188 X      =(1-EB1)*(1-RA2)*(1-CSA1)*(1-CH3)                        $
MELT  189 SEQ188=LBSD*BE3*(1-PD4)*CCPR1*(1-MU6)*(1-CTMU1)*(1-TP1)         $
MELT  190 SEQ189=LDAAC*ZB6*OS3*(1-PA2)*MU6*(1-CTMU1)*(1-MF1)*OF1*X        $
MELT  190 X      =(1-CP3)                                                 $
MELT  191 SEQ190=FLPH1A*V33*MU4*(1-CTMU1)*(1-TP1)                         $
MELT  192 SEQ191=LOSP*OGR11*DG3*(1-GD4)*(1-DSLR1)*(1-TP3)*DS6*X  $
MELT  192 X      =(1-CI4)*REC2                                            $
MELT  193 SEQ192=LOSP*OGR11*(1-GA1)*(1-GB1)*GC1*(1-GD2)*BE41*(1-DSLR1)*X $
MELT  193 X      =(1-MU6)*TP1*TPR1*(1-OB1)                                $
MELT  194 SEQ193=LOSP*OGR11*DG3*(1-GC3)*(1-DSLR1)*(1-PA2)*X       $
MELT  194 X      =(1-TP3)*DS6*(1-CI4)*REC2                                $
MELT  195 SEQ194=EXMFW*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-SR1)*EB1*X        $
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MELT  195 X      =(1-RA2)*(1-RB4)*(1-CSA1)                                $
MELT  196 SEQ195=SLOCAN*(1-MU2)*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*X       $
MELT  196 X      =(1-CSA1)*RVA1*RR5                                       $
MELT  197 SEQ196=FLPH1B*CCSR3*CCPR1*(1-MU4)*(1-CTMU1)*(1-TP1)             $
MELT  198 SEQ197=SLOCAN*(1-MU2)*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*X       $
MELT  198 X      =(1-CSA1)*RVB1*RR4                                       $
MELT  199 SEQ198=LBSD*BE3*(1-PD4)*CCPR1*MU6*(1-CTMU1)*(1-TP1)             $
MELT  200 SEQ199=TLMFW*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-SR1)*EB1*X        $
MELT  200 X      =(1-RA2)*(1-RB4)*(1-CSA1)                                $
MELT  201 SEQ200=LOSP*OGR11*(1-GA1)*(1-GB1)*GC1*(1-GD2)*BE41*(1-DSLR1)*X $
MELT  201 X      =MU6*TP1*TPR1*(1-OB1)                                    $
MELT  202 SEQ201=LOSP*OGR11*GA1*FB1*(1-GC6)*(1-GD8)*(1-PA2)*(1-PB3)*X     $
MELT  202 X      =(1-V37)*(1-TP3)*(1-DS6)*(1-PI3)*(1-CI4)*REC1            $
MELT  203 SEQ202=LOSP*OGR11*FA1*(1-FB2)*GB3*(1-GC6)*(1-GD8)*(1-PA2)*X     $
MELT  203 X      =(1-PB3)*(1-V37)*(1-TP3)*(1-DS6)*(1-PI3)*(1-CI4)*REC1    $
MELT  204 SEQ203=MLOCA*MU4*(1-CTMU1)*RABX1*(1-CSA1)                     $
MELT  205 SEQ204=SLOCAI*B11*(1-PD4)*AC2*(1-CTMU1)*(1-TP1)                 $
MELT  206 SEQ205=RTIE*TD31*CCPR1*(1-MU4)*(1-CTMU1)*(1-TP1)            $
MELT  207 SEQ206=LVBB2*(1-PD5)*MU4*(1-CTMU1)*RT2*PL1*(1-TP1)*(1-EB1)*X    $
MELT  207 X      =(1-RA2)*(1-CSA1)*(1-CH3)                                $
MELT  208 SEQ207=EXMFW*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*SR1*(1-EB1)*X    $
MELT  208 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                        $
MELT  209 SEQ208=CCSA*(1-MU4)*(1-CTMU1)*(1-TP1)*SED*RB5*(1-CSB3)*CH5      $
MELT  210 SEQ209=CCSA*B11*(1-PD4)*(1-MU6)*(1-CTMU1)*(1-TP1)*SED           $
MELT  211 SEQ210=LDCAC*(1-MU4)*(1-CTMU1)*RT1*PL1*EB1*(1-RA2)*(1-RB4)*X    $
MELT  211 X      =(1-CSA1)                                                $
MELT  212 SEQ211=RTIE*DB1*(1-PD5)*(1-MU4)*(1-CTMU1)*TP1*TPR1*MA4*X        $
MELT  212 X      =(1-RA2)*(1-CSA1)*(1-CH3)                                $
MELT  213 SEQ212=LDDAC*(1-MU4)*(1-CTMU1)*RT1*PL1*EB1*(1-RA2)*(1-RB4)*X    $
MELT  213 X      =(1-CSA1)                                                $
MELT  214 SEQ213=TLMFW*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*SR1*(1-EB1)*X    $
MELT  214 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                        $
MELT  215 SEQ214=LASD*TD32*(1-CTMU1)*(1-TP3)*(1-RVB3)                 $
MELT  216 SEQ215=LDBAC*(1-MU6)*(1-CTMU1)*RT4*PL1*EB3*(1-RA2)*(1-RB4)*X    $
MELT  216 X      =(1-CSA1)                                                $
MELT  217 SEQ216=FLPH1B*CCSR3*CCPR1*MU4*(1-CTMU1)*(1-TP1)                 $
MELT  218 SEQ217=CCSTL*CCPR1*(1-MU4)*CTMU1*(1-TP1)                        $
MELT  219 SEQ218=CCSA*B11*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)*SED               $
MELT  220 SEQ219=ERCWA*B11*(1-PD4)*(1-MU6)*(1-CTMU1)*(1-TP1)              $
MELT  221 SEQ220=SLOCAI*BC1*MU1*(1-CTMU1)*(1-TP1)*VA1*(1-RA2)*(1-CSA1)*X $
MELT  221 X      =(1-CH6)                                                 $
MELT  222 SEQ221=LOCV*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-SR1)*EB1*X     $
MELT  222 X      =(1-RA2)*(1-RB4)*(1-CSA1)                                $
MELT  223 SEQ222=LBSD*A11*(1-PD4)*(1-CTMU1)*(1-TP3)*(1-DS6)*(1-PI3)*X     $
MELT  223 X      =CI4                                                     $
MELT  224 SEQ223=LDBAC*MU6*(1-CTMU1)*RT4*PL1*EB3*(1-RA2)*(1-RB4)*X        $
MELT  224 X      =(1-CSA1)                                                $
MELT  225 SEQ224=CCSTL*(1-MU4)*(1-CTMU1)*TP1*TPR1*VA1                     $
MELT  226 SEQ225=LASD*(1-CTMU1)*RT1*PL1*(1-TP3)*(1-EB7)*(1-TB2)*X         $
MELT  226 X      =(1-OB1)*(1-RB5)*(1-CSB3)*(1-RVB3)*(1-CH2)               $
MELT  227 SEQ226=LDAAC*(1-ZB6)*(1-PA2)*(1-MU6)*(1-CTMU1)*RT4*PL1*EB3*X    $
MELT  227 X      =(1-RA2)*(1-RB4)*(1-CSA1)                                $
MELT  228 SEQ227=RTIE*TD31*CCPR1*MU4*(1-CTMU1)*(1-TP1)                $
MELT  229 SEQ228=CCSA*DB1*(1-PD5)*CCPR1*(1-MU4)*(1-CTMU1)*(1-TP1)         $
MELT  230 SEQ229=EXMFW*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*SR1*(1-EB1)*X        $
MELT  230 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                        $
MELT  231 SEQ230=LOSP*(1-OGR11)*BUSD*(1-TP3)*(1-DS6)*X        $
MELT  231 X      =(1-PI3)*CI4                                             $
MELT  232 SEQ231=CCSA*MU4*(1-CTMU1)*(1-TP1)*SED*RB5*(1-CSB3)*CH5          $
MELT  233 SEQ232=SLOCAN*MU2*(1-CTMU1)*TP1*TPR1*RABX2*(1-CSA1)           $
MELT  234 SEQ233=CCSA*B2U21*(1-MU4)*(1-CTMU1)*(1-TP1)*SED                 $
MELT  235 SEQ234=LDCAC*MU4*(1-CTMU1)*RT1*PL1*EB1*(1-RA2)*(1-RB4)*X        $
MELT  235 X      =(1-CSA1)                                                $
MELT  236 SEQ235=ERCWA*B11*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)                  $
MELT  237 SEQ236=RTIE*DA1*PB1*(1-CTMU1)*TP1*TPR1*(1-RB5)*(1-CSB3)*X       $
MELT  237 X      =(1-CH2)                                                 $
MELT  238 SEQ237=RTIE*DB1*(1-PD5)*MU4*(1-CTMU1)*TP1*TPR1*MA4*(1-RA2)*X    $
MELT  238 X      =(1-CSA1)*(1-CH3)                                        $
MELT  239 SEQ238=SLOCAN*(1-MU2)*CTMU1*(1-TP1)*(1-RA2)*(1-RB4)*(1-CSA1)*X $
MELT  239 X      =RR1                                                     $
MELT  240 SEQ239=LDDAC*MU4*(1-CTMU1)*RT1*PL1*EB1*(1-RA2)*(1-RB4)*X        $
MELT  240 X      =(1-CSA1)                                                $
MELT  241 SEQ240=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X     $
MELT  241 X      =(1-V37)*(1-TP3)*(1-DS6)*PI3*(1-CI4)*REC1                $
MELT  242 SEQ241=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*GD1*AE5*(1-DSLR1)*X   $
MELT  242 X      =(1-MU6)*(1-TP1)*REC4                                    $
MELT  243 SEQ242=PLMFW*TD31*CCPR1*(1-MU4)*(1-CTMU1)*(1-TP1)           $
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MELT  244 SEQ243=TLMFW*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*SR1*(1-EB1)*X        $
MELT  244 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                        $
MELT  245 SEQ244=PLMFW*(1-MU4)*(1-CTMU1)*RT1*MR1*PL1*(1-TP1)*SR4*X        $
MELT  245 X      =(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                $
MELT  246 SEQ245=LBSD*A11*(1-PD4)*(1-CTMU1)*(1-TP3)*DS6*(1-CI4)           $
MELT  247 SEQ246=LOSP*OGR11*(1-GA1)*BUSB*(1-GB1)*(1-GC1)*(1-AB6)*X     $
MELT  247 X      =(1-GD1)*(1-BB7)*(1-PA2)*(1-PB3)*(1-V37)*(1-TP3)*X       $
MELT  247 X      =(1-DS6)*(1-PI3)*(1-CI4)                                 $
MELT  248 SEQ247=CCSA*B21*(1-MU4)*(1-CTMU1)*(1-TP1)*SED*(1-RB5)*X         $
MELT  248 X      =(1-CSB3)                                                $
MELT  249 SEQ248=RTIE*B11*(1-PD4)*AC2*(1-MU6)*(1-CTMU1)*(1-TP1)*SED       $
MELT  250 SEQ249=LDAAC*(1-ZB6)*(1-PA2)*MU6*(1-CTMU1)*RT4*PL1*EB3*X        $
MELT  250 X      =(1-RA2)*(1-RB4)*(1-CSA1)                                $
MELT  251 SEQ250=CCSTL*CCPR1*MU4*CTMU1*(1-TP1)                            $
MELT  252 SEQ251=CCSA*MU4*(1-CTMU1)*TP1*TPR1*SED*S22*(1-RB5)*(1-CSB3)*X   $
MELT  252 X      =(1-CH5)                                                 $
MELT  253 SEQ252=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*(1-CSA1)*X $
MELT  253 X      =RVA1*RR5                                                $
MELT  254 SEQ253=FLPH1A*BC1*(1-MU4)*(1-CTMU1)*(1-TP1)*TB2                 $
MELT  255 SEQ254=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*(1-CSA1)*X $
MELT  255 X      =RVB1*RR4                                                $
MELT  256 SEQ255=LOSP*OGR11*DG2*(1-GB2)*(1-GC2)*(1-PA2)*(1-V37)*X     $
MELT  256 X      =AC3*(1-TP3)*(1-RVB3)*REC4                               $
MELT  257 SEQ256=PLMFW*DB1*(1-PD5)*(1-MU4)*(1-CTMU1)*TP1*TPR1*MA4*X       $
MELT  257 X      =(1-RA2)*(1-CSA1)*(1-CH3)                                $
MELT  258 SEQ257=CCSA*(1-MU4)*(1-CTMU1)*TP1*TPR1*SED*(1-RB5)*(1-CSB3)*X   $
MELT  258 X      =RR5*(1-CH5)                                             $
MELT  259 SEQ258=LVBB2*A11*(1-PD5)*(1-CTMU1)*(1-TP3)*TB2*(1-RVB3)         $
MELT  260 SEQ259=LOSP*(1-OGR11)*BUSD*(1-TP3)*DS6*(1-CI4)      $
MELT  261 SEQ260=LOSP*(1-OGR11)*AA2*(1-BA4)*(1-AB4)*(1-BB6)*BE41*X        $
MELT  261 X      =(1-TP3)*(1-RVB3)                                        $
MELT  262 SEQ261=FLPH1B*CE2*(1-CTMU1)*TP1*TPR1                            $
MELT  263 SEQ262=TTIE*TD31*CCPR1*(1-MU4)*(1-CTMU1)*(1-TP1)            $
MELT  264 SEQ263=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*GD1*AE5*(1-DSLR1)*X   $
MELT  264 X      =MU6*(1-TP1)*REC4                                        $
MELT  265 SEQ264=SGTR*PD1*(1-PA2)*(1-PB3)*(1-CTMU1)*(1-SL1)*DS2*X         $
MELT  265 X      =(1-RA2)*(1-RB4)                                         $
MELT  266 SEQ265=LOCV*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-SR1)*EB1*X         $
MELT  266 X      =(1-RA2)*(1-RB4)*(1-CSA1)                                $
MELT  267 SEQ266=CCSTL*(1-MU4)*(1-CTMU1)*TP1*(1-TPR1)*SED                 $
MELT  268 SEQ267=RTIE*B11*(1-PD4)*AC2*MU6*(1-CTMU1)*(1-TP1)*SED           $
MELT  269 SEQ268=CCSTL*MU4*(1-CTMU1)*TP1*TPR1*VA1                         $
MELT  270 SEQ269=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X     $
MELT  270 X      =(1-V37)*TP3*TPR1*CI4*REC3                               $
MELT  271 SEQ270=LBSD*CE1*PD4*(1-V37)*(1-CTMU1)*(1-TP1)                   $
MELT  272 SEQ271=LDAAC*ZB6*OS3*(1-PA2)*(1-MU6)*(1-CTMU1)*MF1*(1-CP3)      $
MELT  273 SEQ272=LASD*B11*(1-PD5)*(1-CTMU1)*(1-TP3)*(1-DS6)*(1-PI3)*X     $
MELT  273 X      =CI4                                                     $
MELT  274 SEQ273=CCSA*DB1*(1-PD5)*CCPR1*MU4*(1-CTMU1)*(1-TP1)             $
MELT  275 SEQ274=TTIE*DB1*(1-PD5)*(1-MU4)*(1-CTMU1)*TP1*TPR1*MA4*X        $
MELT  275 X      =(1-RA2)*(1-CSA1)*(1-CH3)                                $
MELT  276 SEQ275=ERCWTL*(1-CTMU1)*TP1*(1-TPR1)                            $
MELT  277 SEQ276=CCSA*B2U21*MU4*(1-CTMU1)*(1-TP1)*SED                     $
MELT  278 SEQ277=SLOCAI*ZAB5*OS2*(1-MU2)*(1-CTMU1)*(1-MF1)*(1-OF2)*X $
MELT  278 X      =(1-CP3)                                                 $
MELT  279 SEQ278=PLMFW*TD31*CCPR1*MU4*(1-CTMU1)*(1-TP1)               $
MELT  280 SEQ279=PLMFW*MU4*(1-CTMU1)*RT1*MR1*PL1*(1-TP1)*SR4*(1-EB1)*X    $
MELT  280 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                        $
MELT  281 SEQ280=CCSA*MU4*CTMU1*(1-TP1)*SED*RB5*(1-CSB3)*(1-CH5)          $
MELT  282 SEQ281=MSIV*(1-MU4)*(1-CTMU1)*RT1*PL1*EB1*(1-RA2)*(1-RB4)*X     $
MELT  282 X      =(1-CSA1)                                                $
MELT  283 SEQ282=CCSA*B21*MU4*(1-CTMU1)*(1-TP1)*SED*(1-RB5)*(1-CSB3)      $
MELT  284 SEQ283=LVBB2*PD5*PA2*(1-PB4)*(1-CTMU1)*TP1*TPR1*(1-RA2)*X       $
MELT  284 X      =(1-CSA1)*(1-CH3)                                        $
MELT  285 SEQ284=SLOCAN*BC1*MU1*(1-CTMU1)*(1-TP1)*RA2*(1-CSA1)*(1-CH6)    $
MELT  286 SEQ285=LDAAC*ZB6*OS3*(1-PA2)*MU6*(1-CTMU1)*MF1*(1-CP3)          $
MELT  287 SEQ286=LDCAC*DB1*(1-PD5)*PA1*(1-MU4)*(1-CTMU1)*(1-RA2)*X        $
MELT  287 X      =(1-CSA1)*(1-CH3)                                        $
MELT  288 SEQ287=LRCP*AEBE1*(1-CTMU1)*(1-TP1)                          $
MELT  289 SEQ288=LOCV*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*SR1*(1-EB1)*X     $
MELT  289 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                        $
MELT  290 SEQ289=FLPH1A*BC1*MU4*(1-CTMU1)*(1-TP1)*TB2                     $
MELT  291 SEQ290=LASD*B11*(1-PD5)*(1-CTMU1)*(1-TP3)*DS6*(1-CI4)           $
MELT  292 SEQ291=PLMFW*DA1*PB1*(1-CTMU1)*TP1*TPR1*(1-RB5)*(1-CSB3)*X      $
MELT  292 X      =(1-CH2)                                                 $
MELT  293 SEQ292=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*PB3*X         $
MELT  293 X      =(1-V37)*(1-TP3)*(1-DS6)*(1-PI3)*(1-CI4)*REC1            $
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MELT  294 SEQ293=PLMFW*DB1*(1-PD5)*MU4*(1-CTMU1)*TP1*TPR1*MA4*(1-RA2)*X  $
MELT  294 X      =(1-CSA1)*(1-CH3)                                       $
MELT  295 SEQ294=CCSA*MU4*(1-CTMU1)*TP1*TPR1*SED*(1-RB5)*(1-CSB3)*RR5*X  $
MELT  295 X      =(1-CH5)                                                $
MELT  296 SEQ295=LOSP*OGR11*DG3*(1-GB2)*(1-DSLR1)*(1-TP3)*RVB3*X $
MELT  296 X      =REC2                                                   $
MELT  297 SEQ296=LOSP*OGR11*(1-GA1)*DG2*(1-GC2)*(1-DSLR1)*(1-PA2)*X  $
MELT  297 X      =(1-V37)*CCPR1*(1-TP1)*REC4                             $
MELT  298 SEQ297=CCSA*(1-MU4)*(1-CTMU1)*(1-TP1)*SED*RB5*CSB3             $
MELT  299 SEQ298=LBSD*(1-PD4)*AC2*(1-MU6)*(1-CTMU1)*(1-TP1)*VA1          $
MELT  300 SEQ299=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*PA2*(1-PB4)*X        $
MELT  300 X      =(1-V37)*(1-TP3)*(1-DS6)*(1-PI3)*(1-CI4)*REC1           $
MELT  301 SEQ300=LRCP*(1-MU4)*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*X        $
MELT  301 X      =(1-RA2)*(1-RB4)*(1-CSA1)                               $
MELT  302 SEQ301=TTIE*TD31*CCPR1*MU4*(1-CTMU1)*(1-TP1)               $
MELT  303 SEQ302=PLMFW*B11*(1-PD4)*AC2*(1-MU6)*(1-CTMU1)*(1-TP1)*SED     $
MELT  304 SEQ303=RTIE*A11*BC2*(1-CTMU1)*(1-TP3)*TB2*(1-RVB3)             $
MELT  305 SEQ304=CCSTL*MU4*(1-CTMU1)*TP1*(1-TPR1)*SED                    $
MELT  306 SEQ305=EXMFW*AEBE1*(1-CTMU1)*(1-TP1)                        $
MELT  307 SEQ306=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*(1-CSA1)*X $
MELT  307 X      =RVA1*RVB2                                              $
MELT  308 SEQ307=ISI*B11*(1-PD4)*AC2*(1-MU6)*(1-CTMU1)*(1-TP1)           $
MELT  309 SEQ308=TTIE*DA1*PB1*(1-CTMU1)*TP1*TPR1*(1-RB5)*(1-CSB3)*X      $
MELT  309 X      =(1-CH2)                                                $
MELT  310 SEQ309=TTIE*DB1*(1-PD5)*MU4*(1-CTMU1)*TP1*TPR1*MA4*(1-RA2)*X   $
MELT  310 X      =(1-CSA1)*(1-CH3)                                       $
MELT  311 SEQ310=RTIE*A11*DE1*(1-CTMU1)*(1-TP3)*(1-RVB3)                 $
MELT  312 SEQ311=EXMFW*(1-MU4)*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*X       $
MELT  312 X      =(1-RA2)*(1-RB4)*(1-CSA1)                               $
MELT  313 SEQ312=TLMFW*AEBE1*(1-CTMU1)*(1-TP1)                        $
MELT  314 SEQ313=LBSD*(1-PD4)*AC2*MU6*(1-CTMU1)*(1-TP1)*VA1              $
MELT  315 SEQ314=TTIE*B11*(1-PD4)*AC2*(1-MU6)*(1-CTMU1)*(1-TP1)*SED      $
MELT  316 SEQ315=LDAAC*ZB6*(1-PA2)*(1-MU6)*(1-CTMU1)*RT8*PL1*EB3*X       $
MELT  316 X      =(1-RA2)*(1-RB4)*(1-CSA1)                               $
MELT  317 SEQ316=PLMFW*B11*(1-PD4)*AC2*MU6*(1-CTMU1)*(1-TP1)*SED         $
MELT  318 SEQ317=TLMFW*(1-MU4)*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*X       $
MELT  318 X      =(1-RA2)*(1-RB4)*(1-CSA1)                               $
MELT  319 SEQ318=SLOCAN*(1-MU2)*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*CSA1*X $
MELT  319 X      =(1-CSB2)*RR1*(1-CH5)                                   $
MELT  320 SEQ319=SLOCAN*(1-MU2)*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*X      $
MELT  320 X      =(1-CSA1)*CSB1*RR1*(1-CH6)                              $
MELT  321 SEQ320=SLOCAN*MU2*CTMU1*(1-TP1)*(1-RA2)*(1-RB4)*(1-CSA1)*RR1   $
MELT  322 SEQ321=MSIV*MU4*(1-CTMU1)*RT1*PL1*EB1*(1-RA2)*(1-RB4)*X        $
MELT  322 X      =(1-CSA1)                                               $
MELT  323 SEQ322=ISI*B11*(1-PD4)*AC2*MU6*(1-CTMU1)*(1-TP1)               $
MELT  324 SEQ323=LRCP*A11*(1-CTMU1)*(1-TP3)*PR4*(1-TB2)*(1-RB5)*X        $
MELT  324 X      =(1-CSB3)*RVB3*(1-CH5)                                  $
MELT  325 SEQ324=LDCAC*DB1*(1-PD5)*PA1*MU4*(1-CTMU1)*(1-RA2)*(1-CSA1)*X  $
MELT  325 X      =(1-CH3)                                                $
MELT  326 SEQ325=LOCV*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*SR1*(1-EB1)*X        $
MELT  326 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                       $
MELT  327 SEQ326=LASD*DB1*(1-PD5)*(1-CTMU1)*TP3*TPR1*(1-TB2)*(1-RVB3)    $
MELT  328 SEQ327=CCSA*MU4*(1-CTMU1)*(1-TP1)*SED*RB5*CSB3                 $
MELT  329 SEQ328=TTIE*B11*(1-PD4)*AC2*MU6*(1-CTMU1)*(1-TP1)*SED          $
MELT  330 SEQ329=LRCP*MU4*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*(1-RA2)*X    $
MELT  330 X      =(1-RB4)*(1-CSA1)                                       $
MELT  331 SEQ330=LDAAC*ZB6*(1-PA2)*MU6*(1-CTMU1)*RT8*PL1*EB3*(1-RA2)*X   $
MELT  331 X      =(1-RB4)*(1-CSA1)                                       $
MELT  332 SEQ331=TTIE*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-EB1)*(1-RA2)*X        $
MELT  332 X      =(1-RB4)*(1-CSA1)*RR1                                   $
MELT  333 SEQ332=PLMFW*(1-MU4)*(1-CTMU1)*RT1*PL1*TP1*TPR1*AFA5*(1-EB1)*X $
MELT  333 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                       $
MELT  334 SEQ333=PLMFW*PA1*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-AFA3)*X  $
MELT  334 X      =(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)               $
MELT  335 SEQ334=PLMFW*PB1*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-AFA3)*X  $
MELT  335 X      =(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)               $
MELT  336 SEQ335=CCSA*B11*(1-PD4)*CCPR1*(1-MU6)*(1-CTMU1)*(1-TP1)        $
MELT  337 SEQ336=EXMFW*MU4*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*(1-RA2)*X   $
MELT  337 X      =(1-RB4)*(1-CSA1)                                       $
MELT  338 SEQ337=SLOCAI*B11*(1-PD4)*(1-MU1)*(1-CTMU1)*(1-TP1)*(1-SEH)*X  $
MELT  338 X      =(1-RA2)*(1-CSA1)*RR6*(1-CH6)                           $
MELT  339 SEQ338=LOSP*OGR11*DGSYS*TP3*TPR1*(1-CI4)*REC6        $
MELT  340 SEQ339=PLMFW*A11*BC2*(1-CTMU1)*(1-TP3)*TB2*(1-RVB3)            $
MELT  341 SEQ340=LBSD*DA1*(1-PD4)*(1-CTMU1)*TP1*TPR1*(1-TB2)             $
MELT  342 SEQ341=SLOCAI*ZAB5*OS2*MU2*(1-CTMU1)*(1-MF1)*(1-OF2)*X     $
MELT  342 X      =(1-CP3)                                                $
MELT  343 SEQ342=TLMFW*MU4*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*(1-RA2)*X   $
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MELT  343 X      =(1-RB4)*(1-CSA1)                                          $
MELT  344 SEQ343=LOSP*OGR11*(1-GA1)*GB1*(1-GC2)*(1-GD2)*CE1*(1-DSLR1)*X  $
MELT  344 X      =(1-V37)*TP1*TPR1                                          $
MELT  345 SEQ344=LOSP*(1-OGR11)*BUSB*(1-AB6)*(1-BB7)*(1-PD5)*X        $
MELT  345 X      =(1-TP3)*(1-DS6)*(1-PI3)*CI4                               $
MELT  346 SEQ345=PLMFW*(1-MU4)*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-SR1)*X         $
MELT  346 X      =(1-EB1)*(1-RA2)*(1-RB4)*(1-CSA1)*RR1                      $
MELT  347 SEQ346=PLMFW*A11*DE1*(1-CTMU1)*(1-TP3)*(1-RVB3)                  $
MELT  348 SEQ347=CCSA*MU4*(1-CTMU1)*TP1*TPR1*SED*(1-RB5)*(1-CSB3)*RVB1*X $
MELT  348 X      =(1-CH5)                                                   $
MELT  349 SEQ348=SLOCAI*CE1*BC1*(1-CTMU1)*(1-TP1)                          $
MELT  350 SEQ349=CCSA*B11*(1-PD4)*CCPR1*MU6*(1-CTMU1)*(1-TP1)              $
MELT  351 SEQ350=ERCWB*CCSR3*(1-MU4)*(1-CTMU1)*(1-TP1)*SED                 $
MELT  352 SEQ351=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X     $
MELT  352 X      =(1-V37)*CCPR1*(1-TP3)*(1-DS6)*(1-PI3)*(1-CI4)*REC1        $
MELT  353 SEQ352=TTIE*A11*BC2*(1-CTMU1)*(1-TP3)*TB2*(1-RVB3)               $
MELT  354 SEQ353=CCSTL*(1-MU4)*(1-CTMU1)*(1-TP1)*SED*RVA1                  $
MELT  355 SEQ354=RTIE*B11*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)*VA1*TB2*X          $
MELT  355 X      =(1-RA2)*(1-CSA1)*(1-CH6)                                  $
MELT  356 SEQ355=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*AE5*FE2*X      $
MELT  356 X      =(1-TP1)*(1-RVB3)                                          $
MELT  357 SEQ356=LBSD*CE1*(1-PD4)*(1-MU6)*(1-CTMU1)*TP1*TPR1               $
MELT  358 SEQ357=ERCWTL*(1-CTMU1)*(1-TP1)*SU3                              $
MELT  359 SEQ358=TTIE*MU4*(1-CTMU1)*RT1*PL1*(1-EB1)*(1-RA2)*(1-RB4)*X      $
MELT  359 X      =(1-CSA1)*RR1                                              $
MELT  360 SEQ359=PLMFW*MU4*(1-CTMU1)*RT1*PL1*TP1*TPR1*AFA5*(1-EB1)*X       $
MELT  360 X      =(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                          $
MELT  361 SEQ360=TTIE*A11*DE1*(1-CTMU1)*(1-TP3)*(1-RVB3)                   $
MELT  362 SEQ361=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X     $
MELT  362 X      =(1-V37)*(1-TP3)*(1-DS6)*DP7*(1-CI4)*REC1                  $
MELT  363 SEQ362=ERCWTL*(1-CTMU1)*(1-TP1)*RVA1                             $
MELT  364 SEQ363=CCSA*(1-MU4)*(1-CTMU1)*(1-TP1)*SED*S22*(1-RB5)*X          $
MELT  364 X      =(1-CSB3)*CH5                                              $
MELT  365 SEQ364=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X     $
MELT  365 X      =(1-V37)*(1-TP3)*DS6*CI4*REC1                              $
MELT  366 SEQ365=LOSP*(1-OGR11)*BUSB*(1-AB6)*(1-BB7)*(1-PD5)*X        $
MELT  366 X      =(1-TP3)*DS6*(1-CI4)                                       $
MELT  367 SEQ366=PLMFW*PA1*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-AFA3)*X        $
MELT  367 X      =(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                  $
MELT  368 SEQ367=PLMFW*PB1*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-AFA3)*X        $
MELT  368 X      =(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                  $
MELT  369 SEQ368=ELOCA*(1-MU4)*(1-CTMU1)*(1-CSA1)                          $
MELT  370 SEQ369=FLPH1A*MDE1*(1-CTMU1)*TP1*TPR1                            $
MELT  371 SEQ370=CCSTL*(1-MU4)*(1-CTMU1)*(1-TP1)*SED*RVB1                  $
MELT  372 SEQ371=LLOCA*(1-MU4)*(1-CTMU1)*RABX1*(1-CSA1)                 $
MELT  373 SEQ372=CCSA*B2U21*CCPR1*(1-MU4)*(1-CTMU1)*(1-TP1)                $
MELT  374 SEQ373=SLOCAN*TD31*(1-CTMU1)*(1-TP1)                        $
MELT  375 SEQ374=LDCAC*AEBE1*(1-CTMU1)                                  $
MELT  376 SEQ375=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-PA2)*(1-PB3)*X     $
MELT  376 X      =(1-V37)*TP3*(1-TPR1)*(1-DS6)*(1-PI3)*(1-CI4)*REC1         $
MELT  377 SEQ376=LBSD*BE3*(1-PD4)*(1-MU6)*(1-CTMU1)*(1-TP1)*VA1            $
MELT  378 SEQ377=LBSD*CE1*(1-PD4)*MU6*(1-CTMU1)*TP1*TPR1                   $
MELT  379 SEQ378=ERCWTL*(1-CTMU1)*(1-TP1)*RVB1                             $
MELT  380 SEQ379=LASD*DB1*(1-PD5)*(1-CTMU1)*(1-TP3)*TB2*(1-RVB3)           $
MELT  381 SEQ380=SLOCAI*B11*(1-PD4)*MU1*(1-CTMU1)*(1-TP1)*(1-SEH)*RA2*X   $
MELT  381 X      =(1-CSA1)*(1-CH6)                                          $
MELT  382 SEQ381=LDAAC*B11*(1-ZB6)*CE1*(1-PD4)*(1-CTMU1)*(1-TP1)           $
MELT  383 SEQ382=RTIE*B11*(1-PD4)*AC2*CCPR1*(1-MU6)*(1-CTMU1)*(1-TP1)     $
MELT  384 SEQ383=LOSP*(1-OGR11)*BUSD*TP3*TPR1*(1-CI4)          $
MELT  385 SEQ384=PLMFW*MU4*(1-CTMU1)*RT1*PL1*(1-TP1)*(1-SR1)*(1-EB1)*X    $
MELT  385 X      =(1-RA2)*(1-RB4)*(1-CSA1)*RR1                              $
MELT  386 SEQ385=LDCAC*(1-MU4)*(1-CTMU1)*RT1*(1-PL1)*EB1*(1-RA2)*X         $
MELT  386 X      =(1-RB4)*(1-CSA1)                                          $
MELT  387 SEQ386=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*CSA1*X       $
MELT  387 X      =(1-CSB2)*RR1*(1-CH5)                                      $
MELT  388 SEQ387=SLOCAN*MU2*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-RB4)*(1-CSA1)*X $
MELT  388 X      =CSB1*RR1*(1-CH6)                                          $
MELT  389 SEQ388=PLMFW*(1-MU4)*CTMU1*RT1*PL1*(1-TP2)*(1-MA7)*MB27*X        $
MELT  389 X      =(1-AFA3)*(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)         $
MELT  390 SEQ389=PLMFW*(1-MU4)*CTMU1*RT1*PL1*(1-TP2)*MA7*(1-AFA3)*X        $
MELT  390 X      =(1-EB1)*(1-OB1)*(1-RA2)*(1-RB4)*(1-CSA1)                  $
MELT  391 SEQ390=CCSTL*(1-MU4)*(1-CTMU1)*CD1*(1-TP1)*SED                   $
MELT  392 SEQ391=ERCWA*DE2*(1-CTMU1)*(1-TP1)                               $
MELT  393 SEQ392=ERCWB*CCSR3*MU4*(1-CTMU1)*(1-TP1)*SED                     $
MELT  394 SEQ393=LDBAC*AEBE1*(1-CTMU1)*(1-TP1)                          $
MELT  395 SEQ394=LOCV*AEBE1*(1-CTMU1)*(1-TP1)                           $
MELT  396 SEQ395=FLPH1B*CCSR3*(1-MU4)*(1-CTMU1)*(1-TP1)*VA1                $
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MELT  397 SEQ396=SLOCAN*BC1*(1-MU1)*(1-CTMU1)*(1-TP1)*(1-RA2)*(1-CSA1)*X $
MELT  397 X      =RR4*(1-CH6)                                            $
MELT  398 SEQ397=CCSTL*ZB1*(1-MU4)*(1-CTMU1)*(1-TP1)*SED                 $
MELT  399 SEQ398=CCSTL*ZA1*(1-ZB6)*(1-MU4)*(1-CTMU1)*(1-TP1)*SED         $
MELT  400 SEQ399=CCSTL*MU4*(1-CTMU1)*(1-TP1)*SED*RVA1                    $
MELT  401 SEQ400=LOCV*(1-MU4)*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*X        $
MELT  401 X      =(1-RA2)*(1-RB4)*(1-CSA1)                               $
MELT  402 SEQ401=LBSD*BE3*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)*VA1              $
MELT  403 SEQ402=RTIE*B11*(1-PD4)*AC2*CCPR1*MU6*(1-CTMU1)*(1-TP1)        $
MELT  404 SEQ403=CCSTL*CCPR1*(1-MU4)*(1-CTMU1)*TP1*(1-TPR1)              $
MELT  405 SEQ404=LDDAC*AEBE1*(1-CTMU1)*(1-TP1)                         $
MELT  406 SEQ405=ERCWTL*ZB1*(1-CTMU1)*(1-TP1)                            $
MELT  407 SEQ406=ERCWTL*ZA1*(1-ZB6)*(1-CTMU1)*(1-TP1)                    $
MELT  408 SEQ407=LDCAC*DA1*DB1*(1-PD5)*(1-CTMU1)                         $
MELT  409 SEQ408=CCSA*CCPR1*MU4*(1-CTMU1)*(1-TP1)*SED*RB5*(1-CSB3)*X     $
MELT  409 X      =(1-CH5)                                                $
MELT  410 SEQ409=CCSA*MU4*(1-CTMU1)*(1-TP1)*SED*S22*(1-RB5)*(1-CSB3)*X   $
MELT  410 X      =CH5                                                    $
MELT  411 SEQ410=MLOCA*(1-MU4)*(1-CTMU1)*RF1*(1-CSA1)                    $
MELT  412 SEQ411=ELOCA*MU4*(1-CTMU1)*(1-CSA1)                            $
MELT  413 SEQ412=LDAAC*(1-ZB6)*AEBE1*(1-CTMU1)*(1-TP1)                 $
MELT  414 SEQ413=LDDAC*(1-MU4)*(1-CTMU1)*RT1*(1-PL1)*(1-TP1)*EB1*X       $
MELT  414 X      =(1-RA2)*(1-RB4)*(1-CSA1)                               $
MELT  415 SEQ414=CCSA*(1-MU4)*(1-CTMU1)*(1-TP1)*SED*(1-RB5)*(1-CSB3)*X   $
MELT  415 X      =RR5*CH5                                                $
MELT  416 SEQ415=PLMFW*B11*(1-PD4)*MU6*(1-CTMU1)*(1-TP1)*VA1*TB2*X       $
MELT  416 X      =(1-RA2)*(1-CSA1)*(1-CH6)                               $
MELT  417 SEQ416=CCSTL*MU4*(1-CTMU1)*(1-TP1)*SED*RVB1                    $
MELT  418 SEQ417=LLOCA*MU4*(1-CTMU1)*RABX1*(1-CSA1)                    $
MELT  419 SEQ418=CCSA*B2U21*CCPR1*MU4*(1-CTMU1)*(1-TP1)                  $
MELT  420 SEQ419=RTIE*TD31*(1-MU4)*(1-CTMU1)*(1-TP1)*VA1               $
MELT  421 SEQ420=LDBAC*(1-MU6)*(1-CTMU1)*RT4*(1-PL1)*(1-TP1)*EB3*X       $
MELT  421 X      =(1-RA2)*(1-RB4)*(1-CSA1)                               $
MELT  422 SEQ421=LVBB1*(1-CTMU1)*(1-TP1)*PR2*RB5*(1-CSB3)*(1-CH5)        $
MELT  423 SEQ422=SLOCAI*(1-MU2)*(1-CTMU1)*(1-TP1)*SEH*(1-RA2)*(1-RB4)*X  $
MELT  423 X      =(1-CSA1)*SU2                                           $
MELT  424 SEQ423=PLMFW*(1-MU4)*RT1*PL1*(1-TP1)*AFA1                      $
MELT  425 SEQ424=LBSD*A11*TP3*TPR1*(1-DS6)*(1-CI4)                       $
MELT  426 SEQ425=PLMFW*DA1*RT2*PL1*(1-TP1)                               $
MELT  427 SEQ426=PLMFW*(1-MU4)*RT1*PL1*TP1*TPR1*(1-AFA5)*EB1             $
MELT  428 SEQ427=CCSTL*(1-MU4)*(1-TP1)*MA3*(1-MB10)*SED                  $
MELT  429 SEQ428=CCSTL*(1-MU4)*(1-TP1)*MB9*SED                           $
MELT  430 SEQ429=LDCAC*MU4*RT1*(1-PL1)*EB1                               $
MELT  431 SEQ430=RTIE*DB1*PA1*(1-MU4)*TP1*TPR1                           $
MELT  432 SEQ431=PLMFW*MU4*CTMU1*RT1*PL1*(1-TP2)*(1-MA7)*MB27            $
MELT  433 SEQ432=TTIE*B11*MU6*(1-TP1)*VA1*TB2                            $
MELT  434 SEQ433=PLMFW*MU4*CTMU1*RT1*PL1*(1-TP2)*MA7                     $
MELT  435 SEQ434=EXMFW*(1-MU4)*TP1*TPR1*TOT1*OB1                       $
MELT  436 SEQ435=CCSTL*MU4*CD1*(1-TP1)*SED                               $
MELT  437 SEQ436=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*BE33*CE2*X   $
MELT  437 X      =(1-TP1)*(1-DS6)*(1-CI4)                                $
MELT  438 SEQ437=SLOCAI*B11*MU1*(1-TP1)*RR6                              $
MELT  439 SEQ438=FLPH1B*CCSR3*MU4*(1-TP1)*VA1                            $
MELT  440 SEQ439=SLOCAN*(1-MU2)*TP1*(1-TPR1)*RR1                         $
MELT  441 SEQ440=CCSA*(1-MU4)*(1-TP1)*SED*SU2                            $
MELT  442 SEQ441=CCSTL*(1-MU4)*CTMU1*(1-TP1)*VA1                         $
MELT  443 SEQ442=CCSTL*ZB1*MU4*(1-TP1)*SED                               $
MELT  444 SEQ443=CCSTL*ZA1*(1-ZB6)*MU4*(1-TP1)*SED                       $
MELT  445 SEQ444=LDBAC*MU6*RT4*(1-PL1)*(1-TP1)*EB3                       $
MELT  446 SEQ445=PLMFW*B11*AC2*CCPR1*(1-MU6)*(1-TP1)                     $
MELT  447 SEQ446=LOCV*MU4*RT1*(1-PL1)*(1-TP1)*EB1                        $
MELT  448 SEQ447=TTIE*DA1*RT2*PL1*(1-TP1)                                $
MELT  449 SEQ448=LDAAC*(1-ZB6)*(1-MU6)*RT4*(1-PL1)*(1-TP1)*EB3           $
MELT  450 SEQ449=TLMFW*(1-MU4)*TP1*TPR1*TOT1*OB1                       $
MELT  451 SEQ450=SGTR*DA1*BC1                                            $
MELT  452 SEQ451=FLPH1B*A11*TP3*TPR1*(1-RVB3)                            $
MELT  453 SEQ452=CCSTL*CCPR1*MU4*TP1*(1-TPR1)                            $
MELT  454 SEQ453=SLOCAN*MU2*CTMU1*(1-TP1)*RABX2                        $
MELT  455 SEQ454=ERCWB*MU4*(1-TP1)*VA1*TB2                               $
MELT  456 SEQ455=EXMFW*ZAB1*OS3*(1-MU4)*(1-CP3)                        $
MELT  457 SEQ456=FLPH1B*A11*(1-TP3)*RVB3                                 $
MELT  458 SEQ457=MLOCA*MU4*RF1                                           $
MELT  459 SEQ458=LOSP*OGR11*(1-GA1)*BUSA*(1-GB1)*(1-BA4)*(1-GC1)*X     $
MELT  459 X      =(1-GD1)*(1-TP3)*(1-RVB3)                             $
MELT  460 SEQ459=SLOCAN*A11*MU1*(1-TP3)*RVB3                             $
MELT  461 SEQ460=SGTR*RT1*PL1*EB1                                        $
MELT  462 SEQ461=LDDAC*MU4*RT1*(1-PL1)*(1-TP1)*EB1                       $
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MELT  463 SEQ462=CCSA*MU4*(1-TP1)*SED*RR5*CH5                          $
MELT  464 SEQ463=LRCP*B11*CE1*(1-MU6)*(1-TP1)                          $
MELT  465 SEQ464=TTIE*B11*AC2*CCPR1*(1-MU6)*(1-TP1)                    $
MELT  466 SEQ465=RTIE*TD31*MU4*(1-TP1)*VA1                          $
MELT  467 SEQ466=ERCWA*V33*(1-MU4)*(1-TP1)                             $
MELT  468 SEQ467=PLMFW*B11*AC2*CCPR1*MU6*(1-TP1)                       $
MELT  469 SEQ468=CCSA*DB1*(1-MU4)*(1-TP1)*VA1                          $
MELT  470 SEQ469=CCSA*MU4*CTMU1*(1-TP1)*SED*S22                        $
MELT  471 SEQ470=TLMFW*ZAB1*OS3*(1-MU4)*(1-CP3)                     $
MELT  472 SEQ471=LDAAC*(1-ZB6)*MU6*RT4*(1-PL1)*(1-TP1)*EB3             $
MELT  473 SEQ472=LOSP*OGR11*DG2*(1-GB2)*(1-GC2)*TP3*TPR1*TB4*X      $
MELT  473 X     =(1-RVB3)*REC3                                         $
MELT  474 SEQ473=EXMFW*B11*CE1*(1-MU6)*(1-TP1)                         $
MELT  475 SEQ474=LOSP*OGR11*GA1*(1-GB2)*(1-GC2)*(1-GD2)*PB3*TP3*TPR1*X $
MELT  475 X     =(1-TB4)*RVB3                                          $
MELT  476 SEQ475=PLMFW*MU4*RT1*PL1*(1-TP1)*AFA1                        $
MELT  477 SEQ476=LOSP*OGR11*(1-GA1)*GB1*(1-GC2)*(1-GD2)*CE1*(1-TP1)*X  $
MELT  477 X     =REC4                                                  $
MELT  478 SEQ477=CCSA*(1-MU4)*CTMU1*(1-TP1)*SED*RR5                    $
MELT  479 SEQ478=LOSP*OGR11*(1-GA1)*DG2*(1-GC2)*(1-TP1)*VA2*REC4    $
MELT  480 SEQ479=SLOCAN*(1-MU2)*(1-TP1)*S11*(1-S23)*RR1                $
MELT  481 SEQ480=SLOCAN*(1-MU2)*(1-TP1)*S21*RR1                        $
MELT  482 SEQ481=PLMFW*MU4*RT1*PL1*TP1*TPR1*(1-AFA5)*EB1               $
MELT  483 SEQ482=CCSTL*MU4*(1-TP1)*MA3*(1-MB10)*SED                    $
MELT  484 SEQ483=CCSTL*MU4*(1-TP1)*MB9*SED                             $
MELT  485 SEQ484=FLPH1B*CE2*CTMU1*(1-TP1)                              $
MELT  486 SEQ485=LRCP*(1-MU4)*(1-TP1)*PR1*RR1                          $
MELT  487 SEQ486=RTIE*DB1*PA1*MU4*TP1*TPR1                             $
MELT  488 SEQ487=LASD*B11*TP3*TPR1*(1-DS6)*(1-CI4)                     $
MELT  489 SEQ488=LOSP*OGR11*DG2*(1-GB2)*(1-GC2)*TP3*TPR1*(1-TB4)*X  $
MELT  489 X     =RVB3*REC3                                             $
MELT  490 SEQ489=EXMFW*MU4*TP1*TPR1*TOT1*OB1                        $
MELT  491 SEQ490=PLMFW*TD31*(1-MU4)*(1-TP1)*VA1                     $
MELT  492 SEQ491=CCSA*(1-MU4)*(1-TP1)*SED*S22*CSB3                     $
MELT  493 SEQ492=TLMFW*B11*CE1*(1-MU6)*(1-TP1)                         $
MELT  494 SEQ493=LRCP*B11*CE1*MU6*(1-TP1)                              $
MELT  495 SEQ494=TTIE*B11*AC2*CCPR1*MU6*(1-TP1)                        $
MELT  496 SEQ495=CCSA*MU4*(1-TP1)*SED*SU2                              $
MELT  497 SEQ496=CCSTL*MU4*CTMU1*(1-TP1)*VA1                           $
MELT  498 SEQ497=LOSP*OGR11*FAIV*(1-TP3)*(1-DS6)*(1-CI4)*X    $
MELT  498 X     =REC5                                                  $
MELT  499 SEQ498=FLPH1A*PD1*V37*(1-TP1)                                $
MELT  500 SEQ499=SLOCAI*(1-MU2)*(1-TP1)*SEH*RB4*RR4                    $
MELT  501 SEQ500=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*VINV22*(1-TP3)*X    $
MELT  501 X     =(1-DS6)*(1-CI4)*REC1                                  $
MELT  502 SEQ501=EXMFW*B11*CE1*MU6*(1-TP1)                             $
MELT  503 SEQ502=CCSA*MU4*TP1*(1-TPR1)*SED*RB5                         $
MELT  504 SEQ503=TLMFW*MU4*TP1*TPR1*TOT1*OB1                        $
MELT  505 SEQ504=CCSA*CE1*BC33*(1-MU4)*(1-TP1)                         $
MELT  506 SEQ505=PLMFW*DB1*PA1*(1-MU4)*TP1*TPR1                        $
MELT  507 SEQ506=CCSA*(1-MU4)*(1-TP1)*SED*RVB1*CH5                     $
MELT  508 SEQ507=LOSP*OGR11*(1-GA1)*GB1*(1-GC2)*DC1*(1-GD2)*TB4        $
MELT  509 SEQ508=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*AE5*DSLR1*X $
MELT  509 X     =V37*(1-TP1)*(1-RVB3)                                  $
MELT  510 SEQ509=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*AE5*V37*X  $
MELT  510 X     =(1-MU4)*TP1*TPR1                                      $
MELT  511 SEQ510=TTIE*TD31*(1-MU4)*(1-TP1)*VA1                      $
MELT  512 SEQ511=EXMFW*ZAB1*OS3*MU4*(1-CP3)                         $
MELT  513 SEQ512=SLOCAN*CE1*MU1*(1-TP1)*RB5                            $
MELT  514 SEQ513=MSIV*AEBE1*(1-TP1)                                 $
MELT  515 SEQ514=LOSP*OGR11*DG3*(1-GB2)*DSLR1*(1-TP3)*(1-RVB3)*X $
MELT  515 X     =REC2                                                  $
MELT  516 SEQ515=RTIE*A11*TD32*(1-TP3)*(1-RVB3)                     $
MELT  517 SEQ516=TLMFW*B11*CE1*MU6*(1-TP1)                             $
MELT  518 SEQ517=CCSA*MU4*(1-TP1)*SED*S22*RB5                          $
MELT  519 SEQ518=SLOCAN*BC1*MU1*(1-TP1)*RR4                            $
MELT  520 SEQ519=SLOCAI*(1-MU2)*(1-TP1)*SEH*RA2*(1-RB6)*RR5            $
MELT  521 SEQ520=PLMFW*(1-MU4)*RT1*PL1*TP1*TPR1*(1-AFA5)*SR1           $
MELT  522 SEQ521=ERCWA*V33*MU4*(1-TP1)                                 $
MELT  523 SEQ522=MSIV*(1-MU4)*RT1*(1-PL1)*(1-TP1)*EB1                  $
MELT  524 SEQ523=CCSA*DB1*MU4*(1-TP1)*VA1                              $
MELT  525 SEQ524=LOSP*OGR11*GA1*(1-GB2)*(1-GC2)*(1-GD2)*DD1*TP3*TPR1*X $
MELT  525 X     =(1-TB4)*(1-RVB3)                                      $
MELT  526 SEQ525=TLMFW*ZAB1*OS3*MU4*(1-CP3)                         $
MELT  527 SEQ526=TTIE*DB1*PA1*(1-MU4)*TP1*TPR1                         $
MELT  528 SEQ527=CCSA*MU4*CTMU1*(1-TP1)*SED*RR5                        $
MELT  529 SEQ528=TTIE*MU4*RT1*PL1*RABX2                             $
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MELT  530 SEQ529=SLOCAI*MU2*(1-TP1)*SEH*SU2                                $
MELT  531 SEQ530=LOSP*OGR11*GA1*(1-GB2)*DB1*(1-GC2)*(1-GD2)*TP3*TPR1*X     $
MELT  531 X      =(1-CI4)                                                  $
MELT  532 SEQ531=SGTR*MU3*SL1*RABX2                                      $
MELT  533 SEQ532=ERCWB*CCSR3*CCPR1*(1-MU4)*(1-TP1)                         $
MELT  534 SEQ533=LRCP*MU4*(1-TP1)*PR1*RR1                                  $
MELT  535 SEQ534=SGTR*RT1*PL1*SR1                                          $
MELT  536 SEQ535=LOSP*(1-OGR11)*BUSB*(1-BA4)*(1-AB4)*(1-TP3)*TB4*X     $
MELT  536 X      =(1-RVB3)                                                 $
MELT  537 SEQ536=PLMFW*TD31*MU4*(1-TP1)*VA1                            $
MELT  538 SEQ537=CCSA*MU4*(1-TP1)*SED*S22*CSB3                             $
MELT  539 SEQ538=LOSP*OGR11*(1-GA1)*BUSA*(1-GB1)*(1-GC1)*X         $
MELT  539 X      =(1-GD1)*(1-BB14)*(1-TP3)*(1-DS6)*(1-CI4)                 $
MELT  540 SEQ539=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*BE33*V37*X     $
MELT  540 X      =(1-MU4)*TP1*TPR1                                         $
MELT  541 SEQ540=CCSTL*CCPR1*(1-MU4)*(1-TP1)*SU3                           $
MELT  542 SEQ541=LOSP*OGR11*(1-GA1)*(1-GB1)*DB1*(1-GC1)*(1-GD1)*AE5*X      $
MELT  542 X      =(1-TP1)                                                  $
MELT  543 SEQ542=CCSA*(1-MU4)*(1-TP1)*SED*CSB3*RR5                         $
MELT  544 SEQ543=CCSTL*CCPR1*(1-MU4)*(1-TP1)*RVA1                          $
MELT  545 SEQ544=LOSP*OGR11*(1-GA1)*BUSA*(1-GB1)*(1-GC1)*(1-AB6)*X     $
MELT  545 X      =(1-GD1)*(1-TP3)*(1-DS6)*(1-CI4)                      $
MELT  546 SEQ545=SLOCAN*MU2*TP1*(1-TPR1)*RR1                               $
MELT  547 SEQ546=LOSP*(1-OGR11)*BUSB*(1-AB6)*(1-BB7)*TP3*TPR1*X        $
MELT  547 X      =(1-CI4)                                                  $
MELT  548 SEQ547=SGTR*PA1*MU3*DS4                                          $
MELT  549 SEQ548=CCSA*CE1*BC33*MU4*(1-TP1)                                 $
MELT  550 SEQ549=LOSP*OGR11*(1-GA1)*DG2*(1-GD3)*TP1*TPR1*TB4*REC3      $
MELT  551 SEQ550=PLMFW*DB1*PA1*MU4*TP1*TPR1                                $
MELT  552 SEQ551=CCSA*MU4*(1-TP1)*SED*RVB1*CH5                             $
MELT  553 SEQ552=PLMFW*MU4*RT1*PL1*(1-TP1)*RABX2                         $
MELT  554 SEQ553=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*AE5*V37*X      $
MELT  554 X      =MU4*TP1*TPR1                                             $
MELT  555 SEQ554=TTIE*TD31*MU4*(1-TP1)*VA1                             $
MELT  556 SEQ555=SLOCAN*MU2*(1-TP1)*RABX2*CSA1*(1-CSB2)                  $
MELT  557 SEQ556=SLOCAN*MU2*(1-TP1)*RABX2*CSB1                           $
MELT  558 SEQ557=PLMFW*(1-MU4)*RT1*PL1*(1-TP1)*SR1*OB1                     $
MELT  559 SEQ558=CCSTL*CCPR1*(1-MU4)*(1-TP1)*RVB1                          $
MELT  560 SEQ559=LDAAC*ZB6*(1-MU6)*RT8*(1-PL1)*(1-TP1)*EB3                 $
MELT  561 SEQ560=LOSP*OGR11*(1-GA1)*DA1*(1-GB1)*(1-GC1)*GD1*TP1*TPR1*X     $
MELT  561 X      =(1-TB4)*(1-RVB3)                                         $
MELT  562 SEQ561=SLOCAN*(1-MU2)*(1-TP1)*RR1*CH4                            $
MELT  563 SEQ562=LOSP*OGR11*(1-GA1)*DA1*(1-GB1)*(1-GC1)*(1-GD1)*BE41*X     $
MELT  563 X      =(1-TP1)*(1-RVB3)                                         $
MELT  564 SEQ563=LOCV*(1-MU4)*TP1*TPR1*TOT1*OB1                        $
MELT  565 SEQ564=RTIE*AEBE1*TP1*TPR1                                     $
MELT  566 SEQ565=PLMFW*(1-MU4)*RT1*(1-PL1)*(1-TP1)*RR1                     $
MELT  567 SEQ566=PLMFW*MU4*RT1*PL1*TP1*TPR1*(1-AFA5)*SR1                   $
MELT  568 SEQ567=ERCWTL*(1-TP1)*AFR1                                       $
MELT  569 SEQ568=CCSTL*(1-MU4)*(1-TP1)*SED*HH1                             $
MELT  570 SEQ569=MSIV*MU4*RT1*(1-PL1)*(1-TP1)*EB1                          $
MELT  571 SEQ570=LOSP*OGR11*(1-GA1)*DA1*GB1*(1-GC2)*(1-GD2)*TP1*TPR1*X     $
MELT  571 X      =(1-CI4)                                                  $
MELT  572 SEQ571=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*(1-TP3)*(1-DS6)*X      $
MELT  572 X      =SU3*(1-CI4)*REC1                                         $
MELT  573 SEQ572=CCSTL*(1-MU4)*(1-TP1)*SED*CI1                             $
MELT  574 SEQ573=CCSA*BC33*(1-MU4)*TP1*TPR1*SED                            $
MELT  575 SEQ574=TTIE*DB1*PA1*MU4*TP1*TPR1                                 $
MELT  576 SEQ575=ERCWTL*(1-TP1)*HH1                                        $
MELT  577 SEQ576=PLMFW*A11*TD32*(1-TP3)*(1-RVB3)                       $
MELT  578 SEQ577=ERCWTL*(1-TP1)*CI1                                        $
MELT  579 SEQ578=CCSA*A11*BC33*(1-TP3)*(1-RVB3)                            $
MELT  580 SEQ579=PLMFW*(1-MU4)*RT1*PL1*(1-TP1)*SR1*EB1                     $
MELT  581 SEQ580=LASD*B2U21*(1-TP3)*TB2*(1-RVB3)                           $
MELT  582 SEQ581=CCSTL*CCPR1*(1-MU4)*CD1*(1-TP1)                           $
MELT  583 SEQ582=ERCWB*CCSR3*CCPR1*MU4*(1-TP1)                             $
MELT  584 SEQ583=LDAAC*ZB6*MU6*RT8*(1-PL1)*(1-TP1)*EB3                     $
MELT  585 SEQ584=LOSP*OGR11*DG3*(1-GD4)*DSLR1*(1-TP3)*(1-DS6)*X  $
MELT  585 X      =(1-CI4)*REC2                                             $
MELT  586 SEQ585=SLOCAN*MU2*(1-TP1)*S11*(1-S23)*RR1                        $
MELT  587 SEQ586=SLOCAN*MU2*(1-TP1)*S21*RR1                                $
MELT  588 SEQ587=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*BE33*V37*X     $
MELT  588 X      =MU4*TP1*TPR1                                             $
MELT  589 SEQ588=LVBB2*A11*AC2*(1-TP3)*(1-RVB3)                            $
MELT  590 SEQ589=LOSP*OGR11*(1-GA1)*(1-GB1)*DB1*GC1*(1-GD2)*TP1*TPR1*X     $
MELT  590 X      =(1-TB4)                                                  $
MELT  591 SEQ590=LOCV*ZAB1*OS3*(1-MU4)*(1-CP3)                         $
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MELT  592 SEQ591=CCSTL*CCPR1*MU4*(1-TP1)*SU3                                $
MELT  593 SEQ592=CCSTL*ZB1*CCPR1*(1-MU4)*(1-TP1)                            $
MELT  594 SEQ593=CCSTL*ZA1*(1-ZB6)*CCPR1*(1-MU4)*(1-TP1)                    $
MELT  595 SEQ594=TTIE*(1-MU4)*RT1*(1-PL1)*(1-TP1)*RR1                       $
MELT  596 SEQ595=LDCAC*B11*CE1*(1-MU6)                                      $
MELT  597 SEQ596=LOSP*OGR11*GA1*(1-GB2)*(1-GC2)*(1-GD2)*PB3*TP3*TPR1*X      $
MELT  597 X      =(1-TB4)*OB1*(1-RVB3)                                      $
MELT  598 SEQ597=CCSA*MU4*(1-TP1)*SED*CSB3*RR5                              $
MELT  599 SEQ598=CCSTL*CCPR1*MU4*(1-TP1)*RVA1                               $
MELT  600 SEQ599=LOSP*OGR11*DG3*(1-GC3)*DSLR1*(1-TP3)*(1-DS6)*X  $
MELT  600 X      =(1-CI4)*REC2                                              $
MELT  601 SEQ600=LASD*AC2*(1-TP3)*SED*RVB3                                  $
MELT  602 SEQ601=RTIE*A11*B11*(1-TP3)*(1-DS6)*CI4                           $
MELT  603 SEQ602=LASD*BE9*(1-TP3)*(1-RVB3)                                  $
MELT  604 SEQ603=SLBOC*TD31*(1-MU4)*(1-TP1)                          $
MELT  605 SEQ604=LDCAC*DB1*PD5*PA2                                          $
MELT  606 SEQ605=TTIE*A11*TD32*(1-TP3)*(1-RVB3)                      $
MELT  607 SEQ606=SLOCAI*MU2*(1-TP1)*SEH*RB4*RR4                             $
MELT  608 SEQ607=SLOCAN*BC1*MU1*(1-TP1)*RVA1                                $
MELT  609 SEQ608=RTIE*DA1*DB1*TP1*TPR1                                      $
MELT  610 SEQ609=LOSP*OGR11*(1-GA1)*(1-GB1)*(1-GC1)*(1-GD1)*AE5*MDE1*X      $
MELT  610 X      =(1-TP1)*(1-DS6)*(1-CI4)                                   $
MELT  611 SEQ610=LOCV*B11*CE1*(1-MU6)*(1-TP1)                               $
MELT  612 SEQ611=FLPH1B*AE1*(1-TP1)                                         $
MELT  613 SEQ612=LDBAC*B11*CE1*(1-MU6)*(1-TP1)                              $
MELT  614 SEQ613=EXMFW*A11*B11*(1-TP3)*(1-DS6)*(1-CI4)                      $
MELT  615 SEQ614=LRCP*A11*B11*(1-TP3)*(1-DS6)*(1-CI4)                       $
MELT  616 SEQ615=LOSP*OGR11*DGSYS*(1-TP3)*(1-DS6)*PI3*X        $
MELT  616 X      =(1-CI4)*REC5                                              $
MELT  617 SEQ616=LBSD*A11*PD4*(1-TP3)*(1-DS6)*(1-CI4)                       $
MELT  618 SEQ617=PLMFW*MU4*RT1*PL1*(1-TP1)*SR1*OB1                          $
MELT  619 SEQ618=CCSTL*CCPR1*MU4*(1-TP1)*RVB1                               $
MELT  620 SEQ619=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*ZB1*(1-TP3)*X        $
MELT  620 X      =(1-DS6)*(1-CI4)*REC1                                      $
MELT  621 SEQ620=LOSP*OGR11*DG2*(1-GC3)*(1-GD3)*ZA1*(1-ZB6)*X        $
MELT  621 X      =(1-TP3)*(1-DS6)*(1-CI4)*REC1                              $
MELT  622 SEQ621=LDCAC*B11*CE1*MU6                                          $
MELT  623 SEQ622=CCSA*MU4*CTMU1*(1-TP1)*SED*RVB1                            $
MELT  624 SEQ623=LOCV*MU4*TP1*TPR1*TOT1*OB1                          $
MELT  625 SEQ624=PLMFW*MU4*RT1*(1-PL1)*(1-TP1)*RR1                          $
MELT  626 SEQ625=SLOCAI*MU2*(1-TP1)*SEH*RA2*(1-RB6)*RR5                     $
MELT  627 SEQ626=CCSTL*MU4*(1-TP1)*SED*HH1                                  $
MELT  628 SEQ627=CCSA*B11*(1-MU6)*(1-TP1)*VA1                               $
MELT  629 SEQ628=IMSIV*RT1*PL1*(1-TP1)*EB1                                  $
MELT  630 SEQ629=LDDAC*B11*CE1*(1-MU6)*(1-TP1)                              $
MELT  631 SEQ630=CCSTL*MU4*(1-TP1)*SED*CI1                                  $
MELT  632 SEQ631=CCSA*BC33*MU4*TP1*TPR1*SED                                 $
MELT  633 SEQ632=FLPH1A*BE1*(1-TP1)                                         $
MELT  634 SEQ633=RTIE*A11*B11*(1-TP3)*DS6*(1-CI4)                           $
MELT  635 SEQ634=TLMFW*A11*B11*(1-TP3)*(1-DS6)*(1-CI4)                      $
MELT  636 SEQ635=LOSP*OGR11*(1-GA1)*DG2*(1-GC2)*AE5*(1-TP1)*X        $
MELT  636 X      =(1-DS6)*(1-CI4)*REC4                                      $
MELT  637 SEQ636=LDAAC*ZB6*OS3*(1-MU6)*CD1*(1-CP3)                          $
MELT  638 SEQ637=RTIE*OG1*OGR11*DG2*(1-GC3)*(1-GD3)*(1-TP3)*X        $
MELT  638 X      =(1-DS6)*(1-CI4)*REC1                                      $
MELT  639 SEQ638=SLOCAN*B11*AC2*(1-TP1)                                     $
MELT  640 SEQ639=CCSA*DE1*(1-MU4)*(1-TP1)*SED                               $
MELT  641 SEQ640=CCSTL*CCPR1*(1-MU4)*(1-TP1)*MA3*(1-MB10)                   $
MELT  642 SEQ641=CCSTL*CCPR1*(1-MU4)*(1-TP1)*MB9                            $
MELT  643 SEQ642=LOCV*B11*CE1*MU6*(1-TP1)                                   $
MELT  644 SEQ643=PLMFW*MU4*RT1*PL1*(1-TP1)*SR1*EB1                          $
MELT  645 SEQ644=LOSP*OGR11*(1-GA1)*GB1*(1-GC2)*(1-GD2)*PA2*TP1*TPR1*X      $
MELT  645 X      =(1-TB4)*OB1                                               $
MELT  646 SEQ645=CCSA*(1-MU4)*(1-TP1)*SED*CSB3*RVB1                         $
MELT  647 SEQ646=LOSP*OGR11*DG2*(1-GB2)*(1-GD3)*BE85*(1-TP3)*X       $
MELT  647 X      =(1-DS6)*(1-CI4)*REC4                                      $
MELT  648 SEQ647=SGTR*DE1*CCSR3*(1-SL1)                                     $
MELT  649 SEQ648=CCSTL*CCPR1*MU4*CD1*(1-TP1)                                $
MELT  650 SEQ649=LDBAC*B11*CE1*MU6*(1-TP1)                                  $
MELT  651 SEQ650=LBSD*CE1*(1-MU6)*CTMU1*(1-TP1)                             $
MELT  652 SEQ651=PLMFW*AEBE1*TP1*TPR1                                  $
MELT  653 SEQ652=LVBB2*PD5*TP1*TPR1*MA4                                     $
MELT  654 SEQ653=LOSP*OGR11*(1-GA1)*GB1*(1-GC2)*DC1*(1-GD2)*(1-TB4)*X       $
MELT  654 X      =OB1                                                       $
MELT  655 SEQ654=LOSP*OGR11*GA1*(1-GB2)*(1-GC2)*(1-GD2)*B1U21*TP3*TPR1*X $
MELT  655 X      =(1-TB4)*(1-RVB3)                                          $
MELT  656 SEQ655=FLPH1A*B11*PD4*(1-TP1)                                     $
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MELT  657 SEQ656=CCSA*MU4*(1-TP1)*SED*RB5*RVA1                    $
MELT  658 SEQ657=ERCWA*BC1*(1-MU4)*(1-TP1)*TB2                    $
MELT  659 SEQ658=LOCV*ZAB1*OS3*MU4*(1-CP3)                  $
MELT  660 SEQ659=CCSTL*ZB1*CCPR1*MU4*(1-TP1)                      $
MELT  661 SEQ660=CCSTL*ZA1*(1-ZB6)*CCPR1*MU4*(1-TP1)              $
MELT  662 SEQ661=TTIE*MU4*RT1*(1-PL1)*(1-TP1)*RR1                 $
MELT  663 SEQ662=LRCP*DA1*TP1*TPR1*MB4                            $
MELT  664 SEQ663=RTIE*BE1*CE2*(1-TP1)                             $
MELT  665 SEQ664=CCSA*B11*MU6*(1-TP1)*VA1                         $
```

E. GENERIC ISSUES

E.1 WATTS BAR INTERNAL FLOOD ANALYSIS

E.1.1 INTRODUCTION AND SUMMARY

An analysis has been completed to identify accident sequences involving internal floods at Watts Bar Units 1 and 2. The analysis identifies internal flooding initiating events that are risk significant and their associated frequencies and impacts on plant equipment. The flood scenarios are treated as initiating events, and are included in the overall individual plant examination (IPE) risk model. The results from quantifying these initiating events in the IPE risk model are summarized in Section 3.4 of the IPE main report. The scenarios and results are applicable to both units since Units 1 and 2 are functionally identical.

The flood scenarios identified in this analysis are summarized in Table E.1-1 with their estimated frequency and impact on the plant model. Quantification of these scenarios is based on industry experience events (internal flood database) and a plant-specific screening of this database. Figure E.1-1 summarizes the results of this plant-specific screening and identifies the applicable flood scenarios in Table E.1-1. The following provides additional qualitative results and insights from the analysis:

- The auxiliary building at Watts Bar, which houses the vital electrical and safeguards equipment, is unique in that a passive sump is provided at the lowest elevation. The vital electrical equipment is located on the two highest elevations where severe floods are unlikely to reach. The lower elevations contain safeguards equipment such as auxiliary feedwater, safety injection, charging, component cooling, residual heat removal (RHR), and containment spray systems. However, there are open stairwells and grating such that floods propagate to the passive sump. There are flood alarms in the safeguards pump rooms, and the passive sump will hold at least 210,000 gallons. Because of these design features, small floods in the auxiliary building were neglected, and the large flood scenarios postulated in this building are not expected to be important contributors to risk in the plant model.

- Turbine building floods have a relatively high frequency based on industry experience but are not expected to be risk important. The plant design precludes propagation to the vital electrical and safeguards areas in the auxiliary building, and vital safety equipment is not located in the turbine building. Doors to the control building open into the turbine building and are designed to prevent turbine building floods from propagating into the control building. A scenario is included that causes loss of feedwater, condenser, and station air.

- Essential raw cooling water (ERCW) floods have occurred in industry experience, and even a partial loss of ERCW (i.e., a header or pumps) impacts many other systems due to functional dependencies. This analysis postulates ERCW flood scenarios in the intake pumping station and auxiliary building.

- High pressure fire protection (HPFP) floods were evaluated, but no specific scenarios were postulated. The frequency and impact of fire water floods are assumed to be enveloped by the turbine building and auxiliary building flood scenarios already postulated. The preaction fire water system used throughout vital areas appears to be reliable, and the flow capacity of these systems is low.

- The refueling water storage tank (RWST) and the condensate storage tank (CST) are major flood sources, and they could empty into the auxiliary building. Two such scenarios are postulated; however, these scenarios are not expected to be important, based on the plant design.

- The control building is also an important area as it houses process racks, relays, and controls for the plant. There are HPFP sprinklers in rooms and a stand pipe supply to hose racks in the stairwells. In addition, ERCW supplies unit coolers. However, the frequency of a flood in the control building is assessed to be reasonably low, impact is on equipment control if not isolated, personnel are usually present in this area, and the likelihood of the operators not maintaining safety functions (i.e., core damage) is judged to be unlikely.

E.1.2 METHODOLOGY

The basic approach is a conservative screening analysis that first establishes potential major flood sources and safety equipment locations. Flood scenarios are postulated in terms of the flooding source, the extent of propagation to adjacent locations, and the equipment impacted. The frequencies of these scenarios are then quantified as initiating events and combined with independent failures in the overall risk model. A more detailed analysis may be performed, as required, when the risk results are important. The methodology is summarized below:

- **Plant Familiarization.** Key plant design information that provides details of the plant systems and layout is reviewed. This includes the Final Safety Analysis Report (FSAR), flow diagrams, arrangement drawings, internal flood studies, and fire analysis reports (References E.1-1 through E.1-4). The PRA models are reviewed to ensure familiarity with important intersystem dependencies, success criteria, and plant response models to initiating events.

- **Flood Experience Review.** Flood data collected from *Nuclear Power Experience* through September 1987 (Reference E.1-5) are reviewed to ensure familiarization with actual flood events, their locations within the plant, and causes. These data are used in the quantification of internal flood scenario initiating event frequencies. In addition, any plant-specific events are reviewed carefully regarding their potential impact on risk.

- **Evaluation of Flood Sources.** Using the plant design information and a general knowledge of plant layout, major flood sources and their locations are identified. For example, the Tennessee River supplies the ERCW system, which supplies cooling to several plant locations. ERCW is identified as a major flood source, and its locations within buildings are identified from the flow diagram.

- **Evaluation of Plant Locations.** Using plant design information such as arrangement drawings, internal flood studies, and information from the evaluation of flood sources, the most important buildings are identified. Then each building is evaluated further with regard to equipment housed at each elevation/room, flood sources, propagation paths, and means of flood detection and isolation. Flood scenarios are identified for further evaluation when a potential flood is identified that can impact more than one important system.

- **Plant Walk-Through.** A plant walk-through is conducted to collect additional information and to confirm previous documentation and judgments on flood sources, and their potential impact, propagation paths, and detection.

- **Scenarios and Screening.** The potential for an initiating event, propagation to other locations including drainage, detection and isolation potential, and system impact are considered in judging whether a flood scenario should be postulated and quantitatively evaluated. Initial flood scenarios are usually based on conservative assumptions about flood size and system impacts.

  For a scenario to be selected for further evaluation, usually a flood source in a location (propagation included) must either cause an initiating event and impact at least an additional important system, or cause significant system failures. For example, a flood that causes loss of feedwater but no other failures is insignificant because the probabilistic risk assessment (PRA) model already contains loss of main feedwater due to other causes at a much higher frequency. Similarly, a flood that fails one RHR pump train but does not cause an initiating event may not be considered further. The relatively low frequency of the flood, combined with additional failures required to cause core damage, makes it a highly unlikely event.

- **Quantification.** A point estimate screening quantification is usually performed where conservative assumptions about flood size, impact, and operator response are made. The flood scenario is then combined with independent failures in the PRA model, and the resulting core damage frequency is compared with other core damage sequences. The important flood scenarios are evaluated further, as appropriate, to include more realistic flood frequencies as well as detection and operator recovery actions. An uncertainty analysis is performed on dominant scenarios in the PRA model.

  The initial point estimate quantification of the flood initiating event is conducted with one of two methods. The first method uses historical data on the total annual frequency of floods (Reference E.1-5). The total frequency can be apportioned to plant systems and locations on a plant-specific basis. The apportionment is based on a screening of the database for its size, applicability to specific types of systems, and their locations at Watts Bar. The second method sums rupture failure rates for pipes, valves, tanks, and expansion joints in a location. This requires detailed information of the number of valves, type of valves, and piping sections. This method is effective when only a few pipe sections are in a particular location. Only the first method is used in this analysis.

E.1.3 EVALUATION OF FLOOD SOURCES

This section describes major flood sources and their locations in the plant, based on a review of the plant design, system flow diagrams, and a plant walk-through. The following were identified as major flood sources and are described further in the subsections below (drawing series are in parentheses):

- Essential Raw Cooling Water (47W845)
- Cooling Tower and Circulating Water (47W831)
- High Pressure Fire Protection Water and Raw Service Water (47W850 and 47W832)
- Raw Cooling Water (47W844)
- Refueling Water Storage Tank (47W812 and 47W811)
- Condensate Storage Tanks A and B (47W803)
- Primary Water Storage Tank (47W819)

Other sources such as smaller tanks, component cooling, and chilled water have a limited flood source, and are judged to be less significant than the above sources. In Section E.1.4, building locations are evaluated with regard to equipment housed in the building, flood sources, propagation, and detection. Therefore, there is another check against this judgment for the important plant locations.

E.1.3.1 Essential Raw Cooling Water

ERCW is a potentially large flood source due to large pipe diameters and flow rates, and it is virtually an infinite source when unisolated. The water source is the Tennessee River via the intake pumping station. ERCW provides cooling water to the following locations and components:

- **Diesel Generator Building.** ERCW is supplied to the four diesels. Normally closed motor-operated valves located inside the building isolate most of the piping and components.

- **Fifth Diesel Generator Building.** ERCW is supplied to the fifth diesel. Normally closed valves located inside the building isolate most of the piping and components.

- **Turbine Building.** ERCW is supplied to the station air compressors and after coolers.

- **Control Building.** ERCW is supplied to the electrical board room air conditioning condensers (Elevation 692'). Supply and return manual isolation valves to the system are located in the equipment room.

- **Auxiliary Building.** ERCW is supplied to the following components and locations within the auxiliary building:

Component	Elevation
Containment Spray Pump Room Coolers	676
RHR Pump Room Coolers	676
Piping to Containment Coolers	692
Flood Mode Connections (blind flange)	692
Auxiliary Feedwater Suction (isolated) for TDAFW	692
Instrument Room Water Chillers	692
Charging Pump Room Coolers	692
Safety Injection Pump Room Coolers	692
Penetration Room and Pipe Chase Coolers	692
CCS Pump and Auxiliary Feed Pump Space Cooler	713
Auxiliary Feedwater (AFW) Suction (isolated) for MDAFW	713
Penetration Room Coolers	713
Containment Spray Heat Exchangers	713
Component Cooling Heat Exchangers	737
Shutdown Board Room Air Conditioning Water Chillers	737
Penetration Room Coolers	737
Spent Fuel Pit Pump Space Cooler	737
Main Control Room Air Conditioning Water Chillers	737
Auxiliary Control Air Compressors A and B	757
Emergency Gas Treatment Room Coolers	757

E.1.3.2 Cooling Tower and Circulating Water

In industry experience, very large floods in the turbine building have been associated with the circulating water system. This piping is very large, and the water source is very large. The condenser circulating water pumps take suction from the cooling tower at the component cooling water (CCW) pumping station and discharge to the condensers. From the condenser, circulating water flows back to the cooling tower. The impact of a very large flood in the turbine building and the potential propagation and impact to other plant locations are evaluated in Section E.1.4.

E.1.3.3 Fire Water (HPFP)

HPFP water is supplied throughout the plant and is supplied from the Tennessee River via the intake pumping station. This is a potentially important flood source due to the very large source of water. HPFP is supplied to the turbine building, service building, and practically all other buildings onsite. The following summarizes key fire water locations in the plant:

- **Diesel Generator Building.** There are three hose stations (inside air exhaust room 2B on Elevation 760', entrance to board room 1A on Elevation 760', and outside diesel room 2A-A on Elevation 742'). There is a control station on Elevation 742' that supplies preaction sprinklers in the pipe gallery and corridor room. Fire water is also supplied to the fifth diesel generator building.

- **Control Building.** There are two control stations at Elevation 692′ that supply room sprinklers on Elevations 692′ and 755′. There are two control stations at Elevation 729′ (turbine building). One station supplies preaction sprinklers on Elevations 729′ and 755′. The other control station supplies preaction sprinklers in the turbine building to protect the control-turbine building wall. There is a stand pipe system in each of two stairwells, with a hose station at each floor elevation (four hose stations for each stand pipe).

- **Auxiliary Building.** There are five control stations that supply the upper two elevations (electrical rooms including the auxiliary control room on Elevations 757′ and 772′). These control stations are under air supervision, with four stations on Elevation 713′, and one station on Elevation 757′. The battery room HPFP sprinklers are shown normally isolated and require manual actuation.

  There are several other control stations that supply HPFP at and below Elevation 757′ in the auxiliary building.

E.1.3.4 Raw Cooling Water

The raw cooling pumps are located in the intake pumping station, and the system provides cooling to balance-of-plant equipment mostly located in the turbine building. Turbine building floods are considered in more detail in Section E.1.4.3. Raw cooling water does supply the following in the auxiliary building:

- Cooling to the control rod drive (CRD) equipment room air conditioning on Elevation 782′.

- General ventilation system chillers on Elevation 737′.

- Cooling to the titration room chillers on Elevation 713′.

The cooling water supplies on Elevation 782′ are outside the vital electrical areas, and propagation to these areas is unlikely.

E.1.3.5 Refueling Water Storage Tank (RWST)

The RWSTs are located in the yard at grade Elevation 728′, with a capacity of approximately 380,000 gallons each (one per unit). Each tank supplies the containment spray, RHR, charging, and safety injection pumps for each unit in the auxiliary building. These tanks are not crosstied between units. There is no isolation capability at the tank. There are motor-operated valves in each pump suction line.

E.1.3.6 Condensate Storage Tanks A and B

The CSTs are located in the yard at grade Elevation 728′, with a capacity of approximately 397,000 gallons each. In the auxiliary building (AFW supply), these tanks are not crosstied between units. The CSTs are connected with systems in the turbine building where there is a crosstie between units. There are manual valves at each tank and several other valves including automatic motor-operated valves between the tanks.

E.1.3.7 Primary Water Storage Tank

The primary water storage tanks are located in the yard at grade Elevation 728', with a capacity of approximately 187,000 gallons each (one per unit). This water supply is distributed throughout the plant but is usually supplied to areas through small-diameter piping as a demineralized water makeup source.

E.1.4 EVALUATION OF PLANT LOCATIONS

This section evaluates building locations, equipment housed in the location, flood sources, propagation paths, and means of flood detection and isolation. Based on the review of major flood sources in Section E.1.3, plant design and layout drawings, and the location of safety equipment, the following buildings are identified as potentially important buildings and are considered in this section:

- Auxiliary Building
- Control Building
- Turbine Building
- Intake Pumping Station
- Diesel Generator Building

Scenarios are postulated where flood frequency and its consequences are judged to be relatively important. These scenarios are subsequently analyzed and quantified in Section E.1.5.

E.1.4.1 Auxiliary Building

The auxiliary building houses safety electrical and mechanical equipment. The upper elevations (772' and 757') contain emergency AC and DC power systems. There are limited flood sources on these floors. The lower elevations (737', 713', 692', and 676') contain mostly mechanical equipment. There are more significant flood sources on these floors, but there are open stairwells and large floor openings such that floods will propagate to the lowest elevation. The auxiliary building design is somewhat unique in that the lowest elevation (666') acts as a passive sump for the building. Approximately 210,000 gallons are required to fill this area prior to flooding the Elevation 676'.

- **Auxiliary Building Elevation 772' (Reference E.1-1.1).** This elevation houses 480V transformer rooms, 125V vital battery rooms, 480V power board rooms, and mechanical equipment rooms. These vital electrical rooms do not communicate with the refueling area or the control rod drive equipment areas. Propagation is under doors to adjacent rooms and through drains. The two stairwell doors to Elevation 757' are fairly tight with no seals.

  Flood sources are limited to HPFP, most of which is dry and supplies preaction sprinklers in each room. There are limited wet HPFP lines that supply hose racks. The 480V board room air conditioning system in the mechanical equipment rooms

uses air cooler condensing units. No flood scenarios are postulated for the following reasons:

- There are two HPFP preaction systems and four manual sprinkler systems. Operation of the preaction system requires a deluge valve to open, which floods the dry portion of the system. A water flow alarm is generated on a fire protection panel and in the control room. Fusible links prevent sprinklers from spraying a room, and the preaction systems are under air supervision. Loss of system integrity results in a low air pressure alarm at the fire protection panel and in the control room. In addition, the flow rate through the sprinklers in a room is low such that floor areas and drains are sufficient to prevent significant accumulation.

- The amount of wet HPFP lines is limited to pipes in the mechanical equipment rooms (locations A7 and A10 of Reference E.1-1.1) that supply fire hose stations. The frequency of flooding from these lines is low, and propagation to the electrical areas is judged to be insignificant due to the large floor areas and drains. A Hi-Hi-Hi level in the floor and equipment drain tank (control room panel 1-M-5) would alert the operators.

- **Auxiliary Building Elevation 757' (Reference E.1-1.2).** This elevation houses 6.9-kV shutdown board rooms, 125V vital battery board and instrument power board rooms, 480V shutdown board rooms, auxiliary control rooms, and personnel and equipment access rooms. The general arrangement can be seen in Reference E.1-1.2. There is access to control building Elevation 755' and the refueling room in the auxiliary building. Propagation to the control building would not occur until water level exceeded the 6-inch curbs at the doors. The doors to the refueling room are fairly tight with strip seals.

  Flood sources are limited to HPFP and the shutdown board room air conditioning system chilled water. Most HPFP is dry and supplies preaction sprinklers in each room. There are limited wet fire water lines that supply hose racks. No flood scenarios are postulated for the following reasons:

  - There are two HPFP preaction systems and four manual sprinkler systems. Operation of the preaction system requires a deluge valve to open, which floods the normally dry portion of the system. A water flow alarm is generated on a fire protection panel and in the control room. Fusible links prevent sprinklers from spraying a room, and preaction systems are under air supervision. Loss of system integrity results in a low air pressure alarm at the fire protection panel and in the control room. In addition, the flow rate through the sprinklers in a room is low such that floor areas and drains are sufficient to prevent significant accumulation.

  - The amount of wet HPFP lines is limited to pipes in a few rooms (Reference E.1-1.2 locations A2, A9, A17, and A24) that supply fire hose stations and manual sprinkler systems. The frequency of flooding from these lines is low, and propagation to the electrical areas is judged to be insignificant due to the large floor areas and drains. A Hi-Hi-Hi level in the

floor and equipment drain tank (control room panel 1-M-5) would alert the operators.

— The shutdown board room air conditioning system is located in the personnel and equipment access rooms (locations A9 and A17 of Reference E.1-1.2). The shutdown board room chilled water system, which supplies the air conditioners, is actually located on Elevation 737'. The inventory of this system is small, and propagation to the electrical areas is judged to be insignificant due to the large floor areas and drains.

- **Auxiliary Building Elevation 737' (Reference E.1-1.3).** There is no equipment of significance to the PRA model at this elevation. The component cooling water heat exchangers and the spent fuel pool cooling system are located here. The most significant flood source in the general area is 24-inch ERCW piping. However, there are three open stairwells and a large grated floor opening to Elevation 713'. Therefore, propagation into this area from above and floods at this elevation will propagate to the Elevation 713' corridor. For these reasons, no flood scenarios are postulated. However, flood scenarios at the lower elevations should consider flood sources on this elevation.

- **Auxiliary Building Elevation 713' (Reference E.1-1.4).** This elevation contains the motor-driven auxiliary feedwater pumps and component cooling pumps, which are located in the open general area. The most significant flood source in the general area is large ERCW piping, the CST supply to AFW, and propagation from above floors. However, there are three open stairwells and a large grated floor opening to the Elevation 692' corridor.

  The RHR and containment spray heat exchangers are located in four rooms. There is 18-inch ERCW piping in each room and curbs at the doors.

  There is open floor grating in the pipe chases to Elevation 676'.

  Since propagation is to the lower elevation, no flood scenarios are postulated. However, flood scenarios at the lower elevations should consider flood sources on this elevation.

- **Auxiliary Building Elevation 692' (Reference E.1-1.5).** This elevation contains safety injection pumps (two per unit), charging pumps (three per unit), and turbine-driven auxiliary feedwater pumps (one per unit). There are a total of 12 pumps, with each pump in its own separate room. The following summarizes the most significant flood sources:

Pump Room	Flood Source
Turbine Auxiliary Feedwater	10-Inch CST and 10-Inch ERCW
Charging	6-Inch RWST, 2-Inch ERCW, 2-Inch HPFP
Safety Injection	6-Inch RWST, 2-Inch ERCW, 2-Inch HPFP

There are 12-inch curbs to protect the charging pump and safety injection pump rooms from external propagation; e.g., from the corridor or from another pump

room. Each room has a flood detector that alarms on flood alarm panel (Box 2272) on Elevation 757' just outside the Unit 1 control room. A general alarm is generated in the control room on panel 1-M-15.

Water could propagate under a double door into or out the turbine auxiliary feedwater pump rooms.

The most significant flood source in the corridor is 24-inch ERCW piping, 6-inch HPFP, and propagation from above floors. However, there is an open stairwell and a large grated floor opening to the Elevation 676' corridor. Floods in the pipe chase from the RWST (14-inch) or ERCW (24-inch) would propagate to Elevation 676' through grating, with limited leakage into the corridor of Elevation 692'.

Since internal sources could affect only one pump room at a time and propagation is to the lower elevation, no flood scenarios are postulated. However, flood scenarios at the lower elevations should consider flood sources on this elevation.

- **Auxiliary Building Elevations 676' (Reference E.1-1.5) and 666.** Elevation 676' houses the containment spray pumps (two per unit) and the RHR pumps (two per unit). There are a total of eight pumps, with each pump in its own separate room. Each room is protected by a 12-inch curb at the door. The following are the most significant flood sources:

  - 18-inch containment spray line (RWST) in each containment spray pump room.

  - 14-inch RHR line (RWST) in each RHR pump room.

  - 2-inch ERCW line in each of the pump rooms.

  A flood in any of these rooms could fail the pump, and, eventually, the drop-out panel in the room would open draining the water to Elevation 666'. A flood detector in each room will alarm at a flood alarm panel (Box 2272) on Elevation 757' just outside the Unit 1 control room. A general alarm is generated in the control room on panel 1-M-15.

  Any leakage into the corridor, including door failure or propagation from above elevations, would drain through a floor opening (3 feet by 2 feet) to Elevation 666'. There were at least four floor drains in the general area, and the elevator would provide leakage paths to the passive sump at Elevation 666'. Since the pump rooms have a 12-inch curb at their doors, it is unlikely that a flood external to the rooms could impact these pumps unless a large flood occurs and/or the Elevation 666' completely fills.

  Elevation 666' is the lowest elevation of the auxiliary building, and acts as a passive sump for the building. Approximately 210,000 gallons are required to fill this area. The floor and equipment drain sump is also located here, with two 50-gpm sump pumps. There is a high-level alarm for this sump in the control room (panel 1-M-15). There is also a floor drain collector tank located on Elevation 676' and tritiated drain collector tank on Elevation 674'.

There are major flood sources in the auxiliary building that propagate to the passive sump (Elevation 666') and Elevation 676'. These floods are associated with auxiliary feedwater (CSTs), safety injection (RWST), charging (RWST), and ERCW cooling to equipment. Propagation from Elevation 676' to the passive sump (Elevation 666') is less certain for large floods, and large floods that are not isolated early could fill the passive sump and then begin to flood Elevation 676'. For this reason, flood scenarios that flood all RHR and containment spray pumps are postulated and evaluated in Section E.1.5 to investigate the potential significance of a large flood in the auxiliary building.

E.1.4.2 Control Building

The control building houses the control room, relay rooms, the cable spreading room, computer room, auxiliary instrument rooms, communication room, battery rooms, and mechanical equipment rooms. The only interface with the auxiliary building is from the control room on Elevation 757'. However, there is a curb at these doors, and flood sources are limited in the auxiliary building at this elevation. There are doors that open into the turbine building at Elevations 755', 729', and 708'. These doors are air pressure doors that prevent turbine building floods from significantly propagating to the control building. Also, there is an equipment hatch in the turbine building on Elevation 708'. The hatch is over the control building mechanical equipment room on Elevation 692'. This hatch is administratively sealed, and there are signs at the hatch indicating this requirement.

- **Control Building Elevation 755' (Reference E.1-1.6).** This area houses the control room, relay room, technical support center, and mechanical equipment room. There are no water sources in the control room, and there are curbs at the four door entrances to prevent propagation into the room. Two entrances are from auxiliary building Elevation 757'; however, as described in Section E.1.4.1, this area has limited flood sources. The other two entrances are from the control building corridors.

  On one side of the control room, there are offices, a relay room, a corridor with stairwell to lower elevations, and an entrance to the turbine building. The only flood source on this side is HPFP. Double pressure doors open into the turbine building and prevent turbine building floods from significantly propagating into the control building.

  On the other side of the control room, there are offices, toilets, a kitchen, lockers, mechanical equipment room, a corridor with stairwell to the lower elevations, and an entrance to the turbine building. The only significant flood sources are HPFP. Double pressure doors open into the turbine building and prevent turbine building floods from significantly propagating into the control building.

  Most HPFP piping is dry preaction systems that are not considered to be significant sources due to alarms, low flow rates, and the presence of personnel in the area. A fire water standpipe system supplies fire hoses in the stairwells. Flooding from this source would propagate to Elevation 692' where water would collect in the stairwell and eventually fail the door. There are sumps and alarms as described below at Elevation 692'. The stairwell door to lower elevations is sealed and opens

into the corridor. Since this side includes an entrance to the control room, offices, toilets, lockers, and kitchen, there should be significant traffic here, ensuring early detection of floods. It is considered to be very unlikely that a flood in this area could progress for very long and lead to core damage. In the unlikely event that a flood went unisolated for a long period of time causing the control room and lower elevations to become flooded, the operators could take plant control at the auxiliary control room (auxiliary building Elevation 757'). All essential electrical and mechanical systems are located outside the control building. Therefore, floods in the control building are judged to be unlikely causes of core damage.

- **Control Building Elevation 729' (Reference E.1-1.6).** This area houses the cable spreading room. The only water source is limited HPFP piping. The sprinkler system is a preaction system in the spreading room. This piping is normally dry and is not considered to be a significant source due to alarms, low flow rates, and the presence of personnel in the area. A fire water stand pipe system supplies fire hoses in the stairwells. Flooding from this source would propagate to Elevation 692', where water would collect in the stairwell and eventually fail the door. There are two double door entrances from the cable spreading room that open into the turbine building. These doors are air pressure doors and prevent turbine building floods from significantly propagating into the control building.

- **Control Building Elevation 708' (Reference E.1-1.7).** This area houses the computer room and the auxiliary instrument room for each unit. There are no flood sources at this elevation, except for hose stations in the stairwells, and all doors from stairwell and turbine building are sealed. One door opens into turbine building from the corridor just outside the computer room. This is a flood pressure submarine type of door. Another set of doors (airlock) opens into the turbine building from the Unit 1 auxiliary instrument room. These doors are flood pressure doors.

- **Control Building Elevation 692' (Reference E.1-1.7).** This is the lowest elevation of the control building, housing the communication room, battery rooms, battery board inverter rooms, and mechanical equipment rooms. The electrical equipment on this elevation is required to support balance-of-plant equipment in the turbine building. Therefore, floods could cause a turbine trip but would not impact safety equipment in the PRA model. There are no doors that communicate with the turbine or auxiliary buildings.

  The flood sources on this elevation include HPFP water (including two control stations), ERCW (4-inch) in the mechanical equipment room (C1 in Reference E.1-1.7), and possible propagation from fire water in the stairwells and upper elevations. Most HPFP piping is dry preaction systems that are not considered to be significant sources due to alarms, low flow rates, and the presence of personnel in the area. A fire water stand pipe system supplies fire hoses in the stairwells. Flooding from this source would propagate to Elevation 692', where water would collect in the stairwell and eventually fail the door.

  Floor and equipment drain sumps are located under the stairs at both ends of the control building at Elevation 692'. A sump high-level alarm exists in the control

room (panel 1-M-15), with instructions to dispatch an operator to the control building basement to investigate. ERCW supply and discharge supplies to the mechanical equipment room can be isolated in the room or the auxiliary building.

A flood at this elevation could possibly cause a turbine trip if propagation continued into the DC power rooms. (Several inches of water is required.) Even if this event caused a loss of feedwater, its frequency would be less than that of loss of feedwater transient, which is already included in the model. The chance that the flood goes undetected or is not isolated before flooding Elevation 708' is unlikely. It would take more than an hour. In the unlikely event that a flood went unisolated for a long period of time flooding Elevation 708', solid state protection and plant control could be affected. The operators could take plant control at the auxiliary control room (auxiliary building Elevation 757'). All essential electrical and mechanical systems are located outside the control building. Therefore, floods in the control building are judged to be unlikely causes of core damage.

E.1.4.3 Turbine Building

The turbine building is very large, housing the turbine generators and balance-of-plant equipment for both units. The turbine building is an important area because the frequency of large floods is relatively high, and it is important to understand the impact of such floods including the potential propagation into adjacent buildings. The most critical interface with the turbine building is the control building.

There are doors that open into the turbine building from the control building at Elevations 708', 729', and 755'. These doors are air pressure doors and prevent turbine building floods from significantly flooding the control building. The fact that the doors open into the turbine building makes it more difficult to open doors against large floods, thereby preventing significant (particularly at Elevation 708') accidental propagation. Also, there is an equipment hatch on the Elevation 708' floor that could propagate into the control building Elevation 692'. However, this hatch is administratively sealed, and there are signs at the hatch indicating this requirement. There are several doors to the outside yard at Elevation 729', and there are significant floor grating and open stairs from the elevations above Elevation 729' to the turbine building basement. The building volume below Elevation 729' is very large; therefore, there is an opportunity to isolate a flood source before the flood reaches this level. If a flood reached Elevation 729', it would propagate to the yard, which is Elevation 728' or less. Thus, significant accumulation at or above Elevation 729' is unlikely, and only the control building doors at Elevation 708' will see significant water pressure. It is assumed that these doors and the sealed hatch on Elevation 708' will withstand 20 to 25 feet of water pressure.

A large turbine building flood scenario is postulated that causes loss of station air, condensate, feedwater, and the condenser.

E.1.4.4 Intake Pumping Station

The ERCW pumps, raw cooling water pumps, and fire water pumps are located at the intake pumping station. The ERCW pumps are important critical components in the PRA model. Therefore, potential flood events that could fail multiple pumps are investigated.

There are two ERCW pump rooms at Elevation 741'. Each room contains four ERCW pumps. All four train A pumps are in one room and all four train B pumps are in the other room. For each pump, the pump motor and approximately 6 feet of pipe are located in the pump room. The remainder of the system is located below the floor in the equipment rooms. There is a solid wall between the pump rooms, and it is unlikely that a significant water level could be accumulated in either room. In each pump room, there are at least two 1-foot-high by 3-foot-wide wall openings that will drain water to the intake screens in the adjoining room. Floor grating at the intake screens will return water to the river.

On one side of the ERCW pump rooms, the raw cooling water pumps are located outside on a deck at Elevation 728', where water will propagate to the ground (grade Elevation 710') and back to the river. Floods in the equipment rooms under the raw cooling water pumps would propagate to the outside and not impact ERCW. However, floods cannot accumulate at the ERCW or raw cooling water pump locations causing their failure.

On the other side of the ERCW pump rooms, the HPFP pumps and intake screens are located in rooms (approximately Elevation 741'). In addition, there are stairs to the ERCW equipment rooms at Elevation 722'. The HPFP pumps are located at opposite ends on Elevation 741' and are in separate rooms. Therefore, an HPFP water-related flood is unlikely to affect all HPFP pumps. A flood in the fire water pump room next to the train B ERCW pumproom could propagate into the intake screen room and ERCW pump room; however, as described above, this water would propagate to the intake screen room and return to the river.

The ERCW discharge piping, valves, and strainers are located underneath the pump rooms at Elevation 722'. There are two rooms: one for train A discharge headers (one discharge header per unit), and the other for train B discharge headers. These two equipment rooms are separated by one entrance that contains heavy flood protection doors. In each room, there are ERCW pump discharge manual valves (one per pump) and check valves (one per pump), and two strainer headers (one per unit). Each strainer header contains a motor-operated valve (MOV), strainer, and manual valve. Floods in this area would eventually fill the room and propagate to the intake screen and fire pump areas and return to the river.

Abnormal Operating Instruction AOI-13 (Reference E.1-6) provides procedures for loss of essential raw cooling water including flooding events in the pumping station, outside, and the auxiliary building. These procedures address symptoms (alarms and indications) and operator actions. The actions ensure isolation of floods, aligning unaffected headers, and recognition of equipment lost due to isolation.

E.1.4.5 Diesel Generator Building

ERCW and HPFP are located in the diesel generator building and the fifth diesel building. The ERCW supply is normally isolated just inside the building, and floods would not cause an initiating event; therefore, flood scenarios are not postulated.

E.1.4.6 Other Buildings

Other buildings do not contain safety equipment, and it is unlikely that floods in these buildings would cause an initiating event and propagate to other critical locations. Since design basis loss of coolant accidents (LOCA) have been analyzed in detail for the containment building, it is unlikely that flood sources inside the containment would jeopardize safety before detection.

E.1.5 SCENARIO EVALUATION AND QUANTIFICATION

Floods and their potential impacts are characterized in the prior sections. This characterization includes flood sources, potential propagation, isolation capability, detection, and impact on plant systems. This section evaluates and quantifies those scenarios judged to have the most significant risk to the plant. Table E.1-1 summarizes the results in terms of initiating events and impacts on the plant model. The estimated frequency of core damage from these events is quantified in the plant model.

E.1.5.1 Data

The primary source of data used in this analysis is derived from the PLG database (Reference E.1-5), which classifies internal flood events in U.S. nuclear power plants. This database is used to estimate the frequency of internal floods in plant locations from major flood sources. The database covers a total of 740 years of reactor power operation (1,081 calendar years). The number of reactor-years was calculated by summing the plant data years (operation only) listed on pages A-4 and A-5 of Reference E.1-5.

Table E.1-2 summarizes the database events from Reference E.1-5 and presents initial screening results. The initial screening assigns the event to one of the following categories, as shown in Figure E.1-1:

- Turbine Building (includes feedwater, condensate, circulating water, raw water, etc.)
- Service Water System (Essential Raw Cooling Water)
- Fire Water System (HPFP)
- ECCS Related (includes auxiliary feedwater, charging or chemical and volume control system (CVCS), safety injection, RHR, and containment spray, which are associated with the condensate storage tank and RWST)
- Not Included (pertains to containment, outside, circulating water pump house, etc.)

The above categories were chosen because they represent major flood sources. Based on plant-specific equipment locations, plant layout, design, and operation and maintenance practices, the above events are further screened and partitioned to develop flood frequencies. The following summarizes the results of this additional screening:

- **Turbine Building.** The 23 events in the database are evaluated further from a plant-specific basis, as described in Section E.1.5.5. Large floods are postulated in the turbine building.

- **Service Water (ERCW).** The 15 events in the database are evaluated further from a plant-specific basis, as described in Section E.1.5.2 and Table E.1-3. ERCW floods are postulated in the intake pumping station and the auxiliary building.

- **Fire Water (HPFP).** The 17 events in the database are evaluated further from a plant-specific basis, as described in Section E.1.5.3 and Table E.1-4. No HPFP floods were postulated due to frequency and impact relative to other flood scenarios already postulated.

- **ECCS Related.** The 27 events in the database are evaluated further from a plant-specific basis, as described in Section E.1.5.4 and Table E.1-5. RWST and CST floods are postulated in the auxiliary building.

The key buildings (turbine, auxiliary, control, and intake pumping station) are common to both Watts Bar Units 1 and 2. In addition, the ERCW system is common to both units. This means that an event that occurs at one unit while it is shut down could impact the other operating unit. For this reason, maintenance-related events that are expected to be more likely during plant shutdown are not easily screened out or reduced in frequency for the operating unit being evaluated. Therefore, most events in the database are assumed to be applicable during operation for the unit being evaluated.

Plant-specific screening considers the following:

1. Size of the leak and the potential for propagation to equipment of interest. For example, ERCW seal leaks would be small and would flow through wall openings to the intake screens and grating back to the river. Sufficient water cannot collect and fail the leaking pump, let alone the other pumps.

2. Design precludes the event. For example, gravity draining of the river to the pump room does not apply to the intake pumping station design. Plant design is also considered in determining the potential for maintenance events in item 3.

3. The potential for a maintenance event during power operation is considered. However, as described above, shutdown events associated with one unit can impact the other operating unit at Watts Bar. One of the most likely ways to have a large flood may be from maintenance events when valves and equipment are disassembled. Whether there are isolation valves that can be opened remotely (human error or spurious) and initiate a flood is considered as well as the system design, technical specifications, and maintenance practices.

The mean frequency of pipe rupture, database designators ZTPP1B and ZTPP2B in Reference E.1-7, is used when there are only a few pipe sections and the potential for maintenance and human contributors is considered to be unlikely:

$$\text{Pipe} > 3 \text{ inch} = 8.6 \times 10^{-10} \text{ per section-hour} = 7.5 \times 10^{-6} \text{ per section-year.}$$

Pipe < 3 inch = 8.6×10^{-9} per section-hour = 7.5×10^{-5} per section-year.

Using 80% availability for plant operation,

Pipe > 3 inch = 6.0×10^{-6} per section-reactor-year.

Pipe < 3 inch = 6.0×10^{-5} per section-reactor-year.

This method was not used in this analysis.

E.1.5.2 Service Water Events and Scenarios

The service water (ERCW at Watts Bar) events from industry data (Reference E.1-5) were screened to determine their applicability to Watts Bar. The service water-related events and the screening results are summarized in Table E.1-3. A total of 15 events are separated into three groups: pump related, not pump related (valves and coolers), and outside (underground).

As shown in Table E.1-3, 11 of the 15 events are known to have occurred when the plant was shut down. This is not surprising since most major maintenance actions are scheduled for shutdown conditions, when practical. However, at Watts Bar, both Units 1 and 2 share pumps located in the intake pumping station. In addition, heat exchangers and coolers that are supplied by the ERCW (i.e., in the auxiliary building) for both units are usually on the same elevation in a common building. For this reason, there is no discrimination between events at shutdown and operation. A flood event that occurs due to one unit during shutdown is assumed able to impact the other unit during operation.

E.1.5.2.1 Intake Pumping Station

The seven pump-related events in Table E.1-3 would apply to an intake pumping station. Five of the events are classified as small or not applicable at Watts Bar. One event (11) applies to the strainer rooms on Elevation 722′ of the pumping station. The last event (62) is maintenance related and would also apply to the strainer rooms on Elevation 722′. The pump rooms contain only the pump motor and limited piping, and water would return to the river through wall openings. Therefore, no flood scenario is postulated in the pump rooms.

Based on the above, a flood initiating event in a strainer room is postulated. If the operators successfully isolate the flood in accordance with abnormal operating instruction AOI-13 (Reference E.1-6), all four pumps associated with the header causing the flood will be tripped, and two downstream headers (one each to Unit 1 and 2) normally supplied by the isolated header will be aligned to the other pumping station header (four pumps). If the operators fail to isolate the header, there may be insufficient flow to the two downstream headers, which means that a header to each unit may be unavailable rather than the four pumps that supply the headers.

FLPH1 = 2 events per 1,081 plant-years × 2 plants

The following distribution was substituted for the term "2 events in 1,081 years" to account for plant-to-plant variability, plant-specific experience, and uncertainty:

Frequency of Pump House Floods — Large	
Mean	2.3×10^{-3}
5th Percentile	2.5×10^{-5}
95th Percentile	6.7×10^{-3}

Then, the mean frequency of FLPH1 is

FLPH1 = 4.6×10^{-3} per reactor-year, where the impact is assumed to be loss of all four "A" or all four "B" pumps and the associated headers.

The following two flood initiating events are included in the model:

FLPH1A = 2.3×10^{-3} per reactor-year, where the impact is assumed to be loss of all four "A" pumps and the associated headers.

FLPH1B = 2.3×10^{-3} per reactor-year, where the impact is assumed to be loss of all four "B" pumps and the associated headers.

E.1.5.2.2 ERCW — Auxiliary and Control Buildings

The six events that are not pump related but that are associated with valves and coolers are applicable to the Watts Bar auxiliary building. Three events (10, 31, and 47) are considered to be small and, given the auxiliary building design, it would take several hours before flooding would impact the RHR and containment spray pumps on Elevation 676'. Therefore, these events were considered to be insignificant. The other three events are discussed below:

- Event 16 occurred during shutdown due to a disassembled valve. Service water was started and then stopped. At Watts Bar, there are sufficient manual valves to isolate equipment for maintenance, and these valves are locally near the equipment in most cases. Therefore, human errors should be detected immediately at the source, and spurious opening of a valve is unlikely.

- Event 36 occurred because a service water valve to component cooling was removed for maintenance during shutdown. This event is similar to event 16 in that they both have the potential to be large floods; i.e., the system is open. On the other hand, they are expected to occur with personnel present during local realignment.

- Event 107 occurred when service water to the containment unit coolers leaked with both containment sumps unavailable. This event would appear to apply to the containment unit coolers except that it could also be applied to air conditioning units in the auxiliary and control buildings.

It appears that events 16 and 36 could have resulted in large floods since they were maintenance events where equipment was disassembled. Therefore, these two events are applied to the auxiliary building ERCW flood initiating frequency. (Event 107 is discussed later.) The frequency of a large ERCW flood (10,000 gpm is assumed) in the auxiliary building is estimated as follows:

ERCW-Aux = (2 events per 1,081 plant-years) × 2 plants

The following distribution was substituted for the term "2 events in 1,081 years" to account for plant-to-plant variability, plant-specific experience, and uncertainty:

Frequency of Auxiliary Building Floods due to ERCW — Large	
Mean	2.1×10^{-3}
5th Percentile	3.1×10^{-5}
95th Percentile	6.2×10^{-3}

Then, the mean frequency of ERCW-Aux is

ERCW-Aux = 4.2×10^{-3} per reactor-year.

If the operators isolate the flood in 20 to 30 minutes in accordance with abnormal operating instruction AOI-13 (Reference E.1-6), the initial impact would be the loss of a single ERCW header. If the flood is not a main header pipe rupture, then the equipment-related event could be isolated initially rather than using AOI-13, or, if AOI-13 is initially used, then the header can be recovered after the flood source is identified and isolated. Given successful isolation of the flood, it is assumed that the ERCW header is recovered. The following flood event in the auxiliary building is not modeled because it is more likely that the flood is locally isolated and the header is recovered:

FLAB1 = 4.2×10^{-3} per reactor-year × (1-OP1)

FLAB1 = 4.2×10^{-3} per reactor-year, where (1-OP1) is approximately 1.0, and OP1 is the operator error to diagnose and isolate break in accordance with AOI-13 within 30 minutes (see recovery human action FLAB1R in Section 3.3.3).

If the operators fail to isolate this event within 20 to 30 minutes (OP1), then the RHR and containment spray pumps on Elevation 676′ are assumed to become flooded. The following flood initiating event in the auxiliary building, which causes loss of one ERCW header and all RHR and containment spray pumps, is included in the model:

FLAB2 = ERCW-Aux × OP1

FLAB2 = 4.2×10^{-6} per reactor-year, where OP1 is 1×10^{-3} (see recovery human action FLAB1R in Section 3.3.3).

It is assumed that the flood would be isolated prior to reaching higher elevations that would cause further damage. It would take close to 2 hours at the assumed flood rate of 10,000 gpm for the flood level to reach Elevation 692' where the charging, safety injection, and turbine-driven auxiliary feedwater pumps are located. Even if this did occur, the motor-driven auxiliary feedwater pumps and component cooling water pumps are located at Elevation 713', and should provide an opportunity for success.

The unit cooler leakage event (107) occurred during operation and could be applicable to the control building and the auxiliary building where there are normally operating unit coolers or air conditioning units. The frequency of a relatively large flood at specific plant locations that contain unit coolers could be estimated as follows:

FLUC = 1 event per 1,081 plant-years × 2 plants

FLUC = 1.9×10^{-3} per reactor-year total for all unit coolers.

The frequency of an event at a specific location that contains a unit cooler would be estimated as follows:

FLUC1 = FLUC/20 unit coolers = 9.3×10^{-5} per reactor-year.

The frequency and impact of the auxiliary building floods described above are assumed to envelope this event. However, if the frequency of a flood initiating in the control building mechanical equipment room were of interest, the above would be used, adjusted for the number of coolers at that location. However, as described in Section E.1.4, the likelihood of not isolating the event or of not recovering manual control of the plant from the auxiliary control room is considered to be small.

E.1.5.2.3 ERCW — Outside/Underground

The two ERCW events in Table E.1-3 that occurred outside appear to be relatively small leaks. At Watts Bar, this would be a minor impact if the operators isolated the affected supply header and opened a crosstie to an unaffected header in accordance with AOI-13 (Reference E.1-6). These events are neglected since the above scenarios are believed to envelope risk.

E.1.5.3 Fire Water Events and Scenarios

The fire water events from industry data (Reference E.1-5) were screened to determine their applicability to Watts Bar. The fire water-related events and the screening results are summarized in Table E.1-4. A total of 17 events are separated into two groups: inadvertent actuation and leaks/breaks.

The 11 inadvertent actuations are not considered to be significant flooding sources because the capacity of the sprinkler systems in the areas of interest (i.e., the control building and auxiliary building) is relatively small. In addition, the preaction systems at Watts Bar require fusible links to melt or fail and alarms alert the operators of actuation. The local impact from inadvertent actuation should be the only concern since floor areas and drains handle spray flows. Thus, the frequency and impact of actuation are considered to be insignificant.

Two of the six leaks/breaks events (102 and 105) are applicable to the inside of buildings. Event 102 occurred in the turbine building and appears to be related to the pump that is in the pumping station at Watts Bar, and event 105 appears to be a small leak (although not clear). Therefore, fire water pipe breaks or large floods from the fire water system are judged to be unlikely. In addition, the areas of largest concentration of fire water system components (in particular, large piping) are the pumping station, underground, turbine building, and the lower portions of the auxiliary building. Turbine building floods and auxiliary building floods from ERCW, CST, and RWST are judged to envelope fire water contributions to risk based on frequency and impact. There is limited, smaller fire water piping in the control building and the upper electrical portion of the auxiliary building. These sources are judged to be insignificant since only 1% of the total fire water system is expected to be located in these areas.

E.1.5.4 Emergency Core Cooling System (ECCS) Events and Scenarios

The ECCS-related events from industry data (Reference E.1-5) were screened to determine their applicability to Watts Bar. The ECCS-related events and the screening results are summarized in Table E.1-5. ECCS-related events include safety injection systems, containment spray, RHR, CVCS, and auxiliary feedwater. These systems are located in the auxiliary building at Watts Bar, and are connected to the CST or RWST. A total of 27 events are separated into the following four groups:

- **Pump Related (except for high pressure pumps in operation).** These events are potentially applicable to the RHR, containment spray, safety injection, nonoperating CCP, and auxiliary feedwater pumps. All of these pumps are located in the auxiliary building.

- **Valve/Cooler Related.** These events are more appropriately applied to areas that contain heat exchangers or cooling units. These events apply to the auxiliary building at Watts Bar.

- **Inadvertent Spray or Actuation.** These events are potentially large but apply to inside containment at Watts Bar.

- **High Pressure Pumps during Operation.** These events apply to the charging pumps and the auxiliary feedwater pumps during operation. All of these pumps are located in the auxiliary building.

As described in Table E.1-5, some of the events do not apply to Watts Bar, many of the events were small (seals, vents, drains, and leaks), inadvertent actuations mostly apply to the containment, and personnel are expected to be present when many events occurred during testing.

It is unlikely that the small events would cause significant damage based on the auxiliary building design. The design of the Watts Bar auxiliary building is unique in that all of the flood events in Table E.1-5 that apply to the auxiliary building will propagate to the passive sump (Elevation 666'). This sump holds over 200,000 gallons. An extreme impact would be loss of a single pump if the flood occurred in a pump room. Even this is unlikely unless the flood is large enough to exceed the flow under the pump room door and there is a flood alarm in each pump room. The passive sump would have to be filled and

Elevation 676′ flooded in order to impact multiple pumps. The RHR and containment spray pumps are located on Elevation 676′. Flooding on this elevation is considered to be unlikely for the small events, given the flood alarms, passive sump, and the time required to reach Elevation 676′.

To determine the frequency of large events, it is noted that there appear to be no large maintenance events associated with disassembled equipment. However, events 92, 8, and 78 appear to be potentially larger than the other small events since they involved piping and/or weld failures. To establish bounding scenarios in the auxiliary building, it is assumed that these three events are applicable and are large floods (10,000 gpm). If this were the case, the following flood frequency can be derived for ECCS-related events:

ECCS-Aux = 3 events per 1,081 plant-years × 2 plants

The following distribution was substituted for the term "3 events in 1,081 years" to account for plant-to-plant variability, plant-specific experience, and uncertainty:

Frequency of Auxiliary Building Floods due to ECCS — Large	
Mean	3.2×10^{-3}
5th Percentile	6.2×10^{-5}
95th Percentile	9.1×10^{-3}

Then, the mean frequency of ECCS-Aux is

ECCS-Aux = 6.4×10^{-3} per reactor-year in auxiliary building (RWST and CST).

The flood source is assumed to be either the RWST or the CST since these are the major water supplies to the ECCS-related systems. Both flood sources would generate low tank level indications and alarms in the control room. Flood alarms would help determine which pump room is flooded, if applicable. The charging pumps are normally isolated from the RWST, and there are motor-operated isolation valves in the RHR, safety injection, and containment spray pump suction lines. There are no valves at the RWST. There are manual valves at the CST and in each of the auxiliary feedwater pump suction lines.

Two scenarios are postulated where the flood frequency is split in half (a 50% chance that the source is the CST, and a 50% chance that it is the RWST). In addition, the flood must continue unisolated for 20 to 30 minutes to drain the tank significantly and to reach Elevation 676, flooding the RHR and containment spray pumps. Therefore, the following ECCS-related flood initiating events are included in the model:

FLAB3C = ECCS-Aux x 0.5 x OP2

FLAB3C = 2.8×10^{-5} per reactor-year, where OP2 is 8.9×10^{-3} (see recovery human action FLAB3CR in Section 3.3.3) and is the human error associated with failure to isolate the flood prior to losing approximately 200,000 gallons (20 to 30 minutes), at which time it is assumed that the CST is essentially drained and unavailable. In addition, it is

assumed that the RHR and containment spray pumps are flooded and unavailable.

FLAB3R = ECCS-Aux × 0.5 × OP3

FLAB3R = 3.2×10^{-3} per reactor-year, where OP3 is 1.0 (see recovery human action FLAB3RR in Section 3.3.3) and is the human error associated with failure to isolate the flood prior to losing approximately 200,000 gallons (20 to 30 minutes), at which time it is assumed that the RWST is essentially drained and unavailable. In addition, it is assumed that the RHR and containment spray pumps are flooded and unavailable as well as one AFW pump where the flood is assumed to have initiated.

E.1.5.5 Turbine Building

The 23 events in the database, as identified in Table E.1-2, were screened further with regard to size. Only the large events were retained. The 9 events considered from Table E.1-2 are: 1, 2, 4, 22, 53, 57, 58, 93, and 94. Because the turbine building is common to both Watts Bar Units 1 and 2, all events are assumed to be applicable to both operation and shutdown. Events at one unit during shutdown could impact the other operating plant. The frequency of a large turbine building flood leading to an initiating event at each plant is conservatively estimated as follows:

FLTB = (9 events per 1,081 calendar years) × 2 Units

The following distribution was substituted for the term "9 events in 1,081 years" to account for plant-to-plant variability, plant-specific experience, and uncertainty:

Frequency of Turbine Building Floods — Large	
Mean	9.9×10^{-3}
5th Percentile	2.8×10^{-4}
95th Percentile	2.8×10^{-2}

Then, the mean frequency of FLTB is

FLTB = 2.0×10^{-2} per reactor-year, where station air, feedwater, and the condenser are assumed unavailable.

E.1.6 REFERENCES

E.1-1. Watts Bar Nuclear Plant Architectural Drawings:

1. 46W401-8 R7 Auxiliary Reactor and Control Building Architectural Plan Elevations 772.0, 782.0, and 786.0

2. 46W401-7 R12 Auxiliary Building and Control Building Architectural Plan Elevations 755.0 and 757.0
3. 46W401-6 R14 Auxiliary Building and Control Building Architectural Plan Elevations 729.0 and 737.0
4. 46W401-5 R8 Auxiliary Building and Control Building Architectural Plan Elevations 708.0 and 713.0
5. 46W401-4 R7 Auxiliary Building and Control Building Architectural Plan Elevations 676.0 and 692.0
6. 46W402-2 R26F Control Building Architectural Plan Elevations 729.0 and 755.0
7. 46W402-1 R14 Control Building Architectural Plan Elevations 692.0 and 708.0

E.1-2. Watts Bar MELB Flood Level Calculation, TVA Calculation No. 3C38-1086-001, Revision 2.

E.1-3. Watts Bar Nuclear Plant Flow Diagrams:

1-47W803-1 R4	Feedwater
1-47W803-2 R4	Feedwater
1-47W803-3 R0	Feedwater
1-47W804-1 R2	Condensate
1-47W804-2 R2	Condensate
1-47W804-3 R0	Condensate
1-47W812	Containment Spray
1-47W831-1 R0	Condenser Circulating Water
1-47W831-2 R0	Condenser Circulating Water
1-47W832-1 R2	Raw Service Water and Fire Protection
1-47W832-2 R2	Raw Service Water and Fire Protection
1-47W832-3 R0	Raw Service Water and Fire Protection
1-47W844-1 R1	Raw Cooling Water
1-47W844-2 R0	Raw Cooling Water
1-47W844-3 R1	Raw Cooling Water
1-47W844-4 R2	Raw Cooling Water
1-47W845-1 R11	Essential Raw Cooling Water
1-47W845-2 R8	Essential Raw Cooling Water
1-47W845-3 R5	Essential Raw Cooling Water
1-47W845-4 R5	Essential Raw Cooling Water
1-47W845-5 R7	Essential Raw Cooling Water
1-47W850-1 R0	Fire Protection and Raw Service Water
1-47W850-2 R1	Fire Protection and Raw Service Water
1-47W850-3 R0	Fire Protection and Raw Service Water
1-47W850-4 R0	Fire Protection and Raw Service Water

1-47W850-5 R0	Fire Protection and Raw Service Water
1-47W850-6 R1	Fire Protection and Raw Service Water
1-47W850-7 R0	Fire Protection and Raw Service Water
1-47W850-8 R0	Fire Protection and Raw Service Water
1-47W850-9 R0	Fire Protection and Raw Service Water
1-47W850-10 R0	Fire Protection and Raw Service Water
1-47W850-11 R0	Fire Protection and Raw Service Water
1-47W850-12 R0	Fire Protection and Raw Service Water
1-47W850-13 R0	Fire Protection and Raw Service Water
1-47W851-1 R0	Flood and Equipment Drains
1-47W852-1 R0	Floor and Equipment Drains
1-47W852-2 R0	Floor and Equipment Drains
1-47W852-3 R0	Floor and Equipment Drains
1-47W852-4 R0	Floor and Equipment Drains
1-47W852-5 R1	Floor and Equipment Drains
1-47W852-6 R0	Floor and Equipment Drains
1-47W856-1 R1	Demineralized Water and Cask Decon
1-47W856-2 R1	Demineralized Water and Cask Decon

E.1-4. Watts Bar Fire Hazard Analysis Tables, 47W493 Series.

E.1-5. PLG, Inc., "Database for Probabilistic Risk Assessment of Light Water Nuclear Power Plants: Flood Data," Volume 9, Rev. 0, PLG-0500, March 1990; and Supplement 1 to Volume 9, Rev. 0, PLG-0500, dated September 9, 1991.

E.1-6. Watts Bar Abnormal Operating Instruction, AOI-13, "Loss of Essential Raw Cooling Water," Revision 10.

E.1-7. PLG, Inc., "Database for Probabilistic Risk Assessment of Light Water Nuclear Power Plants: Failure Data, " Volume 2, Rev. 0, PLG-0500, July 1989.

Table E.1-1. Internal Flood Results

Flood	Annual Frequency	Description	Cause of Plant Trip	Plant Model Impact
FLTB	2.0-2	Turbine Building	Loss of Feedwater	Loss of Feedwater, Condenser, and Station Air
FLPH1A	2.3-3	ERCW Strainer Room A	Loss of ERCW Header	Loss of All Four ERCW "A" Pumps and Header
FLPH1B	2.3-3	ERCW Strainer Room B	Loss of ERCW Header	Loss of All Four ERCW "B" Pumps and Header
FLAB2	4.2-6	ERCW in Auxiliary Building for 30 Minutes	Loss of ERCW Header	RHR and Containment Spray Unavailable
FLAB3C	2.8-5	CST Drained to Auxiliary Building	Reactor Trip	CST, RHR, Containment Spray, and One AFW Pump Unavailable
FLAB3R	3.2-3	RWST Drained to Auxiliary Building	Reactor Trip	RWST, RHR, and Containment Spray Unavailable

Note: Exponential notation is indicated in abbreviated form; e.g., 2.0-2 = 2.0×10^{-2}.

Table E.1-2 (Page 1 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
1	Quad Cities 2 B.VI.E.26	Turbine	6/74	Feedwater	Feedwater flow regulating valve.	70,000 gallons	Feedwater break and fire deluge actuation.	Caused plant trip.	Included in turbine building flood frequency.
2	Duane Arnold B.VI.E.31	Turbine	7/74	Condensate	Backwash valve would not close.	123,000 gallons	While at-power, maintenance resulted in flooding.	"Cold" water. Plant trip not reported; unclear if it did.	Included in turbine building flood frequency.
3	Dresden 2 B.VI.E.33	Turbine	9/74	Condensate	Condensate booster pump vent line.	20 inches in pump room	Occurred at-power, ruptured vent line.	Unit manually scrammed.	Included in turbine building flood events.
4	Quad Cities B.VI.F.2	Turbine	6/72	Circulating Water	Water box expansion joint.	15 feet	Ruptured following a design change.	Prior to commercial operation.	Included in turbine building flood frequency.
5	Monticello B.VI.F.25	Outside	5/76	Circulating Water	Cooling tower expansion joint failed.	Flooded discharge structure	Failed during shutdown.	--	Not included in detail screening - circulating water and outside.
6	Browns Ferry 2 B.VII.E.44	Auxiliary	9/74	HPCI	Gasket for HPCI turbine gland steam condenser blew.	The Gland Steam condenser hotwell pump flooded	Following a plant trip, the gasket blew. There was no level alarm.	Occurred when high pressure system operated; i.e., after plant trip.	Included in ECCS flood events, HP pumps. See Table E.1-5.
7	Browns Ferry 2 B.VII.E.46	Auxiliary	10/74	HPCI	Gasket for HPCI turbine gland steam condenser blew.	The Gland Steam condenser hotwell pump flooded	Occurred 1 month after event 6.	Occurred when high pressure system operated; i.e., after plant trip.	Included in ECCS flood events, HP pumps. See Table E.1-5.
8	Browns Ferry 3 B.VII.E.147	Auxiliary	4/78	Condensate (ECCS)	Welded joint in ring header.	80,000 gallons	Ring header failed after plant trip as RCIC and HPCI operated.	High pressure systems were operating.	Included in ECCS flood events, HP pumps. See Table E.1-5.

Table E.1-2 (Page 2 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
9	Quad Cities 1 B.VIII.C.26	Outside	4/74	RHR Service Water	Underground piping.	50 gpm	Construction debris pierced pipe to RHR heat exchanger.	Revealed when RHR placed in service; i.e., shut down.	Included in Service Water flood events, outside. See Table E.1-3.
10	Brunswick 1 B.VIII.C.110	Auxiliary	7/77	Service Water	RHR service water heat exchanger outlet valve.	Unclear	Gasket for valve ruptured (flange).	Revealed when RHR placed in service; i.e., shut down.	Included in Service Water flood events, valve. See Table E.1-3.
11	Hatch 1 B.VIII.C.153	Service Water Pump House	10/78	Service Water	Strainer backwash line valve body blew out.	3 Feet of water	Valve closed to permit maintenance ruptured.	May affect only pump out for maintenance.	Included in Service Water flood events, pump. See Table E.1-3.
12	Brunswick 1 B.VIII.C.169	Auxiliary	11/77	HPCI	Floor drains inadequately.	Enough to flood auxiliary oil pump	Sump pumps from other ECCS cubicles flooded sump if transferred water to; i.e., HPCI pump room.	Peculiar to floor drain interconnections arrangement.	Not included in detailed screening - drains.
13	Browns Ferry B.VIII.C.178	Outside/ Turbine	1/79	Drainage System for ground water	Design inadequacy.	Small, no equipment effected	Drainage system could not keep up with water level, dewatering pumps failed.	Peculiar to plant design. Additional redundancy added.	Not included in detailed screening - drains.
14	Browns Ferry 1 B.VIII.C.255	Auxiliary	8/81	RHR Service Water	Air/vacuum valve failed to seal, RHRSW pump.	Pump room flooded	Valve failed during refueling.	Revealed during shutdown.	Included in Service Water flood events, pump. See Table 3.36-3.
15	Fitzpatrick B.IX.E.756	Auxiliary	3/82	RCIC	Failed sump pump	Small	A RCIC valve flooded when the sump pump did not work.	Leak source not identified.	Not included in detailed screening - source was not identified.
16	Dresden B.XVI.C.377	Auxiliary	11/77	Service Water/LPCI	Heat exchanger outlet valve.	3.5 Feet flooded	Valve disassembled but not isolated when river pump started (shutdown).	Heat exchanger maintenance permitted at-power also.	Included in Service Water flood events, valve. See Table E.1-3.

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Table E.1-2 (Page 3 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
17	Quad Cities B.VIII.C.361	Auxiliary	6/85	Service Water/RHR	Pump vent line.	Pump vault filled, sprayed two other pumps	Vent line failure during RHR cooling.	Location of pump vent lines is of interest.	Included in Service Water flood events, pump. See Table E.1-3.
18	Hatch 1 B.XVI.C.1633 B.XVI.C.1547	Auxiliary	5/85	Deluge System for CR Filters	Pressure gauge bumped.	Small (20 gallons)	The pressure gauge actuated the system, a plugged drain caused leakage into a control room panel.	Spurious valve actuation and instrument readings resulted.	Included in Fire Water flood events, inadvertent act. See Table E.1-4.
19	Cooper B.XVI.C.1215 B.VII.F.341	Auxiliary	4/84	Fire Protection System	Deluge valve failed.	Unclear	Inadvertent fire protection actuation.	--	Included in Fire Water flood events, inadvertent act. See Table E.1-4.
20	Point Beach 2 P.VD.133	Auxiliary	4/77	Steam Generator Blowdown	Blowdown tank overflowed.	Small	Leaking blowdown line did not isolate blowdown.	Could associate with a tank.	Not included in detailed screening - steam generator related.
21	TMI 2 P.VI.E.200	Auxiliary	3/79	Liquid Waste System	Holdup tanks overflowed.	50,000 gallons	TMI 2 accident. Tanks overflowed due to transfer of containment sump water.	Could associate with a tank. Happened during accident.	Not included in detailed screening - radwaste related.
22	Crystal River 3 P.VI.E.214	Turbine	1/79	Circulating Water	Secondary services heat exchanger block valve.	65,000 gpm medium	AOV valve opened during heat exchanger cleaning. Circulating water pumped into open service water pipe; plant was at 100% power.	Caused condensate and MFW pumps to trip due to flood.	Included in turbine building flood frequency.
23	TMI 1 P.VI.F.52	Circulating Water Pump House	4/77	Circulating Water	Circulating water pump casing.	Large	Casing split during refueling, flooding pump house.	Separate pump house for circulating water for this plant.	Not included in detailed screening - circulating water.

Table E.1-2 (Page 4 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
24	Trojan P.VIII.A.216	Auxiliary	5/77	Spent Fuel Pool Demineral-izer	Head gasket in demineralizer (manhole cover).	10,000 Gallons (20 to 30 gpm)	Gasket blew during purification of RWST inventory, during shutdown.	Could associate with a tank.	Not included in detailed screening - spent fuel pool.
25	TMI 2 P.VIII.A.410	Auxiliary	2/80	HHSI	Test connection valve separated.	550 gallons	Leak occurred during pump test.	Leak was isolated rather quickly.	Included in ECCS flood events, HP pumps. See Table E.1-5.
26	Surry 2 P.VIII.B.54	Service Water Pump House	6/75	Service Water	Pump seal.	Small	Valve motor in pit below pump shorted.	Seal leak size not reported.	Included in Service Water flood events, pump. See Table E.1-3.
27	Trojan P.VIII.B.134 (Duplicate of Event #24)	Auxiliary	5/77	Spent Fuel Pool Demineralize r	Head gasket in demineralizer (manhole cover).	10,000 gallons (20 to 30 gpm)	Gasket blew during purification of RWST inventory, during shutdown.	Could associate with a tank.	Not included in detailed screening - spent fuel pool.
28	Oconee 1 P.VIII.C.6	Auxiliary	10/74	LPI/DHR	Drain valves left open for cooler and piping.	3 feet (small)	During maintenance to inspect a valve, the system was not isolated properly for draining.	Drain valves could be associated with the valve or the cooler.	Included in ECCS flood events, valve. See Table E.1-5.
29	Oconee 3 P.XI.B.163.196	Turbine	10/76	Main Condenser	Solenoid butterfly valve failed open	Large (for 30 minutes) (tur-bine building flooded 2 ft)	Valves designed to fail open. During refueling, lake drained into turbine building via circulating water. Condenser, circulating water valve (outlet) solenoids.	Not applicable to power operation. Relative elevations peculiar to this plant.	Not included in detailed screening - site elevations.
30	Zion 1 & 2 P.XII.53	Auxiliary	4/73, 11/75	Radwaste	Design error, inadequate capacity.	15 gpm	Numerous instances of small flooding.	No events were significant enough to report separately.	Not included in detailed screening - radwaste related.

Table E.1-2 (Page 5 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
31	Surry 2 P.XVI.C.518	Service Water Valve Pit	10/77	Service Water	2" Service Water drain valves left open	Unclear	During shutdown, flooded when header returned to service.	1 header maybe in maintenance while at power.	Included Service Water flood events, valve. See Table E.1-3.
32	Surry 2 P.XVI.C.679	Turbine	10/78	Main condenser	Drain line insufficient capacity	Unclear	Service water valve pit in turbine building flooded, due to shutdown maintenance.	Affected service water but flood source in turbine building.	Included in turbine building flood events.
33	Surry 1 P.XVI.C.1543	Turbine/ Service Water Valve pit	11/81	Unclear	Not specified.	Valve pit flooded	Service water valve pit in turbine building flooded from unknown source.	Numerous instances of this at Surry, all due to main condenser maintenance.	Not included in detailed screening - source unknown.
34	San Onofre 1 P.XVI.C.1774	Service Water Pump House	3/82	Service Water	Operator error.	Unclear	Circulating water pump not started to depress service water intake water level before maintenance.	Peculiar to ocean site at San Onofre (during shutdown).	Included in Service Water flood events, pump. See Table E.1-3.
35	Turkey Point 3 P.XVIC.1849	Auxiliary	11/82	Liquid waste	Waste holdup tank overflowed	600 gallons (small)	Laundry water spilled.	Occurred at power.	Not included in detailed screening - liquid waste related.
36	Indian Point 2 P.VIII.B.639	Auxiliary	8/84	Service Water	Service water valve removed for maintenance in CCW pump room	Medium	In shutdown with fuel removed, header not completely isolated for maintenance, CCW pumps were flooded.	Maintenance could occur in header while at power. One CCW pump cleaned and started in 3 hours.	Included in Service Water flood events, valve. See Table E.1-3.
37	Brunswick 1 B.VI.C.86	Turbine	9/86	Main Condenser	Main condenser cleaning system leak.	Medium	During startup, led to high main condenser pit water level.	Circulating water pumps tripped.	Included in turbine building flood events.
38	Pilgrim 1 B.VI.E.53	Turbine	1/76	Feedwater	Feedwater regulating valve broken	5,000 gallons (medium)	Valve broke, line isolated by operators.	Plant was then shut down.	Included in turbine building flood events.

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Table E.1-2 (Page 6 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
39	Quad Cities 1 B.VII.C.32	Auxiliary	2/75	Core Spray	Relief valve lifted during test.	20,000 gallons (1,000 gpm)	Relief valve lifted and diverted flow during the spray pump test.	Could occur for any pump test. This test, the pump ran on mini flow.	Included in ECCS flood events, pump. See Table E.1-5.
40	Oyster Creek B.VII.C.48	Auxiliary	4/76	Core Spray	Pump seal leak	3 gpm (small) (1,375 gal.)	The seal leakage occurred but was not associated with a test.	This leak rate may be within capacity of the sump pumps.	Included in ECCS flood events, pump. See Table E.1-5.
41	Peach Bottom 2 B.VII.E.135	Auxiliary	2/78	HPCI	Pump flange gasket leak.	Unclear	The flange leak was associated with a test; closing suction valve stopped the leak.	Leak rate not reported but was enough to cause flood alarm.	Included in ECCS flood events, HP pump. See Table E.1-5.
42	Susquehanna 2 B.VII.E.420	Auxiliary	10/86	HPCI	Drain line left open in steam supply line.	750 gallons	HPCI pump test sprayed steam.	Procedure problem concerning valve checklist.	Included in ECCS flood events, HP pump. See Table E.1-5.
43	Browns Ferry B.VII.F.304	Containment	4/86	Spray	Pressure switches.	Large	Shorting of pressure switches led to inadvertent spray actuation.	Plant was in cold shutdown.	Included in ECCS flood events, inadvertent act. See Table E.1-5.
43(a)	Browns Ferry B.VII.F.304	Containment	4/86	Fire Protection System	Cable tray deluge valves failed when system repressurized.	Large	A yard break depressurized the fire protection system, the valves then failed.	This event is documented with event 43.	Included in Fire Water flood events, inadvertent act. See Table E.1-4.
44	Vermont Yankee B.VIII.A.31	Reactor Building	10/76	RWCU	Flow switch.	Several hundred gallons	RCS leaked into reactor building before leak isolated.	Flow switches later replaced with blank flanges; small LOCA.	Not included in detailed screening - reactor water clean up.
45	LaSalle 1 B.VIII.A.165	Auxiliary	8/84	RWCU	Manual valve left open.	Small	Tank overflowed due to leak from RWCU system.	Occurred when RWCU filters rearranged.	Not included in detailed screening - reactor water clean up.

Table E.1-2 (Page 7 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
46	Millstone 1 B.VIII.A.212	Auxiliary	7/86	RWCU	1' relief line failed for regenerative heat exchanger	Unclear (Small)	Pipe line failure led to leak, line was then isolated.	--	Included in ECCS flood events, valve. See Table E.1-5.
47	Millstone 1 B.VIII.B.1	Auxiliary	5/71	Service Water	RBCCW heat exchanger discharge line on service water side.	Small (failed MCC below)	Service water leakage near heat exchanger during plant cooldown.	Revealed during shutdown.	Included in Service Water flood events, valve. See Table E.1-3.
48	Dresden 1 B.VIII.C.105	Auxiliary	4/77	Fuel Pool Cooling	Heat exchanger inlet vent line.	3,500 gallons	Nipple corroded, caused a leak.	Occurred at power.	Included in ECCS flood events, valve. See Table E.1-5.
49	Quad Cities 1 B.VIII.C.224	Auxiliary	10/80	Service Water/RHR	Pump packing leakage.	Small	Pump leakage and sump pump design inadequacy.	Revealed when RHR operated for shutdown cooling.	Included in Service Water flood events, pump. See Table E.1-3.
50	Quad Cities 1 B.VIII.C.270	Under-ground Piping	11/81	Service Water	Design error (see event 9) RHR service water line.	Unclear	Leakage under turbine building.	Revealed when RHR operated for shutdown cooling.	Included in Service Water flood events, outside. See Table E.1-3.
51	Hatch 2 B.X.56	Auxiliary	12/86	Fuel Pool	Inflatable seals failed.	140,000 gallons	Inflatable seals failed, permitting flood.	Could only have occurred during shutdown.	Not included in detailed screening - spent fuel pool.
52	Millstone 1 B.XII.28	Turbine	3/75	Condensate	Condensate return overflowed.	Small	While at power, condensate overflowed.	Did not cause a plant trip.	Included in turbine building flood events.
53	Browns Ferry 1 B.XVI.C.75	Turbine	5/74	Condensate	Blank flange loosened.	Large (85,000 gallons)	U1 and U2 crosstie to be connected, but condensate system not isolated.	Operations error prior to commercial operation.	Included in turbine building flood frequency.
54	Brunswick 1 B.XVI.C.1634	Contain-ment	7/85	Containment Spray	Maintenance error.	25,000 gallons (secured in 3 minutes)	Inadvertent containment spray actuation during refueling.	Cause is related to the refueling outage maintenance.	Included in ECCS flood events, inadvertent act. See Table E.1-5.

Table E.1-2 (Page 8 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
55	Hatch 1 B.XVI.C.1845; VII.D.412	Auxiliary	12/85	RHR	Air-operated butterfly valve used for pump isolation.	14 feet (large)	Isolation valve opened in response to a loss of offsite power test.	Occurred during refueling; may occur during any maintenance.	Included in ECCS flood events, pump. See Table E.1-5.
56	Arkansas Nuclear One 1 P.V.F.50	Auxiliary	8/85	Letdown	3/4" drain line valve.	500 gallons (several inches)	Valve opened, later isolated locally.	Isolable small LOCA.	Not included in detailed screening - letdown line.
57	Trojan P.VI.E.559	Turbine	3/85	Feedwater	Heat drain pump discharge piping ruptured.	Large	Ruptured, caused loss of condenser vacuum and actuation of fire suppression.	Occurred in response to turbine trip with partial FWI.	Included in turbine building flood frequency.
58	Surry P.VI.E.786, 736,749, 756	Turbine	12/86	Feedwater	Elbow of MFW pump suction ruptured.	Large	Ruptured led to loss of MFW and numerous fire suppression actuation all over the plant.	In response to one MSIV closure and partial FWI.	Included in turbine building flood frequency.
59	Catawba 1 P.VI.F.99	Turbine	8/86	Feedwater	MFW pump turbine condenser valve.	Medium	Valve leaked, then failed open.	Circulating water secured. Plant was at hot standby.	Included in turbine building flood events.
60	San Onofre P.VII.E.210	Outside	6/84	Fire Protection	Fire water pipe underground.	Not reported	Break in a fire main weakened by construction equipment.	May wish to consider as external flood.	Included in Fire Water flood event, leak. See Table E.1-4.
61	Surry 2 P.VIII.B.421, 567	Turbine	8/81	Unclear	Not specified.	Small	Leak flooded service water valve pit.	Service water valve pit normally not in the turbine building.	Included in turbine building flood events.
62	Salem 2 P.VIII.B.571	Service Water Pump House	6/83	Service Water	Check valve flange gasket.	6 Feet	When in cold shutdown, leak occurred when service water restored after header cleaning.	Service water pumps may be in maintenance when at power.	Included in Service Water flood events, pump. See Table E.1-3.

Table E.1-2 (Page 9 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
63	Rancho Seco P.IX.C.317	Auxiliary	12/85	HHSI	HHSI pump seal.	450 gallons (small)	Pump seal leaked when started with suction valve closed.	Occurred in response to an safety injection.	Included in ECCS flood events, HP pump. See Table E.1-5.
64	San Onofre 1 P.XII.147	Auxiliary	8/85	Post-Accident Sampling	Relief valve diaphragm failed, valve opened.	Not reported.	Valve spuriously opened, post-accident sampling lost.	--	Not included in detailed screening - post-accident sampling.
65	Surry 2 P.XVI.C.174	Turbine	1/75	Drainage of Sumps	Operator error.	Valve pit flooded (small)	Operators started sump test, then left; sump overflowed.	Service water valve pit not normally in the turbine building.	Not included in detailed screening - sump drainage.
66	Surry 2 P.XVI.C.1904	Turbine	7/82	Main Condenser	Main condenser inlet water box.	Valve pit flooded (small)	While cleaning a water box, leakage flooded a nearby valve pit.	Service water valve pit not normally in the turbine building.	Included in turbine building flood events.
67	Surry 2 P.XVI.C.1910	Turbine	9/82	Main Condenser	Main condenser water box.	Valve pit flooded (small)	Portable sump pump left unattended, misdirected flow into valve pit.	Service water valve pit not normally in the turbine building.	Included in turbine building flood events.
68	Indian Point 2 P.VI.E.34	Inside Contain-ment	11/73	MFW	Feedwater line to steam generator 22 only.	Unspecified Containment sump level rose	Feedwater linebreak inside containment safety injection occurred on delta-P between steam generators 180-degree crack with maximum width 5/32".	Power at 7%, turbine not yet synched.	Not included in detailed screening - containment.
69	Maine Yankee P.VI.E.435	Inside Containment	1/83	MFW	Feedwater line/ nozzle at No. 2 steam generator inlet nozzle.	Severe, but Containment was entered for inspection	Feedwater linebreak inside containment. MFW was not available after trip. Water hammer occurred due to AFW startup.	Full power, water hammer when steam collapsed due to rising steam generator water level.	Not included in detailed screening - containment.

Table E.1-2 (Page 10 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
70	Arkansas Nuclear One 1 P.VIII.B.96	Auxiliary	8/76	DHR	Flow instrument valve weld.	Minor (~2 gpm)	Cold shutdown, minor leaks due to excessive vibrations.	Similar problem in same material of spray system.	Included in ECCS flood event, valve. See Table E.1-5.
71	Salem 2 P.VIII.A.538	Containment	6/81	CVCS	Letdown isolation valve transferred closed.	3,000 gallons before isolation	A letdown isolation valve closed, safety valve lifted venting to containment.	Vent valve on isolation valve had failed at a weld.	Not included in detailed screening - containment, CVCS.
72	Ft. Calhoun P.V.A.61	Containment	10/76	RCS RCP seals	RCP controlled bleed-off line.	<0.2 gpm	Weld leak on bleed-off line discovered during shutdown.	Insignificant size.	Not included in detailed screening - containment, small RCP seal leak.
73	Indian Point 2 P.V.A.69	Containment	7/77	RCS	RCP seal.	<75 gpm, 90,000 gallons total	RCP seal package failed while at 2% power. No safety injection, but manual shutdown required. Rapid cooldown; plant had to be depressurized and drained to stop the leak. Charging pumps worked.	Second charging pump controlled level, pressurizer pressure also fell. Recirculation not required.	Not included in detailed screening - containment, RCP seal leak.
74	Arkansas Nuclear One 1 P.V.A.84	Containment	5/80	RCS	RCP seal.	>20 gpm, totaled 64,000 gal.	RCP seal leak from 86% power, manual reactor trip and safety injection.	Building pressure increases 0.5 psid. Took 7 hours to get on RHR.	Not included in detailed screening - containment, RCP seal leak.
75	Oconee 2 P.V.A.32	Auxiliary	1/74	CVCS	RCP seal injection line outside containment.	Unclear, 1.5" CVCS line	Leak in seal injection line led to isolation of injection flow to all four RCPs.	Cool down took 75 hours once started.	Included in ECCS flood events, HP pump. See Table E.1-5.
75(a)	Oconee 2 P.V.A.32	Containment	1/74	RCS	RCP seal.	Averaged 90 gpm, 50,000 gallons total	Manual trip and cool-down. Did not go on recirculation.	Seal that failed was for different pump than one which lost injection.	Not included in detailed screening - containment, RCP seal leak.

Table E.1-2 (Page 11 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
76	Robinson 2 P.V.A.40	Containment	4/75	RCS	RCP seal	400 gpm max. (130,000 gallons total)	RCP seal leak, started at full power and increased 6 hours later after trip. Containment pressure increased 3 psig. Safety injection indicated.	Took 3.5 hours for depressurization on RHR. Very little operating history.	Not included in detailed screening - containment, RCP seal leak.
77	Oyster Creek B.VI.E.157	Turbine	6/82	Condensate	1/2" pressure gauge connecting pipe.	9,700 gallons in <1.25 hours.	Sheared small connecting pipe off due to pump vibration.	At 78% power.	Included in turbine building flood events.
78	Dresden 1 B.VII.E.9	Auxiliary	5/71	HPCI	Test return line to condensate.	Not specified	Line ruptured during test.	--	Included in ECCS flood events, HP pumps. See Table E.1-5.
79	Dresden 2 B.VII.E.93	Auxiliary	9/76	HPCI	Test return line.	Very small <1/4" diameter <5 gpm	Small hole in HPCI test return line.	Reactor at 97% power. May not have been a test in progress.	Included in ECCS flood events, HP pumps. See Table E.1-5.
80	Quad Cities 2 B.VI.E.45	Turbine	8/75	MFW	Low flow MFW line.	8,500 gallons and 4,000 from SW deluge	At 170 MW, the low flow line severed as the plant switched from the low flow to the main feedwater regulating valve.	Pump trip and isolation of valves limited the leakage.	Included in turbine building flood events.
80(a)	Quad Cities 2 B.VI.E.45	Turbine	8/75	MFW	Feedwater low flow drain lines.	3-3/4" lines	At 410 MW, feedwater regulating valve failed open; 3-3/4" lines broke due to excessive vibration.	Similar vibration causes as with event 80.	Included in turbine building flood events.

Table E.1-2 (Page 12 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
81	Salem 1 P.V.A.90	Containment	10/78	RCS	RCP seal.	15,000 gallons rate not specified (believe >75 gpm)	At hot shutdown, RCP seal leakage, makeup required shifting to RWST.	Plant was already tripped at time of leakage.	Not included in detailed screening - containment, RCP seal leak.
82	Oconee 3 P.V.C.8	Containment	6/75	RCS	Pressurizer PORV stuck open.	1,500 gallons	From low power during power reduction, transient caused PORV challenge, stuck open.	Pre-TMI B&W plant transient.	Not included in detailed screening - containment, RCS.
83	Calvert Cliffs 2 P.V.A.77	Containment	11/78	RCS	RCP seal pressure sensing line.	Technical Specification (~25 gpm)	Seal pressure sensing line weld cracked; reactor remained critical while operators isolated the line.	Plant at full power.	Not included in detailed screening - containment, RCS.
84	Trojan P.VIII.A.308	Auxiliary	9/77	CVCS	Common suction line for charging pumps.	11 gpm	Small leak detected when plant at 80% power.	--	Included in ECCS flood events, HP pump. See Table E.1-5.
85	Davis-Besse 1 P.IX.D.95	Containment	9/77	RCS	Pressurizer PORV stuck open.	11,000 gallons, operator isolated in 21 minutes	At 9% power, spurious 1/2 FWI caused RCS pressure transient, which challenged PORV. Valve failed open.	Valve closed at open rather than closing setpoint so it cycled nine times.	Not included in detailed screening - containment, RCS.
86	Zion 1 (J.W. Stetkar personal experience)	Containment	1975	RCS	RCS drain valves mispositioned.	(750 gpm) 15,000 gallons	Valve alignment error revealed when another valve operated as part of routine operation.	Occurred at hot shutdown isolated in 20 minutes.	Not included in detailed screening - containment, RCS.
87	Surry 1 P.V.B.2	Containment	11/72	RCS	Hotleg RTD.	3/8" diameter 30,000 gallons	RTD blew out soon after pressurizer pressurized.	Failure pressure was less than earlier hydrotest.	Not included in detailed screening - containment, RCS.

Table E.1-2 (Page 13 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
88	Salem 2 LER 311/84016	Auxiliary	7/84	Charging	Weld of vent valve to header.	Unspecified	3"-long crack in charging pump suction header where vent valve attaches to schedule 10 pipe. Reactor was at 100% power.	Operability of charging pumps questionable.	Included in ECCS flood events, HP pump. See Table E.1-5.
89	Maine Yankee LER 309/83003	Auxiliary/ Containment	1/83	ECCS	Pump vent lines.	Small, via pump casing vent lines	While at power, inadvertent actuation of automatic switchover to recirculation of train A during RWST level testing.	Small drainage of RWST through LPSI and QSS pump vent lines to sump.	Included in ECCS flood events, inadvertent act. See Table E.1-5.
90	Indian Point 2 LER 247/78032	Auxiliary	11/78	Charging	Weld of drain valve to seal injection header.	8.0 gpm	While at power, small leak in seal injection header, where drain valve welded to header.	Leak increased from original 0.5 gphr.	Included in ECCS flood events, HP pump. See Table E.1-5.
91	Indian Point 2 LER 247/77000	Auxiliary	3/77	Charging	Seal injection line.	Unspecified	Weld leaking elbow connection of seal injection line during power operation.	Unit shut down for repairing similar events mentioned on 7/75 and 2/77.	Included in ECCS flood events, HP pump. See Table E.1-5.
92	McGuire 2 LER 370/84017	Auxiliary	8/84	RHR	Weld on letdown line from RHR to CVCS.	3,000 to 7,000 gallons spraying	During cold shutdown with RHR in operation, weld in small pipe and sprayed from stem of valve.	Leaking line was isolated.	Included in ECCS flood events, pump. See Table E.1-5.
93	LaSalle 1 & 2 INPO(SOER)85-5 LER 373/85045	Turbine	5/85	Circulating water	Expansion joint between circulating pump and discharge valve.	2,000 gpm	At 85% power, transient caused joint to rupture, flooded basement to 15 feet, stopped when equilibrated to river.	All circulating water and nonemergency service water lost. Fire water rigged for cooling in <3 hours.	Included in turbine building flood frequency.

Table E.1-2 (Page 14 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
94	Peach Bottom 3 INPO(SOER)85-5 (SER) 50-84	Turbine	1/84	Circulating Water	Water box vent valve left open for maintenance.	1-hour flooded pump room 6-8 ft	60% power, restoring from maintenance, pump room flooded, operators attended other problem.	Condensate pump bearings failed when water displaced oil in bearings, motors not flooded.	Included in turbine building flood frequency.
95	Not Used								
96	Surry 2 P.XVI.C.679	Turbine	10/78	Main Condenser	Drain line insufficient capacity.	Unclear	Service water valve pit in turbine building flooded due to shutdown maintenance.	Affected service water but flood source in turbine building.	Included in turbine building flood events.
97	North Anna P.VII.E.222	Outside	11/84	Fire Protection	Fire protection system main header	Not reported	12 foot crack found in piping	May wish to consider as external flood	Included in Fire Water flood events, leak. See Table E.1-4.
98	Dresden 1 B.VI.E.9	Turbine	5/63	Condensate	Condensate pump.	2" on Condensate room floor	Lube oil supply pump to condensate pump failed. Condensate pump shaft seized, casing cracked at power.	Oil-lubricated condensate pump; no temperature alarm.	Included in turbine building flood events.
99	Turkey Point 3 P.XIV.B.12	4-kV switchgear	11/72	Floor Drain	Drain discharge channel.	1" to 4" on floor	Heavy rains and incomplete discharge canal caused floor drains to back up.	--	Not included in detailed screening - drain related.
100	Beaver Valley 1 P.V.B.10	Containment	6/76	RCS	RCS pressure sensing line.	5,300 gallons	Failure of flexible hose in sensing line, improper choice of hose, 28% power.	Engineering error in hose choice.	Not included in detailed screening - containment, RCS.

Table E.1-2 (Page 15 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
101	Arkansas Nuclear One 1 and 2 P.VI.D.176	Containment	9/78	Containment Spray	ESF relay.	50,000 gallons	MSIV air solenoid created plant transient. Improper set relays caused containment spray actuation and gravity feed as recirculation valves repositioned. 100% power.	--	Included in ECCS flood events, inadvertent act. See Table E.1-5.
102	Peach Bottom B.VII.F.238	Turbine	6/84	Fire Water	Piping	Unknown	Pipe break at elbow during fire system testing.	--	Included in Fire Water flood events, leak. See Table E.1-4.
103	Pilgrim 1 B.VII.F.58	Outside	11/78	Fire Water	Shutoff valve.	Medium	During hydrant repair, shutoff valve blew off, 100% power.	Improper valve reinstallation is cause.	Included in Fire Water flood events, leak. See Table E.1-4.
104	Dresden 2 B.XII.67	Radwaste Auxiliary	6/79	Demineralized water	Hose.	Medium	Demineralized hose ruptured, flooding containment floor.	91% Power	Not included in detailed screening - radwaste.
105	Dresden 2 B.XIV.A.77	Diesel Generator Room	10/79	Fire Water	Careless while performing maintenance activity	Small	While modifying fire system water ran down into diesel generator control cabinet.	Maintenance activity, 98% power.	Included in Fire Water flood events, leak. See Table E.1-4.
106	Crystal River 3 P.VII.A.262	Outside	7/80	Core Flood Tanks	Check valve.	20 gallons	Core flood check valve failed, 500 gallons enter N_2 system, 20 gallons to environment via N_2 R.V.	Shutdown.	Not included in detailed screening - outside.
107	Indian Point 2 P.VII.C.55	Containment	10/81	Service Water	Fan cooler unit coil leak.	100,000 gallons	Leaking fan cooler unit, 100% power.	Both containment sump pumps out of order.	Included in Service Water flood events, valve. See Table E.1-3.

Table E.1-2 (Page 16 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
108	Peach Bottom 3 INPO (SER) 46-83 LER 278/83007	Auxiliary	3/83	RHR/LPCI	RHR/LPCI pumps	60,000 gallons	Inadvertent LPCI actuation during instrument calibration.	Refueling	Included in ECCS flood events, inadvertent act. See Table E.1-5.
109	Oyster Creek NRC IE Information Notice #83-41	Unclear	11/9/80	Fire Water	Automatic fire suppression system was left on while trouble shooting electrical fault	Unclear	While trouble shooting an electrical fault in an automatic fire suppression system, sprinkler actuation occurred because operators did not de-activate automatic feature.	Caused one train of a redundant safety feature actuation system to fail.	Included in Fire Water flood events, inadvertent act. See Table E.1-4.
110	Oyster Creek NRC IE Information Notice #83-41	Unclear	1/82	Fire Water	Pump motor	Unclear	Pump motor overheated causing actuation of fire suppression sprinkler system.	Some safety-related equipment suffered water damage.	Included in Fire Water flood events, inadvertent act. See Table E.1-4.
111	Dresden Unit 3 NRC IE Information Notice #83-41	Auxiliary	11/81	Fire water	Smoke Detector caused actuation of sprinkler system.	Unclear	Ionization-type smoke detector in an HPCI room reacted to high temperature and humidity, actuating an automatic sprinkler system.	This lead to loss of HPCI system.	Included in Fire Water flood events, inadvertent act. See Table E.1-4.
112	Dresden Unit 2 NRC IE Information Notice #83-41	Auxiliary	12/81	Fire Water	High temperature caused actuation of sprinkler system	Unclear	High temperature and humidity caused actuation of sprinkler system in HPCI room. This event is similar to event 111.	Caused HPCI and redundant automatic depressurization system to fail.	Included in Fire Water flood events, inadvertent act. See Table E.1-4.

Table E.1-2 (Page 17 of 17). Categorization of Flooding Events from Industry Data through September 1987 (Reference E.1-5) (References are from NPE unless otherwise noted.)

Event	Plant and Reference	Building	Date	System	Component	Size of Leak	Event Description	Comments	Detailed Screening Information
113/ 114	Farley Unit 1 NRC IE Information Notice #83-41	Cooling Towers	6/10/ 81 and 7/21/ 82	Fire Water	Inadvertent actuation of deluge system due to a maintenance activity	Unclear	These two events resulted in unnecessary actuation of the deluge system for the main cooling towers because control system had been taken out of service for maintenance.	Led to actuation of deluge system and drawdown of two water storage tanks below tech spec. limit.	Included in Fire Water flood events, inadvertent act. See Table E.1-4.
115	Trojan NRC IE Information Notice #83-41	Containment	7/26/ 81	Fire Water	Fire suppression system	Unclear	Smoke from welding caused actuation of fire suppression system.	Caused inoperability of one train of the redundant containment atmosphere hydrogen recombiner system.	Included in Fire Water flood events, inadvertent act. See Table E.1-4.
116	Surry Unit 2 NRC IE Information Notice #83-41	Diesel Generator Room	5/28/ 81	Fire Water	Valve was left slightly open	Unclear	A foam distributor system was installed in the fuel oil tank. Water leaked through open valve.	The diesel generators were technically inoperable until the water was removed.	Included in Fire Water flood events, leak. See Table E.1-4.
117	Ginna NRC IE Information Notice #83-41	Auxiliary	11/14/ 81	Fire Water System	Satellite Station A (provides power to smoke detector circuits)	Unclear	While performing lamp test, actuation of several fire water suppression or sprinklers occurred.	Resulted in the trip of one RPS motor generator set and a small amount of water entering the control rod drive switchgear cabinet. Two rods dropped.	Included in Fire Water flood events, inadvertent act. See Table E.1-4.

Table E.1-3 (Sheet 1 of 2). Plant-Specific Screening Service Water Flood Events

Class of Events	Event	Description	Plant-Specific Screening
Pump Related	11	During maintenance, strainer backwash isolation valve body blew.	Applies to strainer rooms at Elevation 722' in intake pumping station.
	14	Air/vacuum valve failed to seal, shut down.	Small leakage in pump room.
	17	Pump vent line failed and flooded vault.	Small leakage in pump room.
	26	Pump seal leak, valve motor below shorted.	Small leakage in pump room.
	34	CWS not started to depress level before maintenance, shut down.	Not applicable to intake pump station.
	49	Pump packing leak, sump pump inadequate, shut down.	Small leakage in pump room.
	62	Check valve flange gasket, 6 feet of water when header restored, shut down.	Applicable to maintenance in strainer room (Elevation 722').
Not Pump Related (valves, coolers)	10	RHR heat exchanger outlet valve flange gasket ruptured when operated, booster pump, shut down.	Small leak. Applies to auxiliary building.
	16	Maintenance on heat exchanger outlet valve, service water started and stopped, valve disassembled, shut down.	Manual isolation valves are near CCW heat exchanger. Applies to auxiliary building.
	31	Drain valve left open in valve pit after maintenance, shut down.	Small leak.
	36	Service water valve in CCW pump room removed for maintenance, shut down.	Manual isolation valves are used during maintenance. Applies to auxiliary building.
	47	Service water CCW heat exchanger discharge leakage, shut down.	Small leak. Applies to auxiliary building.

Table E.1-3 (Sheet 2 of 2). Plant-Specific Screening Service Water Flood Events

Class of Events	Event	Description	Plant-Specific Screening
	107	Service water to containment unit coolers leaked, both containment sumps unavailable (100,000 gallons).	Inside containment. Could apply to air conditioning units in auxiliary building and control building.
Outside (underground)	9	Construction debris pierced underground pipe, 50 gpm, shut down.	Could affect one ERCW header.
	50	Service water to RHR underground leakage, shut down.	Could affect one ERCW header.

Table E.1-4 (Sheet 1 of 2). Plant-Specific Screening of Fire Water Flood Events

Class of Events	Event	Description	Plant-Specific Screening
Inadvertent Actuation	18	Inadvertent actuation of deluge system when a pressure gauge was bumped. This caused a small leak of approximately 20 gallons.	Applicable to areas that have a deluge system.
	19	Inadvertent startup of fire protection system led to a water hammer event that forced open a deluge valve. Occurred when bulldozer sheared off a fire hydrant. This resulted in an insignificant leak.	Applicable to areas that have a deluge system.
	43(a)	Cable tray deluge inadvertently opened due to faulty deluge valves that opened when system repressurized. Occurred during shutdown. This resulted in a very large leak of approximately 28,000 to 30,000 gallons.	Applicable to areas that have a deluge system.
	109	While troubleshooting an electrical fault in an automatic fire suppression system, inadvertent actuation of the fire suppression system caused one train of a redundant safety feature actuation system to fail.	Applicable to areas that have a deluge system.
	110	Pump motor overheated, causing inadvertent actuation of fire suppression system. Some safety-related equipment suffered water damages.	Applicable to areas that have a deluge system.
	111	Ionization-type smoke detector in an HPCI room reacted to high temperature and humidity, inadvertently actuating an automatic sprinkler system. This caused a loss in HPCI system.	Applicable to areas that have a deluge system.
	112	Similar to event 111.	Applicable to areas that have a deluge system.

Table E.1-4 (Sheet 2 of 2). Plant-Specific Screening of Fire Water Flood Events

Class of Events	Event	Description	Plant-Specific Screening
	113/ 114	Two events resulted in unnecessary actuation of the deluge system for the main cooling towers due to the deactivation of the control system for maintenance work.	Applicable to areas that have a deluge system.
	115	Smoke from welding caused an inadvertent actuation of fire suppression system. Water damage caused inoperability of one train of the redundant containment atmosphere hydrogen recombiner system.	Applicable to areas that have a deluge system.
	117	During tests, actuation of several fire water suppression or sprinklers occurred. Tripped one RPS motor generator set and caused two dropped control rods.	Applicable to area that have a deluge system.
Leaks/Breaks	60	Underground fire main leak during construction. Potential cause due to large construction equipment.	Applicable but does not affect equipment inside buildings.
	97	Underground pipe ruptured with plant at power.	Applicable but does not affect equipment inside buildings.
	102	Pipe break (turbine building) at elbow during motor pump testing. Break detected when second pump auto started.	Applicable; is actually a small leak but has the potential to become very large.
	103	During fire hydrant repair of shutoff valve, it blew off. Occurred outside and at 100% power.	Applicable but does not affect equipment inside buildings.
	105	While modifying fire water system, water ran down into diesel generator control cabinet. Plant at power.	Applicable.
	116	A foam distributor system leaked water into the diesel fuel oil tank through an open valve.	Not applicable.

Table E.1-5 (Sheet 1 of 3). Plant-Specific Screening ECCS Flood Events

Class of Events	Event	Description	Plant-Specific Screening
Pump Related (except for high pressure pumps in operation)	39	Core spray relief valve lifted during test shutdown, 20,000 gallons diverted (1,000 gpm).	Relief valves discharge to PRT inside containment.
	40	Core spray pump seal leak, power (3 gpm).	Small, RWST source.
	55	AOV opened (RHR) during LOSP test, refueling (14 feet of water).	No fail-open AOVs. Not applicable design.
	92	Weld on RHR to CVCS letdown small line (3,000 to 7,000 gallons).	Could apply to RHR or CVCS in auxiliary building. RWST source.
Valve/Cooler Related (except for high pressure pump in operation)	28	LPI/DHR drain valve left open during maintenance, power (3 feet of water).	Small (1 inch or less). Pump rooms have flood alarms. Passive sump. RWST.
	46	RWCU 1-inch relief line for regenerator heat exchanger failed, power continued, isolated.	Small. Normal operating system.
	48	Fuel pool heat exchanger inlet vent line nipple ruptured from corrosion, power, 3,500 gallons.	Small. Applies to auxiliary building.
	70	DHR flow instrument valve weld, 2 gpm.	Small. Applies to RHR in auxiliary building. RWST source.
Inadvertent (spray) Actuation or Automatic Recirculation Alignment	43	Pressure switch shorted and actuated sprays and pumps shut down (30,000 gallons in drywell).	Water was inadvertently sprayed in containment. Not applicable to flooding equipment outside.
	54	Spray actuation due to maintenance error during refueling. 25,000 gallons in 3 minutes.	Inside containment. Not applicable to flooding equipment.
	101	Loss of power and improper relay set idle to spray actuation/recirculation valve reposition.	Inside containment. Not applicable to flooding equipment outside.

Table E.1-5 (Sheet 2 of 3). Plant-Specific Screening ECCS Flood Events

Class of Events	Event	Description	Plant-Specific Screening
	89	One train auto recirculation actuation during RWST level test.	Not applicable to flooding equipment unless it happens when equipment disassembled and unisolated.
	108	Inadvertent actuation in RHR during refueling due to low level false signal, overflowed to lower elevations.	Flooded the spent fuel pool. RWST.
High Pressure Pumps during Operation	8	RCIC/HPCI condenser ring header weld joint fail in the torus room after trip 80,000 gallons.	Event was second of its kind at same plant indicating design problem. No similar arrangement.
	6	HPCI gland steam condenser gasket blew after plant trip (power escalation testing).	Turbine-driven AFW pumps do not have gland steam condensers. Probably small.
	7	Same as event 6 one month earlier.	Same as item 6 above.
	25	HHSI test connection valve separated during test, pump secured (550 gallons), shut down.	Small. Would have an operator locally during AFW, safety injection tests to detect and isolate leaks.
	41	HPCI pump flange leak during test, detected by flood alarm, isolated, power.	Small. Applies to safety injection.
	42	HPCI steam supply drain line left open, sprayed during test, startup (750 gallons).	Small. Applies to turbine-driven AFW. Operator should be locally at the pump during tests.
	63	HHSI pump seal leak during response to safety injection, suction valve close (450 gallons).	Small. System must be operating. Operator should be locally at the pump during test.
	75	Charging seal injection line leak, 1.5-inch line lost flow to all RCP seals.	Small. Inside containment or auxiliary building. Caused a seal LOCA.
	78	HPCI test return line rupture.	Size not indicated. Applies, but operator should be locally at pump during test.
	79	HPCI test return line leak, < 5 gpm, power.	Small. Applies, but operator should be locally at pump during test.

Table E.1-5 (Sheet 3 of 3). Plant-Specific Screening ECCS Flood Events

Class of Events	Event	Description	Plant-Specific Screening
	84	Charging common suction line, 11 gpm at 80% power.	Small. Applies to normally operating systems in auxiliary building.
	88	3-inch crack in charging pump suction header vent valve, pumps unavailable.	Applies to normal operating systems in auxiliary building.
	90	Seal injection header drain valve leak, < 8 gpm.	Small. Applies to normal operating systems in auxiliary building or inside containment.
	91	Seal injection line elbow weld leak at power.	Small. Applies to normal operating systems in auxiliary building or inside containment.

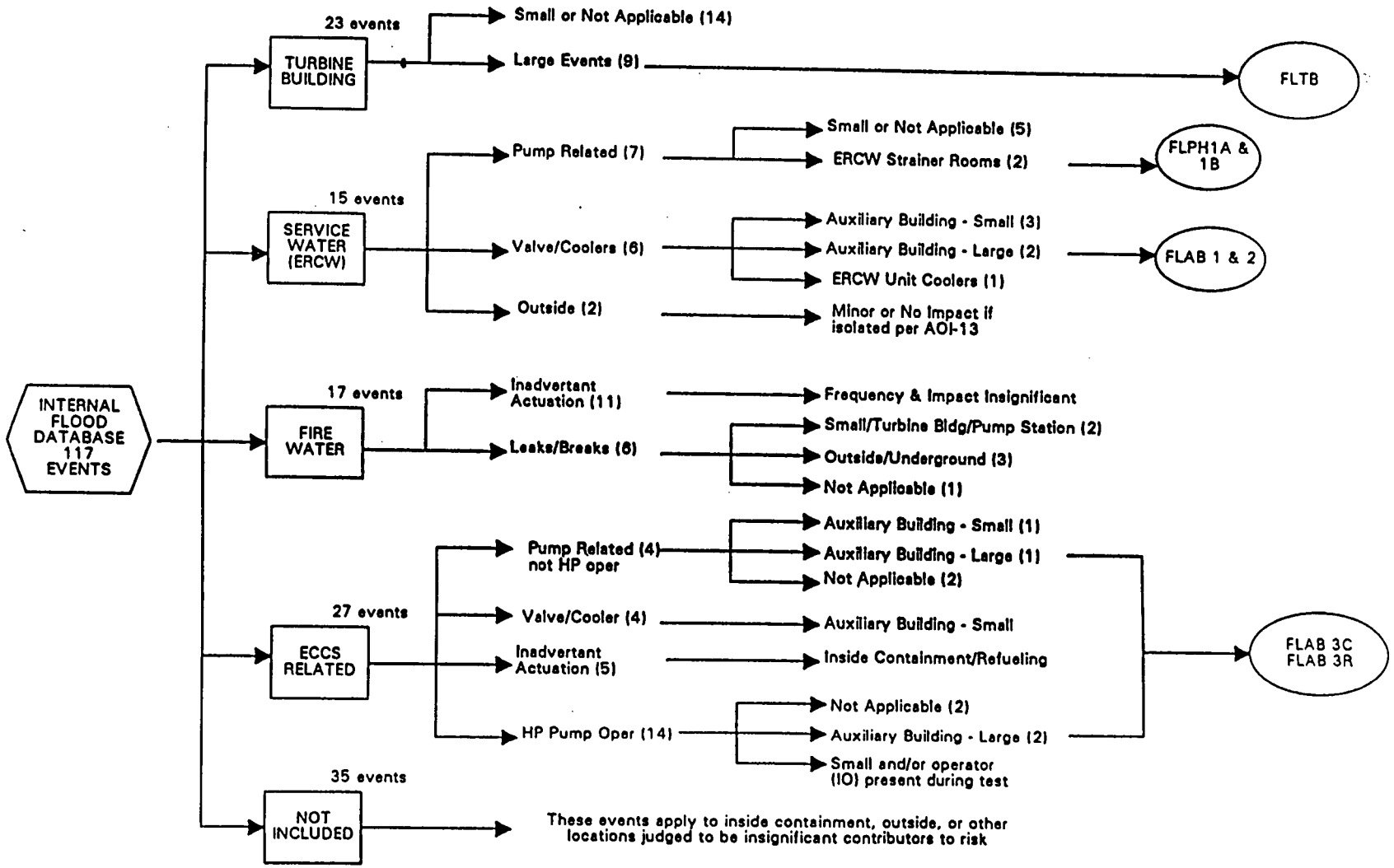

Figure E.1-1. Screening and Partitioning of Flood Events at Watts Bar

E.2 WATTS BAR INTERFACING SYSTEMS LOCA EVALUATION

E.2.1 INTRODUCTION AND SUMMARY

An interfacing systems loss of coolant accident (LOCA) is initiated by failures of valves that isolate the reactor coolant system (RCS) from low pressure systems located outside the containment. These interfaces between the RCS and low pressure systems can be important to risk because the low pressure system can rupture, leading to unavailability of the same emergency core cooling systems (ECCS) that are used to mitigate the event. In addition, reactor coolant escapes outside containment, permitting releases to bypass the containment.

This interfacing LOCA evaluation includes the identification and quantification of interfacing systems LOCA initiating events, an assessment of low pressure system failure modes and their probabilities, and an accident sequence analysis that considers operator and equipment response to these failures.

The following summarizes the procedure used to conduct this evaluation:

- Interfacing LOCA initiating event paths were identified. All containment penetrations that connect to the RCS were screened to identify the critical interfaces. This screening and the identification of interfacing LOCA initiating event paths are described in Section E.2.2.

- Initiating event models were developed and quantified for each interfacing LOCA path. Section E.2.3 describes the development of these models, and Section E.2.6 describes their quantification.

- For each interfacing LOCA path, an overpressurization analysis of the interfacing low pressure system is performed. Component materials, thickness, and their design pressures and temperatures are determined to evaluate failure modes in the low pressure system and their probabilities. Relief valves are identified, and their setpoints, capacities, and discharge paths are determined. The results of this analysis are used in the accident sequence and plant response analysis. The evaluation of low pressure systems design is presented in Section E.2.4.

- An accident sequence analysis incorporates the above evaluations and further evaluates operator response and systems that can be used to recover from an interfacing LOCA initiating event. This analysis includes consideration of plant response for a spectrum of interfacing LOCAs and the operator interface with emergency operating procedures. Event sequence diagrams (ESD) are used to document the accident sequence analysis. The accident sequence analysis is provided in Section E.2.5.

- The ESDs are converted to event trees to quantify accident sequences. Quantification of the interfacing LOCA initiating event, the event trees, and the event tree top event models is described in Section E.2.6.

The residual heat removal (RHR) system was identified as the most important system outside containment that interfaces with the RCS. The RHR system is a lower pressure

design, and both trains are crosstied together. If the system overpressurizes, the potential exists to fail both trains of RHR. Combined with a LOCA, this means containment sump recirculation will fail. If this occurs, it is important that the operators diagnose the event and isolate the LOCA and/or enter ECA-1.1, "Loss of RHR Sump Recirculation," early enough to prevent core damage.

A number of factors contribute to low probability of interfacing LOCAs at Watts Bar:

1. New check valves (74-544 and 74-545), added to protect each pump from the opposite train operation, isolate most of the RHR system from the four cold leg injection paths. These check valves isolate the RHR pumps, heat exchangers, and larger piping.

2. The RHR system is designed to 600 psig, and the materials and schedule of piping provide significant margins. In particular, the 8-inch piping downstream of the new check valves discussed above is very unlikely to rupture. Thus, cold leg injection path initiators that fail RHR are unlikely.

3. The total relief valve capacity of the RHR is approximately 1,700 gpm. This includes the two relief valves on the cold leg discharge headers (400 gpm each) and one relief valve on the hot leg suction path (900 gpm). In the case of the hot leg suction interfacing LOCA, all three of these would be available if the leak is large enough. Therefore, a 1,700-gpm leak is required to pressurize the RHR or a relief valve(s) must fail to open. In addition, the relief valves ensure that the RCS is being depressurized, which means that the pressure transient on the RHR system is not sustaining. This improves the chances that components do not heat up to higher temperatures coincident with high pressure, which would increase the probability of failure.

The following summarizes the quantitative results of the interfacing systems LOCA analysis:

- VI — Cold Leg Injection Path Interfacing LOCA Initiating Event (≥ 150 gpm)

$$\boxed{VI = 4.0 \times 10^{-6} \text{ per year}}$$

- VS — Hot Leg Suction Path Interfacing LOCA Initiating Event (≥ 150 gpm)

$$\boxed{VS = 7.2 \times 10^{-6} \text{ per year}}$$

- Core Damage with Containment Bypass

$$\boxed{4.1 \times 10^{-8} \text{ per year}}$$

Initiating event VS dominates the core damage result because the probability of piping rupture is higher than initiating event VI. The following results of the RHR overpressure evaluation significantly contribute to the low risk calculated:

- The probability of failing the 8-inch piping or valves downstream of the new check valves 74-544 and 74-545, given initiator VI and relief valves discharging 800 gpm to PRT:

$$\boxed{0.05}$$

- The probability of failing the RHR system, given initiator VS and relief valves discharging 1,700 gpm to PRT:

$$\boxed{0.7}$$

The importance of the relief valves and the RHR overpressure design capability can be seen by quantifying the event trees in Section E.2.6 with no credit for operator actions (all operator action split fractions in event tree set to 1.0). The annual frequency of core damage with bypass is

$$\boxed{3.5 \times 10^{-7}}$$

The LOCA outside containment core damage frequency when not mitigated by operators (Top Events VI9 and VSA set to guaranteed failure) is approximately an order of magnitude greater. These results also indicate that the risk is small even when no credit is given to operator response to a LOCA outside containment.

E.2.2 IDENTIFICATION OF INTERFACING LOCA PATHS

As described previously, an interfacing LOCA is initiated by failures of valves that isolate the RCS from low pressure systems located outside the containment. Therefore, by definition, an interfacing LOCA path must penetrate the containment and connect to the RCS. All such penetrations are identified by reviewing the FSAR listing of primary containment penetrations (Reference E.2-1) and the systems flow diagrams that are also identified in Reference E.2-1. Those containment penetrations that connect to the RCS and are greater than 1 inch in diameter are listed in Table E.2-1.

A screening evaluation of the penetrations in Table E.2-1 determines the paths to include as initiating events in the interfacing LOCA model. The purpose of the screening is to identify the most risk-significant paths to model, recognizing that the other paths would not contribute significantly to risk. To make this judgment, the paths chosen should be the more likely initiating event paths and have the more significant impact on mitigating systems located outside containment. The following summarizes the design features considered in the screening evaluation:

- Design and operating pressure of components/systems outside the containment.

- The number, type, and normal position of isolation valves between the RCS and components/systems outside the containment.

- Pipe diameter of path.

- Potential consequences from failure of valves in the path and/or from pipe failure outside the containment.

A positive combination of two or more of the above design features will usually justify a judgment of low risk. For example, a small line outside containment would only lead to a small LOCA, and the consequences on mitigating systems would typically be minimal. Clearly, the penetrations chosen as most important interfacing LOCA paths do not satisfy positive aspects of the above design features. For example, the low pressure injection paths are large pipe diameters, there are two isolation check valves in series that isolate the low pressure design outside containment, and the potential consequences include failure of both low pressure injection trains. (Containment sump recirculation also becomes unavailable.)

Based on the above evaluation, the following interfacing LOCA paths are identified and analyzed further:

- Low head safety injection to the cold legs. As shown in Figure E.2-1, there are four interfacing LOCA paths, and each path has two check valves in series.

- RHR suction line from hot leg number 4. As shown in Figure E.2-2, there are four normally closed MOVs in this path.

The following interfacing LOCA initiating events are defined to represent the above paths:

- **VI.** An interfacing LOCA initiated by one of the four low head injection paths to the cold legs.

- **VS.** An interfacing LOCA initiated by the RHR suction path from hot leg number 4.

Given the identification of interfacing LOCA initiating event paths, the next steps are to establish failure modes for each initiating event and to collect more detailed design information on each low pressure system path outside containment. This is described further in Sections E.2.3 and E.2.4. The failure models and data developed in Section E.2.3 establish the initiating event portion of the model. The more detailed design information and overpressure analysis described in Section E.2.4 support the event sequence analysis tasks.

E.2.3 INITIATING EVENT MODELS AND DATA

E.2.3.1 Valve Leakage Events

An interfacing LOCA can be initiated by a spectrum of leakage events that range from a small leak that exceeds the makeup capacity of the charging system and challenges relief valves in the low pressure system to the catastrophic failure of a valve that structurally

challenges the interfacing low pressure system. Watts Bar valve design data are summarized in Table E.2.2.

Figure E.2-3 presents the frequency of exceeding check valve leakage rates from industry experience. These experience data were developed from a review of all check valve failure events in U.S. light water reactors during the period from 1972 through 1984 as reported in *Nuclear Power Experience* (Reference E.2-2). Among the several hundred check valve failures identified, only those associated with PWR, ECCS, and RCS were considered to be the most relevant for the valves considered here, which are initially seated and testable. No disc rupture event was identified, and the maximum leak rate observed was 200 gpm.

A total exposure time of 1×10^8 check valve hours was estimated by counting the number of check valves in all power plants in the database of the RCS and ECCS systems (Reference E.2-3). A best line fit to the data was obtained using Bayesian regression techniques (Reference E.2-4), and it is presented along with the calculated bounds at 90% confidence in Figure E.2-3.

From the data in Figure E.2-3, the frequency of random valve disc failures resulting in different leakage rates can be obtained as input to the initiating event quantification. Although the data are for check valves, it is assumed that they are also applicable to MOVs.

E.2.3.2 Initiating Event Failure Models

As described in Section E.2.2, interfacing LOCA initiating events are caused by failure of two valves in series, allowing the RCS to pressurize the lower pressure system outside containment. In general, the frequency of failure of two valves, V1 and V2, in series can be expressed as (Reference E.2-5):

$$\lambda_s(2V) = \lambda(V1)*F(V2/V1) + \lambda(V2)*F(V1/V2) \qquad \text{(E.2.1)}$$

where

$\lambda_s(2V)$ = the failure probability of two valves in series.

$\lambda(V1)$ = the independent failure probability of V1.

$\lambda(V2)$ = the independent failure probability of V2.

$F(V2/V1)$ = the conditional failure probability of V2, given that V1 has failed.

$F(V1/V2)$ = the conditional failure probability of V1, given that V2 has failed.

F(V1) is not necessarily the same as F(V2), as the valves experience different operating conditions; for example, valve V1 experiences a higher differential pressure as it is closer to the reactor vessel. When valve V1 leaks, the space between the valves, V1 and V2,

becomes pressurized. If the fraction of time that valve V1 experiences leakage is called P_l, Equation (E.2.1) becomes

$$\lambda_s(2V) = \lambda(V1)*F(V2/V1)*(1-P_l) + \lambda'(V1)*F'(V2/V1)*P_l + \lambda(V2)*F(V1/V2)*(1-P_l) + \lambda'(V2)*F'(V1/V2)*P_l \quad \text{(E.2.2)}$$

where the primes indicate failure probabilities with a pressurized space between the valves. With leakage of valve V1, the higher differential pressure exists across valve V2 instead of valve V1. Given this fact, the following assumptions are made to simplify Equation (E.2.2):

(a) $\lambda'(V2) \simeq \lambda(V1)$

(b) $\lambda'(V1) << \lambda(V1)$

(c) $\lambda(V2) << \lambda'(V2)$

(d) $F'(V1/V2) \sim F(V2/V1)$

Assumption (a) states that the failure probability of either valve, given high differential pressure, is approximately equal. Assumptions (b) and (c) state that the failure probability of either valve under low pressure loading is smaller than the failure probability under high pressure loading. Assumption (d) states that the conditional probability of one valve under low pressure loading, given the failure of a valve under high pressure loading, is approximately the same for the pressurized and unpressurized conditions. Under these assumptions, Equation (E.2.2) becomes

$$\lambda_s(2V) = \lambda(V1)*F(V2/V1) + \lambda'(V1)*F'(V2/V1)*P_l + \lambda(V2)*F(V1/V2)*(1-P_l) \quad \text{(E.2.3)}$$

To further simplify Equation (E.2.3), the following assumptions are made:

(e) $\lambda(V1) >> \lambda(V2)$

(f) $F(V2/V1) \geq F(V1/V2)$

(g) $\lambda(V1)*F(V2/V1) > \lambda'(V1)*F'(V2/V1)$

Assumption (e) is the same as assumptions (b) and (c) above; a valve with high differential pressure loading has a higher probability of failure than a valve with low differential pressure loading. Assumption (f) states that the probability of random failure of valve V1 contained in F(V1/V2) is less than or equal to F(V2/V1), which contains the probability of failure of valve V2 due to shock impact after valve V1 fails as well as the random failure of valve V2.

Combining assumptions (e) and (f) results in assumption (g). From the latter assumption, it is conservative estimate that

$$\lambda(V1)*F(V2/V1) = \lambda'(V1)*F'(V2/V1) \quad (E.2.4)$$

Following assumptions (e), (f), and (g) and Equation (E.2.4), Equation (E.2.3) can be rewritten as:

$$\lambda_s(2V) = \lambda(V1)*F(V2/V1)*(1+P_l) \quad (E.2.5)$$

The fraction of time, P_l, that the space between the valves is pressurized is between 0 and 1. As only a small amount of leakage is required to pressurize the space between the valves, P_l is conservatively assumed to be equal to 1, and Equation (E.2.5) becomes

$$\lambda_s(2V) = 2*\lambda(V1)*F(V2/V1) \quad (E.2.6)$$

Therefore, a conservative expression for the probability of failure of two valves in series is twice the product of the failure probability of a single valve (under high differential pressure) and the conditional failure probability of the second valve, given that the first has failed.

E.2.3.2.1 Failure of Two Cold Leg Injection Check Valves

Initiating event VI represents failure of two series check valves in any low head injection line. The following failure modes apply to the failure of two check valves in series:

1. Rupture of valve V1, which goes undetected, and then valve V2 ruptures between tests.

2. Rupture of valve V1, and then rupture of valve V2 on demand.

The failure mode, "V1 stuck open after test and V2 ruptures," does not apply as the RHR cold leg injection valves (63-560, 63-561, 63-562, 63-563, 63-632, 63-633, 63-634, and 63-635) are leak tested at least once every 18 months (surveillance instruction 1-SI-4.0.5.63.C.1.T.S, Rev. 0, Technical Specification 4.4.6.2.2). Valve seating is verified at this time, and the valves are not tested during operation.

The expression for the probability of failure of two check valves was given in Equation (E.2.6). The term F(V2/V1) in this equation contains two components, failure modes 1 and 2 above. To derive an expression for Equation (E.2.6) in terms of known failure frequencies, the frequency of mode 1, random valve failure, will be determined first.

As shown in Section 6.6 of the Seabrook Station PSA (Reference E.2-6), the determination of the frequency of occurrence of random failures may be accomplished by assuming that the two series check valves in each path represent a standby redundant system, and failure of the downstream check valve cannot occur until failure of the valve with the high

differential pressure loading has occurred. The probability of random failure (unreliability) for a single injection path is given by

$$Q_{path} = 1 - e^{-\lambda(V1)t}[1 + \lambda(V1)t] \quad (E.2.7)$$

In this analysis, $\lambda(V1)$ is the failure frequency of exceeding leakages of 150 gpm. This expression is then used to derive a failure (hazard) rate for the path:

$$\lambda_{path}(t) = -1/(1 - Q_{path}) * d/dt[1 - Q_{path}] \quad (E.2.8)$$

or, substituting using Equation (E.2.7):

$$\lambda_{path}(t) = \lambda(V1)/[1 + 1/\lambda(V1)t] \quad (E.2.9)$$

As the plant goes into cold shutdown every 18 months, at which time the valves are inspected, the time-dependent failure rate, Equation (E.2.9), is bounded at $T_s = 18$ months. Therefore, Equation (E.2.9) is integrated over a time T to obtain the average failure rate over 1 year:

$$\lambda_{path} \text{ (per year)} = [\lambda(V1)T_s - \ln(1 + \lambda(V1)T_s)]/T \quad (E.2.10)$$

When $\lambda(V1)T_s << 1$, this result can be expanded using a limiting procedure to obtain:

$$\lambda_{path} \text{ (per year)} = \lambda^2(V1)T_s^2/2T \quad (E.2.11)$$

The rupture on demand component of the path failure frequency, failure mode 2 above, is merely the product of $\lambda(V1)$ and the rupture on demand failure rate F_d. This factor is multiplied by 2, as in Equation (E.2.6), because of two possible combinations of valve failures. Thus, Equation (E.2.11) can be expanded to include the rupture on demand failure; thus, the final expression for failure of two check valves is

$$\lambda_{path} \text{ (per year)} = \lambda(V1)[\lambda(V1)T_s/2 + 2F_d] \quad (E.2.12)$$

The contribution from failure mode 1 above does not include the factor of 2 from Equation (E.2.6) because it does not apply for the case of V2 (RHR side valve) rupture first or stuck open. This failure mode would drain the accumulator and be detected in the control room.

Initiating event VI is a specific case of a path with two series check valves. As there are four injection lines, the final equation for path, VI, is

$$\lambda(VI) = 4*\lambda(V1)[\lambda(V1)T_s/2 + 2F_d] \quad (E.2.13)$$

where λ is the failures per hour.

E.2.3.2.2 Failure of Four Motor-Operated Valves

Initiating event VS represents failure of two sets of two parallel MOVs in series in the RHR suction path from hot leg #4. The following failure modes apply to the failure of two MOVs in series:

1. Rupture of valve V1, which goes undetected, and valve V2 ruptures between tests.
2. Rupture of valve V1, and then valve V2 ruptures on demand.

Spurious actuation is not included as a failure mode because several conditions are required to open MOVs 74-1, 74-2, 74-8, and 74-9. Power is normally removed from the valve control circuits to prevent spurious actuation.

RHR isolation MOVs (74-1, 74-2, 74-8, and 74-9) are stroke tested for operability only during cold shutdown conditions, as exercising the valves during normal operations results in overpressurizing the RHR system. The failure mode "MOV indicates closed but is open after test" does not apply in this analysis because the MOVs 74-1, 74-2, 74-8, and 74-9 are equipped with stem-mounted limit switches, which are tested at least once every 18 months, as required by Technical Specification 4.4.6.2.2 (Reference E.2-7).

The expression for failure modes 1 and 2 for two series MOVs is similar to Equation (E.2.12) developed above, with the addition of a factor of 2 for the first failure mode, following the logic of Equation (E.2.6):

$$F_{path} = F(V1)[F(V1)T_s + 2F_d] \qquad \text{(E.2.14)}$$

Because this path consists of two sets of two parallel MOVs (Figure E.2-2), there are four possible combinations of two MOVs in series. Therefore, the equation for initiating event VS is as follows:

$$\lambda(VS) = 4*\lambda(V1)[\lambda(V1)T_s + 2F_d] \qquad \text{(E.2.15)}$$

E.2.4 OVERPRESSURIZATION ANALYSIS

E.2.4.1 RHR System Design

In Section E.2.2, the RHR system was identified as the most important interfacing LOCA system. The potential interfacing LOCA paths include the four cold leg injection paths and the suction path from the hot leg No. 4. These paths are shown in Figures E.2-1 and E.2-2 along with the RHR pump, heat exchangers, and other major valves. RHR system flow is through the tube side of the heat exchangers (U tube type). The RHR pumps are the vertical, centrifugal type with mechanical seals to prevent RCS leakage. The RHR system also includes pipe flanges at the following locations:

- Spool piece for temporary strainers in the pump suction.
- Air-operated butterfly valves 74-16, 74-28, and 74-32.
- Heat exchangers and pumps.
- FE-74-12 and FE-74-24.

The RHR system is equipped with the following relief valves that discharge to the PRT inside containment:

Relief Valve	Location	Capacity
63-626	Line to Cold Leg injection	400 gpm at 600 psig
63-627	Line to Cold Leg injection	400 gpm at 600 psig
74-505	Suction line - Hot Leg	900 gpm at 450 psig
63-637	Line to Hot Leg injection	20 gpm at 600 psig

The RHR system is designed to 600 psig and 400°F, and the material of major components (piping, valves, heat exchangers, and tubes) is austenitic stainless steel. The pumps are carbon steel clad with stainless steel. Portions of the RHR system that isolate the system from reactor coolant pressure are designed to 2,485 psig and 650°F. This interface is shown in Figures E.2-1, E.2-2, and E.2-4.

The following summarizes piping material and pipe schedules for that portion of the RHR system designed to 600 psig:

Diameter (inches)	Material	Schedule
4 and smaller	ASME SA 312, Type 304	40S
8	ASME SA 312, Type 304	40S
10	ASME SA 312, Type 304	40S
12	ASME SA 358, Type 304	40S
14	ASME SA 358, Type 304	40

E.2.4.2 RHR Overpressure Evaluation

When an interfacing systems LOCA initiates, the RHR system can be pressurized up to the full RCS pressure. This would occur if leakage exceeds the capacity of the RHR relief valves or if the relief valve(s) did not open for smaller leaks. It is the overpressurization of the RHR system to RCS conditions that is evaluated in this section. The following two additional, nonstatic failure modes have been considered in previous analyses and can be neglected:

- **Dynamic Shock Effects.** A worst case scenario, postulated to be initiated by a sudden, complete rupture of the discs in two series of valves, will not cause stresses on piping greater than the equivalent to full RCS pressure (Reference E.2-8).

- **Water Hammer Events.** Previous analyses have shown that the frequency of unfilled piping in combination with the probability of pipe failure due to water hammer is small compared to the frequency of RHR piping or seal failure from static overpressurization (Reference E.2-8).

The overpressure analysis described below has been taken from Reference E.2-9.

The failure pressures developed here are based on the material strengths and methods outlined in Reference E.2-10.

A range of temperature from room temperature to 800°F is considered. All temperatures are assumed to be material temperatures rather than fluid temperatures. Unless leak areas are presented for a given component and failure mode, failure pressure is considered to result in a large, uncontrolled leak area.

It is assumed that the pressure capacities have a lognormal distribution. This assumption is made because a lognormal distribution has been shown to be a valid description of the variability in material strengths. In addition, for a random variable that can be expressed as the product and quotient of several random variables, the distribution of the dependent variable tends to be lognormal regardless of the distributions of the independent base variables.

With the pressure capacity assumed to be a lognormal random variable and denoting it as P, the probability of failure occurring at a pressure less than or equal to a specific value p is expressed as:

$$P_f = \text{Prob}\ (P \leq p) = \phi \left[\frac{\ln\ (p/\hat{P})}{\beta_c} \right] \qquad \text{(E.2.16)}$$

where

P_f = probability that failure occurs at a pressure $P \leq p$.

P = random pressure capacity.

p = specific pressure

β_c = logarithmic standard deviation of P.

$\hat{P}$ = median pressure capacity.

Φ (.) = cumulative distribution function for a standard normal random variable.

In Equation (E.2.16), the pressure capacity for a given failure mode is probabilistically described by the following expression:

$$P = \hat{P} \bullet M \bullet S \qquad \text{(E.2.17)}$$

in which $\hat{P}$ is the median pressure capacity, M is a lognormally distributed random variable having a unit median and a logarithmic standard deviation β_M representing the uncertainty in modeling, and S is also a lognormally distributed random variable with a unit median value and a logarithmic standard deviation β_S representing the uncertainty in the material properties. The overall uncertainty in the median capacity is obtained by taking the square root of the sum of the squares of β_M and β_S.

The median pressure capacity represents the internal pressure level for which there is a 50% probability of failure (leakage or burst) for a given failure mode. The median values are evaluated from limit state analyses for the different failure modes. The uncertainties, β_M and β_S, are associated with variability due to a lack of knowledge related to differences

between the analytical model and the real structure. Modeling uncertainties are associated with the assumptions used to develop analytical models and their ability to properly represent the failure condition. The strength uncertainties are associated with variabilities related to the material resistance. Examples of the sources of strength uncertainties include variability in steel yield and ultimate strengths, stress-strain relationships, and the influence of elevated temperatures on material strength.

Uncertainties will exist in the estimated pressure capacities due to differences between the analytical idealization of the structure and the real conditions. There are numerous possible sources of modeling uncertainties. Examples of the sources of modeling uncertainties include assumptions used to develop the internal force distributions, failure criteria, and the use of empirical formulae. Moreover, since the uncertainties are dependent on the particular failure mode under consideration, they must be evaluated on a case-by-case basis. However, in many instances, the evaluation of these uncertainties would require very detailed analysis and/or extensive data that may not be available. As a result, it was necessary to use subjective evaluation and engineering judgment to estimate these uncertainties.

E.2.4.2.1 Pipe

The RHR piping of interest includes various diameters up to 24 inches, and both 304 and 316 stainless steel is used. Depending on the location in the system, wall thicknesses vary from 0.375 inch for several large-diameter pipes to as heavy as Schedule 160.

Table E.2-3 shows median failure pressures for the pipe sizes of importance in the RHR system. Pipes with diameters less than 4 inches have capacities above the range of interest. Pressure capacities for a temperature range from room temperature to 800°F are given. In addition to the base condition of no corrosion, pressure capacities for 0.02 and 0.04-inch corrosion are also shown.

Variabilities for the above failure pressures are shown in the table below. The variabilities are different for the 304 and 316 stainless steels, as noted, and are also temperature dependent. The variabilities include estimates of the variation in material strength, stress/strain relations, biaxial strain effects, the possibility of large pipe bending stresses due to thermal expansion of pipes designed for lower temperature service, and the possibility of partial through wall flaws. Although the possibility of a major partial through wall flaw probably increases with the number of pipe segments and welds in a given piping run, the relatively large variability associated with piping failure should at least initially permit treating a given pipe run as a single element in the risk analysis, regardless of the number of segments and welds in the line.

Temperature (°F)	Lognormal Standard Deviation	
	304SS	316SS
Room	0.22	0.18
400	0.33	0.22
600	0.36	0.24
800	0.39	0.26

E.2.4.2.2 Gasketed Flange Connections

Most of the piping joints in the Watts Bar RHR system are full penetration butt welds. However, gasket flange connections are present at the pump inlet strainer (14-inch, 300-pound rated) and at the 74-16, 74-28, and 74-32 air-operated Fisher Continental butterfly valves, which are 8-inch, 300-pound flanges.

The flanges are standard ANSI 300-pound flanges with Flexitalic raised face-type CG spiral-wound 304 SS and asbestos gaskets (Reference E.2-11). The flanges are secured with SA-453, Grade 660 studs or better, torqued to produce initial stresses of from 30,000 to 60,000 psi.

The behavior of gasketed flanges under pressure and temperature conditions is quite complex. The variables affecting the leak pressure and the methodology used to develop the gross leak pressure (GLP) and leak rates and leak areas for bolted flanges is discussed in Reference E.2-10. The definition of the onset of gross leakage, or gross leak pressure, as the point at which the gasket stress is equal to the pressure being retained, is used quite generally in the gasket industry. For pressures less than GLP, the mass leak rate is calculated from the results of gasket leakage tests with water reported in Reference E.2-12. Leakage of this form is related to the presence of the seams and crevasses in the flange/seal joint rather than to any apparent leak area. For pressures above the GLP, it was judged that the leakage is no longer due to seams and crevices in the flange/seal joint but primarily due to actual separation of the flange and gasket. Thus, a leak area is calculated that is intended to be in addition to the leak rate calculated at GLP. The leak area is calculated as the mean gasket perimeter times the separation distance at the gasket. The separation distance is affected by bolt extension, gasket recovery, and flange flexibility. Of these, the contribution of the bolt extension is by far the most dominant.

Gross leak pressures, leak rates, and leak areas for 8-inch and 14-inch 300-pound flanges are shown in Table E.2-4 for several initial bolt stress and joint relaxation conditions. It is seen that GLP increases and the mass leak rate decreases with increasing initial bolt stress. The leak area decreases with an increase in initial bolt stress because the increased bolt stress creates a greater lock-up force that must be overcome before the gasket begins to unload. It can be noted that for 300-pound flanges, the joint relaxation has little effect on the flange leak resistance. Since the bolt yield stress is not exceeded for up to two times GLP, a variation in bolt yield stress of the magnitude expected for the SA-453, Grade 660 bolts has no effect on the results.

Assuming that 35,000-psi initial bolt stress and 25% joint relaxation represent median-centered values, median GLP of about 2,470 psig for the 8-inch flanges and 2,790 psig for the 14-inch flanges are indicated. A lognormal standard deviation of 0.14 is recommended for the 8-inch GLP, with 0.16 for the 14-inch GLP.

The mass leak rates for pressures less than the GLP are low for the 300-pound rated flanges, and the GLPs are high for the median case. A variability of 0.54 for the leak rates for both flanges is used in accordance with Reference E.2-10. Similarly, the leak areas for the flanges are also relatively low, and a combined variability of 0.12 is recommended for the leak areas of both sizes of flanges.

E.2.4.2.3 Valves

Three failure modes are postulated for the various valves present in the Watts Bar RHR system. These include failure of the valve body, failure of the stem packing or packing retention flange, and failure of the bolted bonnet. Since the valve body thickness is typically significantly greater than that of the adjacent piping, it was judged that failure of the adjacent piping will occur prior to failure of the valve body. Also, the types of valve stem packing used in the valves tend to compress under high pressure conditions, providing a greater resistance to leakage. Although it is certainly possible that the stem packing for some valves could deteriorate in response to service conditions, it was judged that any resulting leak would be quite small and would have a negligible effect on both the valve and system operation. Thus, it was assumed that the only credible failure mode for the RHR system valves pertains to failure of the bolted bonnet seals.

The bolted bonnet valves are sealed using style R spiral wound gaskets compressed between the bonnet and valve body, which are machined in a tongue and groove configuration. Most valves of interest in the RHR system are 300-pound rated. The Westinghouse valves all use SA-453 Grade 660 bonnet bolts, which have ASME Code room temperature yield and ultimate strengths of 85 and 130 ksi, respectively. The Anchor Darling 74-544 and 74-545 8-inch swing check valves use SA 564-630-1100 bonnet bolts, which have ASME Code room temperature strengths of 115 and 140 ksi, respectively. Thus, yielding of the high strength bonnet bolts is not expected for any of the Watts Bar RHR valves for the pressures of interest.

Bolted bonnet valve gasket and bolting data for the RHR valves of interest are shown in Table E.2-5.

Table E.2-6 shows the corresponding median valve gross leak pressures, leak rates, and leak areas. A lognormal standard deviation of 0.54 is recommended for bonnet leak rates and 0.12 for leak areas for all valves listed in Table E.2-6.

Valves smaller than 3 inches typically have very high pressure capacities. The valve bodies are normally relatively thick, and often a threaded and seal welded bonnet are used. The 74-16, 74-28, and 74-32 air-operated Fisher Continental butterfly valves are considered to be controlled by the 8-inch, 300-pound rated flanges discussed in the previous section.

E.2.4.2.4 RHR Heat Exchanger

The RHR heat exchanger is a U-tube heat exchanger mounted vertically. The tube side of the heat exchanger is the concern for interfacing systems LOCA. The tube side cylinder (channel) is a 1-inch-thick, 37-inch O.D. cylinder fabricated from SA-240 type 304 stainless steel. The 2:1 semiellipsoidal head is also 1-inch-thick 304 stainless steel. The U-tubes are ⅝-inch O.D. No. 18 B.W.G. SA-249 type 304 stainless steel. The tube sheet is 46-inch O.D. by 5⅝ thick with a ¼-inch 304 weld overlay and is secured to the channel and shell side flanges by 52 1⅛-inch studs torqued to 600 foot-pound. Sealing is provided by spiral wound gasket with 40-inch I.D. and 41½-inch O.D.

Potential failure modes investigated include failure of the channel cylinder due to hoop stress, plastic collapse of the dished head, failure of the U-tubes, and leakage past the tube sheet flange. The median failure pressures for the cylinder and dished head buckling capacities together with their respective variabilities are shown in the following table.

Temperature (°F)	Tube Side Cylinder*		Tube Side Head Buckling*	
	$\hat{P}$ (psig)	β	$\hat{P}_o$ (psig)**	β
Room	3,190	0.19	4,380	0.19
400	2,930	0.30	2,680	0.23
600	2,790	0.33	2,260	0.23
800	2,620	0.37	1,900	0.24

*All leak areas are large, uncontrolled leaks.
**Assume 0.2 probability of crack formation, given head buckling occurs.

The pressure capacity of the tubes is well above the range of interest. Median gross leak pressures, leak rates, and leak areas for the tube sheet for several cases of assumed joint relaxation are shown in Table E.2-7.

Assuming an initial bolt stress of 45,000 psi and 15% joint relaxation represent the median conditions, a median GLP of about 920 psig with a lognormal standard deviation of about 0.13 are indicated for the tube sheet flange leakage. A variability of about 0.12 on leak area is recommended.

E.2.4.2.5 RHR Pump

The RHR pump is a single-stage centrifugal pump mounted vertically. The pump casing and stuffing box extensions are SA 182 F 304 stainless steel. The twenty-four 2-inch-diameter box studs are SA-453 Grade 660 torqued to 2,625 foot-pound (Reference E.2-13).

The shaft seal is a tungsten carbide/carbon face seal. The gland ring is SA 240 type 316 stainless steel, which is held in place by four ¾-inch-diameter studs on a 7¼-inch-diameter bolt circle torqued to 80- to 90-foot pound.

The pump was designed for 600 psi operating pressure at 400°F, with a design capacity of 3,000 gpm at 1,780 rpm. A maximum flow of 5,000 gpm during a LOCA may be obtained.

Potential failures of the RHR pump due to interfacing systems LOCA conditions include fracture of the casing or stuffing box extension, leakage past the casing/stuffing box extension, gasket lift off of the gland ring, or crushing of the carbon face seal element. The internal pressure capacity of the RHR pump is expected to be high and failure modes to be controlled by leakage past the stuffing box extension/casing gasket.

Assuming that an initial bolt stress of 35,000 psi and a 15% joint relaxation represent the median conditions, a median GLP of about 2,190 psig and lognormal standard deviation of about 0.16 result (Table E.2-8).

The next failure mode is expected to be crushing of the stationary carbon face seal at a median pressure of about 2,700 psig. A lognormal standard deviation of about 0.35 is associated with this failure pressure. A median leak area of about 1.0 square inches with a lognormal standard deviation of about 0.5 is expected as a result of seal failure. The pressure capacities of the other potential failure modes are expected to have somewhat higher capacities.

E.2.5 EVENT SEQUENCE ANALYSIS

E.2.5.1 Overview of Plant Response

An interfacing LOCA is initiated by leakage of reactor coolant through valves that separate the RCS from the RHR system. The initiating event for this analysis is a leak that causes loss of RCS inventory to exceed the makeup capacity of the CVCS (about 150 gpm). Smaller leaks would not cause an immediate plant trip, although leakage greater than the technical specification limits would result in a controlled shutdown. The sequence timing and impact of a small leak are judged to be insignificant in comparison to the larger leaks included in this analysis.

Pressure and/or temperature indications and alarms would alert the operators in the control room of overpressure conditions in the RHR system. In addition, leakage will also be revealed when RHR relief valves open, pressurizing the PRT. PRT pressure, temperature, and level indication and alarms exist in the control room. Eventually, the PRT will overpressurize, and containment pressure will rise. Therefore, the RCS system will exhibit conditions of a small break LOCA inside containment even if the RHR system is not breached. For large leakage events, a safety injection signal and these LOCA inside containment conditions can occur almost immediately.

For small leaks, flow through the RHR system and out the relief valves is governed by the interfacing LOCA leak size. RHR system pressure is determined by the relief valves. As the interfacing LOCA rupture size increases, causing RHR system pressure to exceed the relief valve settings, relief valve flow would become choked. The relief valve discharge would determine flow rate, and the interfacing LOCA rupture size would determine the pressure.

Modular Accident Analysis Program (MAAP) calculations have been performed for similar designed systems but not Watts Bar. For the generic MAAP calculation, it was assumed that the suction line isolation valves disappeared, and it was also postulated that both RHR pump seals ruptured. This created a leakage path out of the system equivalent to 2.6 square inches in addition to the RHR relief valve discharge. These calculations indicate that high pressure injection would occur in about 5 seconds, the PRT rupture disc would fail in less than 30 seconds, and the RCS pressure would decay to below the injection line relief valve setpoint in less than 12 minutes and to about 250 to 350 psi in a little more than 1 hour. The primary system pressure would remain above 250 psi until the RWST becomes depleted without operator action to depressurize and cool down. The RWST would be depleted in about 6 hours. In the case of Watts Bar, containment spray would initiate early, causing the RWST to be depleted much earlier (< 1 hour).

This event would be considered terminated by reducing the leak rate out the primary system to less than 150 gpm. This is achieved by either isolating the leak or depressurizing the RCS to limit break flow. Emergency procedure ECA-1.2, "LOCA Outside Containment," provides instructions on isolating a LOCA outside containment. If the LOCA cannot be isolated, ECA-1.2 instructs operators to go the ECA-1.1, "Loss of RHR Sump Recirculation," to conserve the RWST. Emergency procedure ECA-1.1 instructs the operators to initiate makeup to RWST and reactor coolant cool down to cold shutdown.

The above analysis indicates the reactor coolant system and, thus, the RHR system is at its maximum pressure of 2,235 psig for only a few seconds. The hydrostatic stresses experienced by RHR components decay away quite rapidly, indicating that subsequent failures due to the combination of sustained high pressure and temperatures become less likely. In addition, the response of the plant and its operators may initially be that for a small LOCA inside containment. In fact, if no breaches of the RHR pressure boundary occur, the event may be treated as a LOCA.

In the case of Watts Bar, containment spray initiation is set at 2.81 psid in the containment, and the total capacity of the two spray pumps is approximately 8,000 gpm. The two spray pumps could empty the RWST in less than an hour if the operators do not stop the pumps. Therefore, transfer to containment sump recirculation is expected to occur early unless the interfacing LOCA is isolated.

Figure E.2-5 provides a summary event sequence diagram regarding operator response and the emergency operating instructions that was developed for Sequoyah. The Watts Bar Emergency Instructions (Reference E.2-14) are similar to those for Sequoyah. However, the Watts Bar procedures were frozen about 1986 with ECA 1.1 and ECA 1.2 incomplete (drafts). In addition, there will be improvements to both Sequoyah and Watts Bar as they upgrade to later versions of the Owner's Group generic procedures. For these reasons, no special effort was made to develop Watts Bar-specific event sequence diagrams. The following discussion and event sequence response were developed from the Sequoyah analysis and are considered to be applicable to Watts Bar.

Emergency Instruction E-0, Step 21 instructs operators to check containment conditions (pressure, radiation, sump level, and temperature) and if any condition is high, go to E-1, "Loss of Reactor or Secondary Coolant." This is likely to occur before the operators reach E-0, Step 26, which checks auxiliary building radiation due to a LOCA outside

containment. RHR relief to the PRT will look like a LOCA inside containment. If the operators reach Step 26 and a high radiation condition exists, they would be instructed to go to ECA-1.2, "LOCA Outside Containment." Assuming that Step 21 is the more likely path, Step 17 in E-1 has the operator check auxiliary building radiation as in E-0, Step 26, except that the operator response is quite different. In E-1, the operators are instructed to "try to identify and isolate the radiation leakage paths BUT do not stop any ECCS injection when isolating leakage." However, ECA 1.2 is not referenced. If the operators do not recognize the LOCA outside containment at Step 17, they should recognize that RCS cool down and depressurization are required, which are beneficial actions. "Power" could be available to RHR pumps even if they are not working at ES-1.1 Step 1 or E-1 Step 21; thus, it is uncertain whether ECA-1.1 would be entered. Eventually, operators should go to ECA-1.1 on low RWST alarms and RHR pumps not working. The concern with the above procedures is that E-0 and E-1, Step 17 create uncertainties whether the operators will enter ECA-1.2 early enough to isolate the ISLOCA before the RWST is depleted. ECA-1.2 transfers to ECA-1.1 if the LOCA cannot be isolated. Therefore, it is possible that the RWST will be emptied, and transfer to sump recirculation will occur prior to recognizing the need to enter ECA-1.2 and ECA-1.1. The concern here is that the RHR pumps will be unavailable for sump recirculation due to seal, gasket, or pipe failures caused by RCS temperature and pressure. If the interfacing LOCA cannot be isolated or if there is a LOCA in the RHR system due to overpressurization, then there may not be time to provide adequate makeup to the RWST when recirculation fails.

The RHR system piping, pumps, and heat exchangers are located in the auxiliary building as described below:

- The suction and discharge piping runs through the pipe chases on Elevation 713' and below. There is open grating in the pipe chases to Elevation 676'. There are at least two doors that separate the pipe chase entrances on Elevations 713' and 692' from the open floor areas. On Elevation 713', the motor-driven auxiliary feedwater pumps and component cooling water pumps are located in the open floor area. On Elevation 692', the safety injection, charging, and turbine-driven auxiliary feedwater pumps are located in separate rooms. Water propagation is to Elevation 676' and then to the passive sump on Elevation 666' (210,000-gallon capacity). Therefore, flooding and environmental impacts on high pressure injection and auxiliary feedwater are not judged to be as important as the need for operator actions to isolate the LOCA, preserve the RWST inventory, provide makeup to the RWST, and cool down the RCS.

- The RHR heat exchangers are located in separate rooms with a curbed door entrance on Elevation 713'. Breaks in this location would propagate outside the room and down open stairs and floor grating to Elevations 692', 676', and 666'. Environmental impacts on the motor-driven auxiliary feedwater and component cooling pumps from steam are possible. However, the auxiliary building is large, and there are large openings to the upper elevations. In addition, the turbine-driven auxiliary feedwater and high pressure injection pumps are located on Elevation 692' in separate rooms. Therefore, flooding and environmental impacts on high pressure injection and auxiliary feedwater are not judged to be as important as the need for operator actions to isolate the LOCA, preserve the RWST inventory, provide makeup to the RWST, and cool down the RCS.

- The RHR pumps are located on Elevation 676' in separate rooms with a curbed door entrance. There are flood alarms and a floor opening that is designed to open from 3 to 4 feet of water. The containment spray pumps are located at this same elevation in separate rooms with a curbed door entrance. Since RHR system ruptures propagate to this elevation and the passive sump below, it may be possible to flood all of these pumps if the RWST is emptied into the auxiliary building. However, it is more likely that a portion of the RWST would be inside the containment. The RHR pumps are more likely to be impacted environmentally in the room by pump seal and gasket failures. The containment spray pumps are less likely to be influenced by this environment because they are in separate rooms with doors, curbs, and room coolers.

Based on the above, it is judged to be unlikely that the availability of secondary cooling and high pressure injection due to floods and environmental impacts is as important as operator actions. In addition, it is unlikely that core damage sequences due to interfacing LOCAs in the auxiliary building would have water covering the LOCA path; i.e., source term scrubbing. Given core damage and containment bypass, it is unlikely that containment spray pumps would be available in the long term as they are located at Elevation 676'.

E.2.5.2 Plant Response to RHR Injection Path LOCA

This section evaluates plant response to an interfacing system LOCA initiating event through one of the four RHR injection paths in Figure E.2-1. The leak enters the lower pressure-designed RHR through motor-operated FCV 63-93 or 63-94, as shown in Figures E.2-1 and E.2-2. The ESD in Figure E.2-6 is used to document the plant response evaluation and is described below. The event tree developed to quantify the ESD is described in Section E.2.6. If RHR relief valves open and ruptures in the RHR system do not occur, the sequence is treated as a small LOCA inside containment and is not analyzed further because the frequency is small. The ESD does not address the availability of auxiliary feedwater and high pressure injection because it is judged that human reliability dominates failure. In addition, other low frequency scenarios such as ATWS are not considered. Success in the ESD for LOCAs outside containment requires operator actions including one or both of the following:

- Isolation of the LOCA as prescribed in ECA-1.2 before the RWST becomes emptied; i.e., switchover to sump recirculation. RHR pumps are assumed to be unavailable. Closure of motor-operated FCV 63-93 or 63-94 will stop the LOCA, and high pressure injection pumps will continue to refill RPV before the RWST empties. Then auxiliary feedwater will provide successful long-term cooling.

- It is possible that operators would recognize that sump recirculation will fail due to loss of RHR or that they will enter ECA-1.1 without isolating the LOCA. ECA-1.1 does provide an opportunity for success if makeup to the RWST is started early enough, the RWST volume is preserved, and the RCS is depressurized and cooled down to cold shutdown.

The following provides a description of the ESD (Figure E.2-6):

- **Initiating Event (VI).** The initiating event is defined as a leak equal to or greater than 150 gpm past two series check valves in one of the four RHR low pressure injection paths to the RCS cold legs (Figure E.2-1). This size leak would exceed the makeup capacity of the CVCS. The sequence timing and impact of smaller leaks are judged to be insignificant compared to the larger leaks included in this analysis.

- **RHR Pumps, Heat Exchangers, and RWST Isolated (V1).** This block questions whether the RHR system upstream of check valves 74-544 and 74-545 is isolated from the initiating event. The following valves are normally closed (Figure E.2-2):

  — Check valves 74-544 and 74-545 may fail to close, if open, and bring the remaining portion of the RHR into the analysis. Whether the RWST suction check valve is closed is asked in block V9.

  — Manual valve HCV 74-34 is normally locked closed. If this valve were left open, the LOCA would be outside containment through the RWST. Depending on the LOCA size and the RWST vent capacity, the RWST may survive until the LOCA is isolated (block V12).

  — Manual valves HCV 74-36 and 74-37 are normally closed. If either valve were left open, the remaining portion of the RHR system would be brought into the analysis. Whether the RWST suction check valve is closed is asked in block V9.

  The rupture failure mode of the above valves is included in block V7. Success of block V1 means that the RHR pumps, heat exchangers, and piping upstream are protected. Whether the discharge relief valves open and whether the leak is within the relief valve capacity are questioned next in blocks V3 and V4. Given failure of block V1, block V2 differentiates the above failure modes between the LOCA to RWST and leaks into the remaining portion of RHR.

- **Manual Valve 74-34 Closed (V2).** This block differentiates the failure modes in block V1. Success means the leak is not through the RWST and therefore must be the result of manual valve 74-36 or 74-37 or check valve 74-544 or 74-545. This means that the leak is into the remaining portion of RHR, which includes the pumps and heat exchangers. Whether check valve 63-502 from the RWST is open is questioned in block V9. Failure of block V2 means that manual valve 74-34 is open and that the leak is into the RWST.

- **Relief Valves 63-626 and 63-627 Open (V3).** This block questions whether both RHR discharge relief valves open. Success means that reactor coolant will discharge into the PRT inside containment. It is assumed that the relief valves will discharge 800 gpm at RCS pressure. (The valves are rated at 400 gpm at 600 psig.) This means that the initiating leak must be greater than 800 gpm to pressurize the RHR system. This is questioned in block V4. Success also means that the RCS will eventually depressurize through the relief valves into the containment. This is important if the leak is greater than 800 gpm in block V4 and the system remains intact in block V7. Since there is no sustained pressure at RCS

pressure, leaks at valve bonnets should increase until pressure reduces, and the probability of failure at block V7 due to increasing temperature should be less because the pressure is not sustaining. Failure of either relief valve is conservatively assumed to pressurize the RHR system (i.e., one relief valve opening would handle a 400-gpm leak but is neglected); then the integrity of the 8-inch piping and valves is questioned in block V7. In this case, the RCS pressure is assumed to remain high, soaking the valve bonnet gaskets at high temperature and pressure. Therefore, a small LOCA is assumed outside containment even when the 8-inch piping remains intact.

- **Leak within Relief Valve Capacity (V4).** The initiating event is a leak greater than 150 gpm. This block questions whether the leak is equal to or less than the relief valve capacity (800 gpm), given that the relief valves successfully opened in block V3. Success means that the leak is within the relief valve capacity and that the RHR system is not pressurized much beyond design. Thus, the leak is discharging into the PRT, and the event is a small LOCA. The ESD ends in an undeveloped end state because the frequency of this LOCA inside containment is small in comparison to the LOCA initiators already included in the IPE model. Failure of block V4 means that the leak is greater than the combined relief valve capacity and the RHR system will be pressurized to RCS pressure. Since the relief valves are discharging 800 gpm into the containment through the PRT, the containment will be pressurizing, and the RCS will be depressurizing. Whether the 8-inch piping and valves remain intact is addressed in block V7.

- **Relief Valves 63-626, 63-627, and 74-505 Open (V5).** This block questions whether both RHR discharge relief valves and the suction relief valve all open when the whole RHR system is pressurized. Check valve 74-544 or 74-545 or manual valve 74-36 or 74-37 is open in block V2. Success means that reactor coolant will discharge to the PRT inside containment. It is assumed that the relief valves will discharge 1,700 gpm at RCS pressure. (The two discharge valves are rated at 400 gpm at 600 psig, and the suction valve is rated at 900 gpm at 450 psig.) This means that the initiating leak must be greater than 1,700 gpm to pressurize the RHR system. This is questioned in block V6. Success also means that the RCS will eventually depressurize through the relief valves into the containment. This is important if the leak is greater than 1,700 gpm in block V6, and the system remains intact in block V8. Since there is no sustained pressure at RCS pressure, leaks at valve bonnets and flanges should increase until pressure reduces. Failure of either relief valve is conservatively assumed to pressurize the RHR system (i.e., one relief valve opening would handle at least a 400-gpm leak but is neglected); then the integrity of the RHR system would be important. In this case, the RCS pressure is assumed to remain high, soaking the valve bonnet gaskets, pump seals, and gaskets at high temperature and pressure. It is conservatively assumed in the ESD that this failure at block V5 results in a large LOCA outside containment and that the RHR system is unavailable.

- **Leak within Relief Valve Capacity (V6).** The initiating event is a leak greater than 150 gpm. This block questions whether the leak is equal to or less than the relief valve capacity (1,700 gpm), given that the relief valves successfully opened in block V5. Success means that the leak is within the relief valve capacity, and the RHR system is not pressurized much beyond design. Thus, the leak is discharging

into the PRT, and the event is a medium LOCA. The ESD ends in an undeveloped end state because the frequency of this LOCA inside containment is small in comparison to the LOCA initiators already included in the IPE model. Failure of block V6 means that the leak is greater than the combined relief valve capacity and the RHR system will be pressurized to RCS pressure. Since the relief valves are discharging 1,700 gpm into the containment through the PRT, the containment will be pressurizing, and the RCS will be depressurizing. Whether the RHR system remains intact is addressed in block V8.

- **RHR 8-Inch Piping and Valves Remain Intact (V7).** This block questions whether the 8-inch piping and valves, downstream of the RHR pumps and heat exchangers, remain intact when subjected to RCS pressure. This block is questioned if the check valves and manual valves are closed and remain closed during the initiating event (success of block V1). This block is asked twice in the ESD under the following two different conditions:

  — The relief valves open (block V3 success) and the leak is greater than their capacity (block V4 failure). Under this condition, the RCS will depressurize through the relief valves into the containment, and containment spray is likely to actuate. If the 8-inch piping and valves remain intact (block V7 success), leakage through valve bonnets is expected to increase until the RCS depressurizes and the RHR pumps are protected. Thus, in effect, there is no LOCA outside containment, and RHR is protected. The ESD ends in an undeveloped end state because the frequency of this LOCA inside containment is small in comparison to the LOCA initiators already included in the IPE model. Failure of block V7 results in a large LOCA outside containment. Sequence success requires the operators' recovery in blocks V12 and V13.

  — The relief valves fail to open (block V3 failure), which is assumed to pressurize the RHR system downstream of the pumps. Under this condition, the RCS is not depressurizing through the relief valves into the containment, and containment spray is not as likely to actuate. Note that the model neglects the case in which one relief valve is open (400 gpm). If the 8-inch piping and valves remain intact (block V7 success), leakage through valve bonnets is expected to last longer since the RCS is not depressurizing. This sustained pressure and temperature are assumed to fail gaskets and to cause a small LOCA outside containment. Thus, in effect, there is a small LOCA outside containment; containment spray may not be actuated, which draws the RWST inventory, but the RHR pumps are protected. Sequence success requires one of the operator actions in blocks V12 and V13. Failure of block V7 results in a large LOCA outside containment.

- **RHR System Remains Intact (V8).** This block determines whether the RHR system remains intact, given that the RHR system is not isolated upstream of check valves 74-544 and 74-545 (block V1 failure) and the LOCA is not through the RWST (block V2 and V9 success). In this case, the RHR system includes larger pipe diameters, the pumps, and heat exchangers. To pressurize the RHR system, either the leak is greater than the combined relief valve capacity of 1,700 gpm (block V6 failure) or all relief valves do not open (block V5 failure). When block V5

fails, a large LOCA outside containment is assumed due to a sustained pressure and temperature transient on the RHR pump seals and valve bonnet gaskets. The pressure transient is not sustaining in the case in which the relief valves are successful (block V5 success), and therefore the high pressure challenge is short and there is likely no rupture outside if the system withstands the initial transient. A small LOCA is assumed due to pump seal failure.

- **Check Valve 63-502 Closed (V9).** If the initiating LOCA is into the RHR system (block V2 success), block V9 questions whether the RWST suction check valve (63-502) is closed. Failure results in a LOCA to the RWST that must be isolated. Success means that the leak is into the RHR system, and whether relief valves open is questioned (block V5).

- **Leak within Relief Capacity of RWST (V10).** For the cases in which the LOCA is into the RWST, this block questions whether the leak is within the capacity of the RWST vent. Failure is assumed to cause RWST failure and core damage. No credit is given for isolating the LOCA quick enough to allow auxiliary feedwater alone to provide a success. Success allows the operators to isolate the event in blocks V11 and/or V12.

- **Operators Close FCV 63-1 (V11).** If the initiating event leak is into the RHR system (block V1 failure and block V2 success), check valve 63-502 is open (block V9 failure), and the leak is within the RWST relief capacity (block V10 success). Then, this block questions whether the operators isolate the LOCA to the RWST by closing motor-operated FCV 63-1. Success means that the RHR system response is similar to the case in which block V9 is success (no LOCA to RWST).

- **Operators Isolate LOCA (ECA-1.2) (V12).** This block questions whether the operators successfully isolate a LOCA by closing motor-operated FCV 63-93 or 63-94 as prescribed in ECA-1.2. If this is accomplished before sump recirculation (RHR pumps are assumed unavailable), the LOCA is stopped and high pressure injection can still refill the reactor vessel before makeup to RWST is initiated or auxiliary feedwater can provide long-term cooling. Success results in a stable, long-term cooling state because human reliability is assumed to dominate in comparison to equipment failures. The success of this block depends on the sequence of events prior to entering this block. The following summarizes the different conditions:

  - RHR pumps are isolated from leak (block V1 success), both relief valves open (block V3 success), and the leak is greater than the relief capacity of 800 gpm (block V4 failure). In this case, containment spray will be initiated and if it is not stopped, transfer to sump recirculation will occur quickly. There will be water in the sump, and the RHR pumps are protected, but no credit is allowed for sump recirculation in this analysis when a LOCA outside containment occurs.

  - RHR pumps are isolated from leak (block V1 success), and both relief valves fail to open (block V3 failure). There will be no water in containment sump, and containment spray is not actuated. If the 8-inch piping remains intact (block V7 success), a small LOCA occurs outside containment. There is

significantly more time than with the above case. If the 8-inch piping fails (block V7 failure), a large LOCA occurs outside, reducing the time for operator actions.

- The above two conditions are repeated when the RHR pumps are pressurized (block V1 failure and block V9 or V11 success) except that the LOCA inside containment case is 1,700 gpm. When the RHR pumps are pressurized, it is assumed that the RHR pump seals fail (small LOCA and RHR pumps unavailable).

- LOCAs to the RWST (block V2 or V9 failure), and the LOCA size is less than the RWST relief capacity (block V10 success). It is assumed that the LOCA must be isolated within 30 minutes; otherwise, the RWST and high pressure injection systems will fail.

Except for RWST LOCAs that fail the RWST or are not isolated, the operators are given another opportunity when block V12 fails. Block V13 questions whether ECA-1.1 is entered soon enough to preserve the RWST, provide makeup, and cool down to cold shutdown.

- **Operators Successfully Use ECA-1.1 (V13).** It is possible that operators would recognize that sump recirculation will fail due to loss of RHR or that they will enter ECA-1.1 without isolating the LOCA. ECA-1.1 does provide an opportunity for success if makeup to the RWST is started early enough, the RWST volume is preserved, and the RCS is depressurized and cooled down to cold shutdown. The time available also depends on the sequence and previous operator actions, as described above for block V12.

E.2.5.3 Plant Response to RHR Suction Path LOCA

This section evaluates plant response to an interfacing system LOCA initiating event through the RHR suction path in Figure E.2-2. The plant response is similar to the discharge path leak discussed in the previous section except that the suction path has no check valves and manual valves to isolate the majority of the RHR system from the leak. The suction path leak enters the RHR system on the pump suction side and will pressurize the whole system if the relief valves fail to open or the leak exceeds the capacity of relief valves. The ESD in Figure E.2-7 is used to document the plant response evaluation and is described below. The event tree developed to quantify the ESD is described in Section E.2.6. If RHR relief valves open and the initiating leak does not exceed relief capacity, the sequence is treated as a small or medium LOCA inside containment and is not analyzed further because the frequency is small. The ESD does not address the availability of auxiliary feedwater and high pressure injection because it is judged that human reliability dominates failure. In addition, other low frequency scenarios such as ATWS are not considered. Success in the ESD for LOCAs outside containment requires operator actions including one or both of the following:

- Isolation of the LOCA by closing motor-operated FCV 74-3 and 74-21 (which is not proceduralized in ECA-1.2) before the RWST becomes emptied; i.e., switchover to sump recirculation. RHR pumps are assumed to be unavailable. Closure of motor-operated FCVs 74-3 and 74-21 will stop the LOCA, and high pressure

injection pumps will continue to refill RPV before the RWST empties. Then auxiliary feedwater will provide successful long-term cooling.

- It is possible that operators would recognize that sump recirculation will fail due to loss of RHR or that they will enter ECA-1.1 without isolating the LOCA. ECA-1.1 does provide an opportunity for success if makeup to the RWST is started early enough, the RWST volume is preserved, and the RCS is depressurized and cooled down to cold shutdown.

The following provides a description of the ESD (Figure E.2-7):

- **Initiating Event (VS).** The initiating event is defined as a leak equal to or greater than 150 gpm past four series motor-operated FCVs (74-1, 74-2, 74-8, and 74-9) in the RHR suction path from RCS hot leg 4 (Figure E.2-2). This size leak would exceed the makeup capacity of the CVCS. The sequence timing and impact of smaller leaks are judged to be insignificant compared to the larger leaks included in this analysis.

- **Check Valve 63-502 Closed (V21).** Block V21 questions whether the RWST suction check valve (63-502) is closed. Failure results in a LOCA to the RWST that must be isolated unless it is too large and fails RWST. Success means that the leak is into the RHR system, and the ESD asks whether manual valve 74-34 is open as it is another path to the RWST.

- **Manual Valve 74-34 Closed (V22).** This block asks whether manual valve 74-34 is open to the RWST. Success means the leak is not to the RWST. This means that the leak is into the RHR system, which includes the pumps and heat exchangers. Failure of block V22 means that manual valve 74-34 is open, and that the leak is into the RWST. Failure results in a LOCA to the RWST, which must be isolated unless it is too large and fails RWST.

- **Leak within Relief Capacity of RWST (V23).** For the cases in which the LOCA is into the RWST (block V21 or V22 failure), this block questions whether the leak is within the capacity of the RWST vent. Failure is assumed to cause RWST failure and core damage. Success allows the operators to isolate the event in block V24 or V25.

- **Operators Close Motor-Operated FCVs 74-33 and 74-35 (V24).** If manual valve 74-34 is open (block V22 failure), and the leak is within the RWST relief capacity (block V23 success), then this block questions whether the operators isolate the LOCA to the RWST by closing motor-operated FCV 74-33 and 74-35. Success means that the RHR system response is similar to the case in which block V22 is success (no LOCA to RWST). Failure is assumed to eventually fail the RWST and injection, and to lead to core damage with bypass.

- **Operators Close MOV 63-1 (V25).** If check valve 63-502 is open (block V21 failure), and the leak is within the RWST relief capacity (block V23 success), then this block questions whether the operators isolate the LOCA to the RWST by closing MOV 63-1. Success means that the RHR system response is similar to the

case in which block V22 is success (no LOCA to RWST). Failure is assumed to eventually fail the RWST and injection, and lead to core damage with bypass.

- **Relief Valve 74-505 Opens (V26).** This block questions whether the suction relief valve opens when the whole RHR system is pressurized. Success means that reactor coolant will discharge to the PRT inside containment. It is assumed that the relief valve will discharge 900 gpm at RCS pressure. (The suction relief valve is rated at 900 gpm at 450 psig.) This means that the initiating leak must be greater than 900 gpm to pressurize the RHR system. This is questioned in block V27. Success also means that the RCS will eventually depressurize through the relief valve into the containment. This is important if the leak is greater than 900 gpm in block V27 and greater than the relief capacity of the discharge relief valves (V28 and V29) and the system remains intact in block V30. Since there is no sustained pressure at RCS pressure, leaks at valve bonnets, RHR pump, and heat exchanger gaskets should increase until pressure reduces. If relief valve 74-505 fails, whether the discharge relief valves open is questioned in block V28.

- **Leak within Relief Valve Capacity (< 900 gpm) (V27).** The initiating event is a leak greater than 150 gpm. This block questions whether the leak is equal to or less than the relief valve capacity (900 gpm), given that the relief valves successfully opened in block V26 or V28. Success means that the leak is within the relief valve capacity, and the RHR system is not pressurized much beyond design. Thus, the leak is discharging to the PRT, and the event is a small-to-medium LOCA. The ESD ends in an undeveloped end state because the frequency of this LOCA inside containment is small in comparison to the LOCA initiators already included in the IPE model. Failure of block V27 means that the leak is greater than the relief valve capacity. There are two cases in the ESD: (1) suction relief valve 74-505 is open, and the leak is greater than 900 gpm and the discharge relief valves are questioned, and (2) suction relief valve fails to open, and the discharge relief valves are successful. Since relief valves are discharging 800 gpm to the containment through the PRT, the containment will be pressurizing, and the RCS will be depressurizing.

- **Relief Valves 63-626 and 63-627 Open (V28).** This block questions whether both RHR discharge relief valves open when the RHR system is pressurized. Success means that reactor coolant will discharge to the PRT inside containment. It is assumed that the relief valves will discharge 800 gpm at RCS pressure. (The two discharge valves are rated at 400 gpm at 600 psig.) This means that the initiating leak must be greater than 800 gpm to pressurize the RHR system. This is questioned in blocks V27 and V29. Success also means that the RCS will eventually depressurize through the relief valves into the containment. This is important if the leak is greater than 900 gpm in block V27 or 1,700 gpm in block V29, and the system remains intact in block V30. Since there is no sustained pressure at RCS pressure, leaks at valve bonnets, RHR pumps, and heat exchanger gaskets should increase until pressure reduces. Failure of either relief valve after suction relief valve 74-505 fails to open is conservatively assumed to pressurize the RHR system (i.e., one relief valve opening would handle at least a 400-gpm leak, but is neglected); then the integrity of the RHR system would be important. In this case, the RCS pressure is assumed to remain high, soaking the valve bonnet gaskets, pump seals, and gaskets at high temperature and pressure. It is

conservatively assumed in the ESD that this failure results in a large LOCA outside containment, and the RHR system is unavailable.

- **Leak within Relief Valve Capacity (< 1,700 gpm) (V29).** This block questions whether the leak is equal to or less than the relief valve capacity (1,700 gpm), given that all relief valves successfully opened in blocks V26 and V28. Success means that the leak is within the relief valve capacity, and the RHR system is not pressurized much beyond design. Thus, the leak is discharging to the PRT, and the event is a medium LOCA. The event sequence diagram ends in an undeveloped end state because the frequency of this LOCA inside containment is small in comparison to the LOCA initiators already included in the IPE model. Failure of block V29 means that the leak is greater than the combined relief valve capacity, and the RHR system will be pressurized to RCS pressure. Since the relief valves are discharging 1,700 gpm to the containment through the PRT, the containment will be pressurizing, and the RCS will be depressurizing. Whether the RHR system remains intact is addressed in block V30.

- **RHR System Remains Intact (V30).** This block questions whether the RHR pumps, heat exchangers, and piping remain intact when subjected to RCS pressure. This block is questioned whenever the leak exceeds the RHR system relief capacity, which includes failure of relief valves to open. This block is only asked if 900 to 1,700 gpm is relieving to the containment through the PRT. Thus, RCS will be depressurizing, and the pressure transient on the RHR system is not sustained at RCS pressure. If the RHR system remains intact (block V30 success), significant leakage through valve bonnets is expected to last only until the RCS depressurizes; however, there is a probability of RHR pump seal failure (small LOCA). In effect, there is a small LOCA outside containment. Failure of block V30 results in a large LOCA outside containment. Sequence success requires the operators' recovery in blocks V31 and V32.

- **Operators Close Motor-Operated FCVs 74-3 and 74-21 and Piping Intact (V31).** This block questions whether the operators successfully isolate a suction path LOCA by closing motor-operated FCVs 74-3 and 74-21, which is not proceduralized. If this is accomplished before sump recirculation (RHR pumps are assumed unavailable), the LOCA is stopped, and high pressure injection can still refill the reactor vessel before makeup to RWST is initiated or auxiliary feedwater can provide long-term cooling. Success results in a stable, long-term cooling state because human reliability is assumed to dominate in comparison to equipment failures. The success of this block depends on the sequence of events prior to entering this block. The following summarizes the different conditions:

  - In the case in which all relief valves are open (1,700 gpm to PRT), there will be water in the containment sump, and containment spray will be initiated. If containment spray is not stopped, transfer to sump recirculation will occur quickly. No credit is allowed for sump recirculation in this analysis for LOCAs outside containment.

  - In the case in which one or two relief valves fail to open (900 gpm to PRT), there will be water in the containment sump, and containment spray will be initiated. If containment spray is not stopped, transfer to sump recirculation

will occur quickly. If sprays are stopped, transfer to recirculation is slower than the above case.

- In the case in which no relief valves open, there will be no water in the containment sump, and containment spray will not be initiated. Transfer to sump recirculation will not occur as quickly as above, but this depends on the RHR response.

- LOCAs to the RWST (block V21 or V22 failure), and the LOCA size is less than the RWST relief capacity (block V23 success). It is assumed that the LOCA must be isolated within 30 minutes; otherwise, the RWST and high pressure injection systems will fail.

Except for RWST LOCAs that fail the RWST or are not isolated, the operators are given another opportunity when block V31 fails. Block V32 questions whether ECA-1.1 is entered soon enough to preserve the RWST, provide makeup, and cool down to cold shutdown.

- **Operators Successfully Use ECA-1.1 (V32).** It is possible that operators would recognize that sump recirculation will fail due to loss of RHR or that they will enter ECA-1.1 without isolating the LOCA. ECA-1.1 does provide an opportunity for success if makeup to the RWST is started early enough, the RWST volume is preserved, and the RCS is depressurized and cooled down to cold shutdown. The time available also depends on the sequence and previous operator actions, as described above for block V31.

E.2.6 ACCIDENT SEQUENCE QUANTIFICATION

This section describes quantification of the initiating events, the event trees, and the event tree top event models.

E.2.6.1 Initiating Event Quantification

E.2.6.1.1 Valve Failure Data Analysis

The initiating event frequencies quantified in this section for VI (injection) and VS (suction) refer to the frequency of exceeding a leakage of 150 gpm, which is the capacity of the charging pump. Leaks that are larger than the capacity of the charging system will depressurize the RCS to the containment, taking on the characteristics of a small or medium LOCA when the pressurizer relief tank fails.

The first failure mode of interest in quantification is valve disc rupture or gross leakage of a check valve. The failure frequency obtained will be a rate of failure per hour, and the same value will be used for MOV rupture or gross leakage. This failure frequency is obtained from the curve in Figure E.2-3. The median failure frequency at a leak rate of 150 gpm or greater is 1.8×10^{-8} per hour from Figure E.2-3. Assuming a lognormal

distribution and a range factor of 10, the distribution of this frequency has the following characteristics:

Parameter	Frequency (events per hour)
Mean	4.8×10^{-8}
5th Percentile	1.7×10^{-9}
95th Percentile	1.7×10^{-7}

E.2.6.1.2 Injection Line Frequency

Figure E.2-8 gives the fault tree used to calculate the injection line failure frequency. This fault tree is based on Equation (E.2.13). The other failure frequency needed to quantify this fault tree is "check valve rupture on demand." "Check valve failing open after test" is not included as a failure mode because, as stated in Section E.2.3, the valves are seal leak tested every cold shutdown period. Reference E.2-5 developed a median for F_d to account for the failure of the second valve to hold under the pressure shock, given the failure of the first valve. Assuming a range factor of 5, the distribution of "check valve rupture on demand" becomes

Parameter	Frequency (events per demand)
Mean	2.3×10^{-4}
5th Percentile	2.7×10^{-5}
95th Percentile	6.8×10^{-4}

After quantification, the frequency of failure of four paths, each containing two series injection check valves, that produces leakage to the RHR system in excess of 150 gpm is obtained. The distribution for event VI is as follows:

Parameter	Frequency (events per year)
Mean	4.0×10^{-6}
5th Percentile	1.1×10^{-8}
95th Percentile	7.5×10^{-6}

E.2.6.1.3 Suction Line Frequency

Figure E.2-9 gives the fault tree used to calculate the suction line failure frequency. This fault tree is based on Equation (E.2.15). The other failure frequency needed to quantify this fault tree is "MOV rupture on demand." As stated in Section E.2.3, spurious actuation and "MOV failing open after test" failure modes are not included in this analysis because power is normally removed from the valve control circuits, and the valves are stem-mounted and seal leak tested every cold shutdown. The distribution of "MOV rupture on demand" is assumed to be the same as that of check valve rupture on demand, F_d, given above, because of the lack of data specific to MOVs.

After quantification, the frequency of failure of two MOVs in series that produces leakage to the RHR system in excess of 150 gpm is obtained. The distribution for event VS is as follows:

Parameter	Frequency (events per year)
Mean	7.2×10^{-6}
5th Percentile	1.3×10^{-8}
95th Percentile	1.2×10^{-5}

E.2.6.2 Event Tree Quantification

This section describes the event trees used to quantify accident sequences, given an interfacing LOCA initiating event. Section E.2.6.2.1 describes the VILOCA event tree in response to a leak through one of the four cold leg discharge paths (VI initiating event). Section E.2.6.2.2 describes the VSLOCA event tree in response to a leak through the hot leg suction path (VS initiating event). The event trees are quantified by linking the initiating events described in Section E.2.6.1 directly to the event trees. The support system event tree is not modeled as well as other functions such as scram, high pressure injection, and auxiliary feedwater because the human actions contained in this analysis are judged to dominate the results.

The VILOCA and VSLOCA event trees are provided in Figures E.2-10 and E.2-11. Table E.2-9 provides a list of the data variables used. The variable used for disc leakage at 800 gpm is also used for leakage at 900 gpm in the VSLOCA tree. This is due to the relative accuracy of obtaining numbers from Figure E.2-4. Table E.2-10 provides the quantitative results from quantifying the event tree top event models and split fractions described in the following sections. Section E.2.6.3 describes the event tree end states and quantitative results.

Successful initiating event mitigation requires one of the following:

- Relief valves open and discharge to the PRT, **and** the initiating leak is less than the relief valve capacity. This is a LOCA inside containment, and is treated as success because its frequency is small in comparison to the frequency of LOCAs in the IPE model.

- Relief valves open and discharge to the PRT, **and** the initiating leak is greater than the relief valve capacity (RHR pressurizes), **and** the RHR system withstands the pressure transient. RCS relief to the PRT of 900 to 1,700 gpm does not allow a sustained temperature and pressure transient on the RHR. This is a LOCA inside containment after the pressure decreases and is treated as success because its frequency is small in comparison to the frequency of LOCAs in the IPE model.

- The RHR system pressurizes and fails, causing a LOCA outside containment. Operators isolate the LOCA outside containment before transfer to sump recirculation or RWST failure. This allows high pressure injection to refill the reactor vessel, and either auxiliary feedwater or ECA-1.1 can be used to provide cooling.

- The RHR system pressurizes and fails, causing a LOCA outside containment. The LOCA either cannot be isolated or operators misdiagnose. Operators recognize that containment sump recirculation will fail in time to implement ECA-1.1. The RWST volume is preserved, makeup to RWST is started, and cool down is initiated early enough to prevent core damage.

E.2.6.2.1 VILOCA Event Tree

The initiating event is VI, as described in Section E.2.6.1, and the event tree is based on the ESD described in Section E.2.5.2. The applicable ESD block(s) is provided in parenthesis for each top event described below to facilitate reference to more detailed discussions of plant response. The VILOCA event tree is provided in Figure E.2-10. The following describes event tree VILOCA and its top events:

- **Top Event VI1 — RHR Pumps Isolated (V1).** This top event determines whether the RHR pumps and the majority of the system are isolated from the discharge path downstream of check valves 74-544 and 74-545. Top event failure occurs if any of the following valves are open:

  - **Check Valve 74-544 or 74-545.** The check valve on the opposite train is verified seated during the quarterly pump test. Failure mode is therefore failure of a check valve to close on demand. Failure brings the whole RHR system into the analysis.

  - **Manual Locked Close Valve 74-34.** If this valve is left open, the LOCA is to the RWST. The failure mode is transfer open.

  - **Manual Valve 74-36 or 74-37.** If either valve is left open, the whole RHR system is brought into the analysis. The failure mode is transfer open.

  Only one split fraction is required for this top event (VI11).

- **Top Event VI2 — Manual Valve 74-34 Closed (V2).** Given failure of Top Event VI1, this top event differentiates between the RWST LOCA and the RHR system LOCA. The split fraction (VI21) for this top event is the probability of valve 74-34 being open, divided by split fraction VI11. Success of Top Event VI2 means that one of the other valves is open to the RHR system.

- **Top Event VI3 — Check Valve 63-502 Closed (V9).** This top event asks whether check valve 63-502 is open, thus resulting in LOCA to the RWST. The failure mode is check valve fails to close on demand, and only one split fraction (VI31) is required.

- **Top Event VI4 — Leak < RWST Vent Capacity (V10).** This top event questions whether the leak is less than the vent capacity of the RWST. Success allows the operators an opportunity to isolate the leak. Failure is assumed to rupture the RWST and cause loss of injection and core damage. The split fraction (VI41) is quantified identically to Top Event VI7, split fraction VI71; that is, the conditional frequency of a 800-gpm or greater leak, given the initiating event frequency, which is based on a 150-gpm or greater leak.

- **Top Event VI5 — Operator Closes Motor-Operated FCV 63-1 (V11).** Given a LOCA through check valve 63-502 to the RWST, Top Event VI3 failure, and the leak is within the tank relief capacity (Top Event VI4 success), this top event questions whether the operators isolate the leak by closing motor-operated FCV 63-1. Procedures do not appear to address closing this valve, and power must be restored to the valve to close it remotely. This top event is presently set to guaranteed failure (split fraction VI5F).

- **Top Event VI6 — Relief Valves Open (V3 or V5).** This top event questions whether the relief valves open to the PRT successfully. If the RHR system is isolated (Top Event VI1 success), both relief valves 63-626 and 63-627 must open for success. If RHR is not isolated (Top Event VI1 failure), all three relief valves (63-626, 63-627, and 75-505) must open. Therefore, there are two split fraction:

  — VI61 (Top Event VI1 success): one of two relief valves fail to open.
  — VI62 (Top Event VI1 failure): one of three relief valves fail to open.

- **Top Event VI7 — Leak < Relief Capacity (V4 or V6).** Given that the relief valves open in the previous top event, this top event asks whether the leak is less than the relief valve capacity. If it is, there is no pressure transient on RHR. Failure indicates that the leak is larger, and that RHR will be pressurized to RCS pressure. There are two split fractions:

  — VI71 (Top Event VI1 success): conditional frequency leak > 800 gpm.
  — VI72 (Top Event VI1 failure): conditional frequency leak > 1,700 gpm.

  The above frequencies are quantified conditional on the initiating event leak frequency, which is based on 150 gpm or greater.

- **Top Event VI8 — RHR System Intact (V7 or V8).** This top event addresses the probability that the RHR system structurally fails, given overpressurization. Failure is defined as a large LOCA outside containment. The following split fractions are used:

  — **VI81 (Top Event VI1 success and Top Event VI6 success).** Only 8-inch piping and valves are pressurized, and the RCS is depressurizing at 800 gpm, which means that the overpressure condition on RHR is not sustaining. Initial leaks due to valve bonnets would subside to small leakage after pressure reduces, given Top Event VI8 success.

  — **VI82 (Top Event VI1 success and Top Event VI6 failure).** Only 8-inch piping and valves are pressurized, but the pressure is sustaining since there is no relief to PRT. The sustaining pressure is assumed to guarantee a small LOCA outside containment due to bonnet seal failures, given Top Event VI8 success.

  — **VI83 (Top Event VI1 failure and Top Event VI6 success).** Whole RHR system is pressurized including the pumps, and the RCS is depressurizing at 1,700 gpm, which means that the overpressure condition on RHR is not sustaining. Initial leaks due to pump flanges, heat exchanger flanges, and

valve bonnets would subside to small leakage after pressure reduces, given Top Event VI8 success.

Note that when the whole RHR system is pressurized including the pumps and there is no pressure relief (Top Event VI1 failure and Top Event VI6 failure), the pressure is sustaining, and a large LOCA outside containment is assumed, due to, as a minimum, pump seals, pump flange seal failures, heat exchanger flange seal failures, and valve bonnet seal failures. For this condition, VI8 is bypassed in the event tree.

These split fractions (probability of rupture) are quantified from the overpressure structural analysis results in Section E.2.4. In the case of split fractions VI81 and VI82, only the probability of rupturing 8 inch schedule 40S 304SS is required because the remaining RHR system is isolated and valve body ruptures are less likely than pipe ruptures. The conditions for VI81 are such that RCS pressure will not stay at 2,250 for very long, given the 800 gpm LOCA to the PRT. Pipe temperature should not increase substantially before RCS begins to depressurize. The following two cases were quantified to estimate the probability of VI81:

- Probability of pipe rupture (0.02 in corrosion allowance) at 2,300 psig and room temperature; i.e., time 0. The probability of failure is 5×10^{-3} at 2,377 psig.

- Probability of pipe rupture (0.02 in corrosion allowance) at 2,000 psig and 400°F; i.e., time > 0. The probability of failure is 5×10^{-2} at 2,089.

Split fraction VI81 is conservatively set at 5×10^{-2}. The conditions for split fraction VI82 are such that valve bonnet leaks could bring hot RCS water into the 8-inch piping sections, and since the relief valves are not open, the pressure will be sustaining. The following was quantified to estimate the probability of VI82:

- Probability of pipe rupture (0.02 in corrosion allowance) at 2,300 psig and 600°F. The probability of failure is 0.1 at 2,108 psig.

Split fraction VI82 is set at 0.1.

In the case of split faction VI83, the whole RHR system is pressurized; therefore, additional ruptures must be considered. The conditions for VI83 are such that RCS pressure will not stay at 2,250 for very long, given the 1,700-gpm LOCA to the PRT. Pipe and component temperatures should not increase substantially before RCS begins to depressurize. The following two cases were quantified to estimate the probability of VI83:

- **Case 1.** Probability of rupture (0.02-inch corrosion allowance) at 2,300 psig and room temperatures; i.e., time 0.

- **Case 2.** Probability of rupture (0.02-inch corrosion allowance) at 1,800 psig and 400°F; i.e. time > 0.

The following summarizes the estimated probabilities of failure modes and the total for both cases:

Failure Mode	Failure Probability	
	Case 1	Case 2
8-Inch Schedule 40S 304SS	5×10^{-3}	.05
12-Inch Schedule 40S 304SS	2×10^{-2}	.05
14-Inch Schedule 40S 304SS	2×10^{-2}	.05
18-Inch Schedule .375 Wall 304SS	.5	.5
RHR Heat Exchanger Tube Side Cylinder	.05	.05
RHR Heat Exchanger Tube Side Head Buckling	$< 10^{-3}$	0.01
Total	0.6	0.7

Split fraction VI83 is set to 0.7 for the rupture failure mode. However, there is a pump seal failure mode that has a high probability of occurrence, but this failure mode results in a relatively small LOCA (about 1-inch^2). For this reason, the RHR pumps are assumed to be unavailable whenever the RHR system is pressurized.

- **Top Event VI9 — Operator Isolates LOCA (ECA-1.2) (V12).** This top event models the operators diagnosing the LOCA outside containment and isolating the LOCA as described in ECA-1.2. The chance of success depends on the specific sequence timing, which depends on the size of LOCA outside containment, the size of LOCA to the PRT, and whether containment sprays have actuated and/or been stopped. If the LOCA is isolated before transfer to sump recirculation, the operators can use the remaining RWST volume to refill the reactor vessel and then use auxiliary feedwater to provide cooling. There is another opportunity for success if the operators misdiagnose the event. If the operators stay in E-1, they will likely transfer to ES-1.1 at Step 21, and start cooling down and depressurizing the RCS, which are beneficial actions. When the RWST reaches 29%, a low-level alarm would sound. Then the operators would enter ES-1.2 to establish sump recirculation, but the RHR pumps would not be available. The operators must realize this to enter ECA-1.1 to prevent core damage. ECA-1.1 instructs the operators to make up to the RWST, preserve the RWST, and to cool down to cold shutdown.

  If the RWST reaches 8% before ECA-1.2 or ECA-1.1 is entered, then core damage with containment bypass is assumed.

  The following split fractions are defined:

  — VI91 (VI1 = S*VI6 = S*VI8 = F): 900 gpm to PRT and large LOCA outside.

  — VI92 (VI1 = S*VI6 = F*VI8 = S): no flow to PRT and small LOCA outside.

  — VI93 (VI1 = S*VI6 = F*VI8 = F): no flow to PRT and large LOCA outside.

- VI94 (VI1 = F*VI6 = S*VI8 = S): 1,700 gpm to PRT and small LOCA through RHR pump seal.
- VI95 (VI1 = F*VI6 = S*VI8 = F): 1,700 gpm to PRT and large LOCA outside.
- VI96 (VI1 = F*VI6 = F*VI8 = B): no flow to PRT and large LOCA outside.
- VI97 (VI1 = F*VI3 = F*VI4 = S*VI5 = F): < 900 gpm to RWST, isolation.
- VI98 (VI1 = F*VI2 = F*VI4 = S): < 900 gpm to RWST, isolation.
- VI99 (VI1 = F*VI4 = F): > 900 RWST rupture, core damage without bypass.

Until the human reliability analyses is performed, a 90% chance of success is assumed (i.e., split fraction is 0.1) for the above cases. A sensitivity case with the operators guaranteed to fail is included in the event tree quantification.

E.2.6.2.2 VSLOCA Event Tree

The initiating event is VS, as described in Section E.2.6.1, and the event tree is based on the ESD described in Section E.2.5.3. The applicable ESD block(s) is provided in parenthesis for each top event described below to facilitate reference to more detailed discussions of plant response. The VSLOCA event tree is provided in Figure E.2-11. The following describes event tree VSLOCA and its top events:

- **Top Event VS1 — Check Valve 63-502 Closed (V21).** This top event asks whether check valve 63-502 is open (Top Event VS1 failure), thus resulting in LOCA to the RWST. The failure mode is check valve fails to close on demand, and only one split fraction (VS11) is required.

- **Top Event VS2 — Manual Valve 74-34 Closed (V22).** This top event models the manual locked-closed valve 74-34. If it is open, there is a LOCA to the RWST. The split fraction (VS21) for this top event is the probability of valve 74-34 transferring open.

- **Top Event VS3 — Leak < RWST Vent Capacity (V23).** This top event questions whether the leak is less than the vent capacity of the RWST. Success allows the operators an opportunity to isolate the leak. Failure is assumed to rupture the RWST and cause loss of injection and core damage. The split fraction (VS31) is quantified identically to Top Event VS7, split fraction VS71; that is, the conditional frequency of a 900-gpm or greater leak, given the initiating event frequency, which is based on a 150-gpm or greater leak.

- **Top Event VS4 — Operator Closes MOV(s) To Isolate RWST (V24 or V25).** Given a LOCA through check valve 63-502 or manual valve 74-34 to the RWST, Top Event VS1 or VS2 failure, and the leak is within the tank relief capacity (Top Event VS3 success), this top event questions whether the operators isolate the leak by closing MOV(s). The check valve leak can be isolated by closing MOV 63-1. Procedures do not appear to address closing this valve, and power must be restored to the valve to close it remotely. The open manual valve can be isolated by closing

FCVs 74-33 and 74-35. This also appears not to be proceduralized. This top event is presently set to guaranteed failure (split fraction VS4F).

- **Top Event VS5 — Relief Valve 74-505 Opens (V26).** This suction path relief valve opens at 450 psig with a 900-gpm capacity to the PRT. Success means the leak must be greater than 900 gpm to challenge the discharge relief valves (Top Event VS6). Failure means the discharge reliefs will be challenged. The failure mode for split fraction VS51 is failure to open on demand.

- **Top Event VS6 — Relief Valves 63-626 and 63-627 Open (V28).** This top event questions whether the discharge relief valves open to the PRT successfully (400 gpm each at 600 psig). Both relief valves 63-626 and 63-627 must open for success. If either relief valve fails to open on demand (split fraction VS61), the top event is assumed to fail.

- **Top Event VS7 — Leak < 900 gpm (V27).** Given that the relief valves open (Top Event VS5 or VS6 success) in the previous top events, this top event asks whether the leak is less than the relief valve capacity. If it is, there is no pressure transient on RHR. Failure indicates that the leak is larger and that RHR will be pressurized to RCS pressure. There is one split fraction (VS71), which is quantified conditional on the initiating event leak frequency, which is based on 150 gpm or greater.

- **Top Event VS8 — Leak < 1,700 gpm (V29).** Given that the relief valves open (Top Event VS5 and VS6 success) in the previous top events, this top event asks whether the leak is less than the relief valve capacity. If it is, there is no pressure transient on RHR. Failure indicates that the leak is larger, and that RHR will be pressurized to RCS pressure. There is one split fraction (VS81), which is quantified conditional on the initiating event leak frequency, which is based on 150 gpm or greater.

- **Top Event VS9 — RHR System Intact (V30).** This top event addresses the probability that the RHR system structurally fails, given overpressurization. Failure is defined as a large LOCA outside containment. The following split fractions are used:

  — **VS91 (Top Event VS5 success and Top Event VS6 success).** RCS is depressurizing at 1,700 gpm, which means that the overpressure condition on RHR is not sustaining. Initial leaks due to valve bonnets, RHR pump, and heat exchanger leak would subside after pressure reduces, given Top Event VS9 success.

  — **VS92 (Top Event VS5 success or Top Event VS6 success).** RCS is depressurizing at 900 gpm, which means that the overpressure condition on RHR is not sustaining. Initial leaks due to valve bonnets, RHR pump, and heat exchanger leak would subside after pressure reduces, given Top Event VS9 success.

Note that when the RHR system is pressurized and there is no pressure relief (Top Event VS5 failure and Top Event VS6 failure), the pressure is sustaining, and a large LOCA outside containment is assumed, due to, as a minimum, pump seals,

pump flange gasket failure, heat exchanger flange gasket failure, and valve bonnet seal failures. For this condition, Top Event VS9 is bypassed in the event tree.

These split fractions (probability of rupture) are quantified from the overpressure structural analysis results in Section E.2.4. The whole RHR system is pressurized; thus, the failure modes are the same as described in the previous section for split fraction VI83. In fact, split fraction VS91 is the same as VI83. Split fraction VS92 is quantified for two cases to estimate the probability of failure:

- **Case 1.** Probability of pipe rupture (0.02 corrosion allowance) at 2,300 psig and room temperature; i.e., time 0.

- **Case 2.** Probability of pipe rupture (0.02 corrosion allowance) at 2,000 psig and 400°F; i.e., time > 0 with 800-gpm relief.

Failure Mode	Failure Probability	
	Case 1	Case 2
8-Inch Schedule 40S 304SS	5×10^{-3}	0.5
12-Inch Schedule 40S 304SS	.02	0.1
14-Inch Schedule 40S 304SS	.025	0.1
18-Inch Schedule .375 Wall 304SS	0.5	0.5
RHR Heat Exchanger Tube Side Cylinder	0.5	0.1
RHR Heat Exchanger Tube Side Head Buckling	$< 10^{-3}$	0.2
Total	0.6	0.8

Split fraction VS92 is set to 0.8.

- **Top Event VSA — Operator Isolates LOCA, ECA-1.2 (V31 or V32).** This top event models the operators diagnosing the LOCA outside containment and preventing core damage. This can be accomplished by isolating the LOCA or implementing ECA-1.1. Isolation could be accomplished within the control room by closing FCVs 74-3 and 74-21; however, this would isolate both RHR pumps from the RWST, and this is not proceduralized in ECA-1.2. The chance of success depends on the specific sequence timing, which depends on the size of LOCA outside the containment, the size of LOCA to the PRT, and whether containment sprays have actuated and/or been stopped. If the LOCA is isolated before transfer to sump recirculation, the operators can use the remaining RWST volume to refill the reactor vessel and then use auxiliary feedwater to provide cooling. There is another opportunity for success if the operators misdiagnose the event. If the operators stay in E-1, they will likely transfer to ES-1.1 at Step 21, and start cooling down and depressurizing the RCS, which are beneficial actions. When the RWST reaches 29%, a low-level alarm would sound. Then the operators would enter ES-1.2 to establish sump recirculation, but the RHR pumps would not be available. The operators must realize this to enter ECA-1.1 to prevent core damage. ECA-1.1 instructs the operators to make up to the RWST, preserve the RWST, and to cool down to cold shutdown.

If the RWST reaches 8% before ECA-1.2 or ECA-1.1 is entered, then core damage with containment bypass is assumed.

The following split fractions are defined:

- VSA1 (VS5=S*VS6=S*VS9=S): 1,700 gpm to PRT and small LOCA through RHR pump seal.
- VSA2 (VS5=S+VS6=S)*VS9=S: 900 gpm to PRT and small LOCA through RHR pump seal.
- VSA3 (VS5=S*VS6=S*VS9=F): 1,700 gpm to PRT and large LOCA outside.
- VSA4 (VS5=S+VS6=S)*VS9=F: 900 gpm to PRT and large LOCA outside.
- VSA5 (VS5=F*VS6=F*VS9=B): no flow to PRT and large LOCA outside.

Until the human reliability analysis is performed, a 90% chance of success is assumed (i.e., split fraction is 0.1) for the above cases. A sensitivity case with the operators guaranteed to failure is included.

E.2.6.3 Accident Sequence End States and Results

The following four accident sequence end states were defined:

- **LOCA.** These are sequences in which RHR relief valves open and either the leak into the system is less than the relief valve capacity (RHR not pressurized) or the leak is greater than relief valve capacity (RHR pressurized), but the system withstands pressure transient. There is no LOCA outside containment. The "LOCA" is inside containment at a frequency less than initiators already included in the IPE.
- **Success.** These are sequences in which the operators successfully mitigate a LOCA outside containment. Therefore, the interfacing LOCA initiating event must cause structural failure in the RHR system, and then the operator must either isolate the LOCA or be successful in ECA-1.1.
- **CD.** These are core damage sequences without containment bypass. The operators isolated the LOCA outside containment; core damage occurred.
- **CDB.** These are core damage sequences with containment bypass in which the operators fail to mitigate a LOCA outside containment. It is assumed that the LOCA outside containment is not isolated.

The event tree quantification results for initiating event VI are as follows:

End State	Result
LOCA	4.0×10^{-6}
SUCCESS	3.0×10^{-8}
CDB	3.3×10^{-9}
CD	1.0×10^{-11}

CD stands for core damage without containment bypass.

The results for initiating event VS are as follows:

End State	Result
LOCA	6.9×10^{-6}
SUCCESS	2.8×10^{-7}
CDB	3.7×10^{-8}

The total frequency of LOCAs inside containment is much less than the frequencies of small or large LOCAs due to internal events. The frequency of core damage without bypass is negligible in comparison to the frequency of core damage due to internal events. Finally, the frequency of core damage with containment bypass (CDB) will be compared to similar Level 2 release categories resulting from other initiators.

E.2.7 REFERENCES

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E.2-3. EG&G Idaho, Inc., "Data Summaries of Licensee Event Reports of Valves at U.S. Commercial Nuclear Power Plants," prepared for U.S. Nuclear Regulatory Commission, NUREG/CR-1363, Vol. 1, June 1980.

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E.2-9. Wesley, D. A., H. Hadidi-Tamjed, "Pressure-Dependent Fragilities for the Watts Bar Nuclear Plant RHR System," EQE Engineering Consultants, March 1992.

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E.2-11. TVA Piping Bill of Material 47 BM 432-2, Rev. 5, July 15, 1986.

E.2-12. Bazergui, A., L. Marchand, and J. Raut, Further Gasket Leakage Behavior Trends, Bulletin 325, Welding Research Council, New York, NY, July 1987.

E.2-13. Tennessee Valley Authority, Watts Bar Nuclear Plant, Maintenance Instruction MI-74.1, Removal, Inspection, and Replacement of RHR Pump, Revision 10, March 9, 1990.

E.2-14. Watts Bar Emergency Instructions

E-0	Reactor Trip or Safety Injection, Revision 4
E-1	Loss of Reactor or Secondary Coolant, Revision 3
ES-1.1	Post LOCA Cooldown, Revision 3
ES-1.2	Transfer to RHR Containment Sump, Revision 4
ECA-1.1	Loss of RHR Sump Recirculation, Revision 0
ECA-1.2	LOCA Outside Containment, Revision 0

Table E.2-1 (Page 1 of 2). Containment Penetrations that Connect to RCS — Screening

Penetration No.	Description	Line Diameter (inches)	Screening
X-15	CVCS Letdown	2	The normal open path (valves 62-73 and 62-77) is small, and valves fail closed on loss of power. Flow and impact outside containment is not significant.
X-16	CVCS Charging	3	There are two or three check valves in series inside containment, two isolation valves outside containment, and the design pressure outside is high. The line is also relatively small. This path is considered insignificant.
X-17	RHR Hot Leg Injection	12	There is a normally closed MOV and two series check valves to each of the two hot legs. These paths were neglected because this failure frequency will be much smaller than that of penetrations X-20A and X-20B, which contain only two check valves in series and will dominate the total failure frequency.
X-20A	RHR Injection B	8	Inside containment are two check valves in series to two cold legs. A normally open MOV is outside containment with a low pressure design. Retained as interfacing LOCA path.
X-20B	RHR Injection A	8	Inside containment are two check valves in series to two cold legs. A normally open MOV is outside containment with a low pressure design. Retained as interfacing LOCA path.
X-21	Safety Injection Hot Leg Injection B	4	Normally closed MOV outside containment and two series check valves to two hot legs inside containment. These paths were neglected because penetrations X-20A and X-20B that contain only two check valves in series will dominate the total failure frequency, and the safety injection design pressure is higher with smaller lines.
X-22	Charging Injection	3	Two check valves inside containment. Normally closed MOVs outside and normally operating high pressure system. This path is considered insignificant.

Table E.2-1 (Page 2 of 2). Containment Penetrations that Connect to RCS — Screening

Penetration No.	Description	Line Diameter (inches)	Screening
X-32	Safety Injection Hot Leg Injection A	4	Normally closed MOV outside containment and two series check valves to two hot legs inside containment. These paths were neglected because penetrations X-20A and X-20B contain only two check valves in series will dominate the total failure frequency, and the safety injection design pressure is higher with smaller lines.
X-33	Safety Injection	4	Two check valves in series to four cold legs, and lines are small. A normally open MOV outside containment and high pressure design. These paths were neglected because the failure frequency of penetrations X-20A and X-20B will dominate.
X-43A	CVCS/RCP Seal Injection	2	There are two check valves in series inside containment, and the lines are small. There are manual valves outside containment, and the design pressure is high. This path is considered insignificant.
X-43B	CVCS/RCP Seal Injection	2	There are two check valves in series inside containment, and the lines are small. There are manual valves outside containment, and the design pressure is high. This path is considered insignificant.
X-43C	CVCS/RCP Seal Injection	2	There are two check valves in series inside containment, and the lines are small. There are manual valves outside containment, and the design pressure is high. This path is considered insignificant.
X-43D	CVCS/RCP Seal Injection	2	There are two check valves in series inside containment, and the lines are small. There are manual valves outside containment, and the design pressure is high. This path is considered insignificant.
X-44	CVCS/Seal Water Return	4	Seal leakoff lines are small (~ 1 inch) and the MOV inside containment can be closed. The design pressure outside containment is low (200 psig) after another MOV. An RCP seal LOCA is required and is modeled in the Level 1 analysis.
X-107	RHR Supply	14	Four combinations of two normally closed MOVs in series inside containment from hot leg 4. Retained as an interfacing LOCA path.

Table E.2-2. Watts Bar Valve Design Data

Valve	Type	Size	Vendor	Drawing	Bolts (Bonnet)			
					(#) Size	Material	Effective Length (inches)	Torque
74-3	MOV Gate	14	West		(20) 1-1/16		4	
74-16	AOV Butter	8	Contintal		(12) 1		7	
74-21	MOV Gate	14	West$_3$		(20) 1-1/16		4	
74-28	AOV Butter	8	Contintal		(12) 1		7	
74-32	AOV Butter	8	Contintal		(12) 1		7	
74-33	MOV Gate	8	West		(16)-5/8		2-3/4	
74-34	HCV Gate	8	West					
74-35	MOV Gate	8	West$_{33}$		(16)-5/8		2-3/4	
74-36	HCV	8	West		(16)-5/8		2-3/4	
74-37	HCV	8	West$_{36}$		(16)-5/8		2-3/4	
74-544	Check	8	Darling	W9123452*	(12) 1	SA564-603-1100	2	189
74-545	Check	8	Darling	W9123452*	(12) 1	SA564-630-110	2	189
74-514	Check	8	West		(16)-5/8		1-5/8	
74-515	Check	8	West$_{514}$		(16)-5/8		1-5/8	
74-520	HCV	8	West		(16)-5/8		2-3/4	
74-521	HCV	8	West$_{520}$		(16)-5/8		2-3/4	
74-524	HCV	8	West		(16)-5/8		2-3/4	
74-525	HCV	8	West$_{524}$		(16)-5/8		2-3/4	
63-1	MOV Gate	14	West		(20) 1			
63-502	Check	12	West		(16) 1			
63-72	MOV Gate	18	West					
63-73	MOV Gate	18	West					
72-40	MOV Gate	8	West					
72-41	MOV Gate	8	West					
63-8	MOV Gate	8	West					
63-11	MOV Gate	8	West					

Table E.2-3. Pipe Median Failure Pressures

Diameter (inches)	Schedule	Material	Corrosion (inches)	Failure Pressure (psig)			
				Room Temperature	400°F	600°F	800°F
3	40 S	304	0.0	7,790	6,690	6,225	5,880
			0.02	7,070	6,070	5,650	5,340
			0.04	6,350	5,450	5,070	4,790
6	160	316	0.0	16,910	14,720	13,740	13,030
			0.02	16,440	14,310	13,355	12,670
			0.04	15,960	13,900	12,970	12,300
8	40 S	304	0.0	4,465	3,830	3,570	3,370
			0.02	4,190	3,595	3,345	3,160
			0.04	3,910	3,360	3,120	2,950
8	160	304	0.0	14,720	12,630	11,760	11,110
			0.02	14,390	12,350	11,500	10,865
			0.04	14,070	12,075	112,400	10,620
10	40 S	304	0.0	4,030	3,460	3,220	3,040
			0.02	3,810	3,270	3,040	2,880
			0.04	3,590	3,080	2,870	2,710
10	140	316	0.0	13,960	12,160	11,350	10,760
			0.02	13,685	11,930	11,120	10,545
			0.04	13,410	11,670	10,890	10,330
12	40 S	304	0.0	3,760	3,230	3,010	2,840
			0.02	3,580	3,070	2,860	2,700
			0.04	3,390	2,910	2,710	2,560
12	140	316	0.0	13,090	11,400	10,640	10,090
			0.02	12,860	11,200	10,450	9,910
			0.04	12,630	10,990	10,260	9,730
14	40	304	0.0	3,690	3,170	2,950	2,785
			0.02	3,520	3,020	2,810	2,660
			0.04	3,350	2,880	2,680	2,530
14	140	316	0.0	13,280	11,565	10,790	10,230
			0.02	13,070	11,380	10,620	10,070
			0.04	12,860	11,190	10,450	9,910
18	.375 Wall	304	0.0	2,410	2,065	1,920	1,820
			0.02	2,280	1,955	1,820	1,720
			0.04	2,150	1,845	1,720	1,620
24	.375 Wall	304	0.0	1,785	1,530	1,430	1,350
			0.02	1,690	1,450	1,350	1,280
			0.04	1,595	1,370	1,270	1,200

Table E.2-6. Bolted Bonnet Valve Gasket Stress, Gross Leak Pressure, and Leak Rate

Valve Number	Valve Size (inches)	Valve Operator	Valve Type	Eff. Gasket Stress (psi)	Act. Gasket Stress (psi)	Pressure Area (sq in)	Preload Pressure (psi)	Gross Leak Pressure (psi)	Leak Rate at GLP (mg/sec)	Leak Area at 1.25 GLP (sq in)	Leak Area at 1.5 GLP (sq in)	Leak Area at 1.75 GLP (sq in)	Leak Area at 2.0 GLP (sq in)
300# Valves													
74-3	14	MOV	Gate	16,649	11,040	223.787	826	2,137	1	0.10	0.20	0.29	0.39
74-21	14	MOV	Gate	16,649	11,040	223.787	826	2,137	1	0.10	0.20	0.29	0.39
74-33	8	MOV	Gate	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
74-34	8	HCV	HCV	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
74-35	8	MOV	Gate	15,624	11,040	74.662	793	2,305	0	0.04	0.08	0.11	0.15
74-36	8	HCV	HCV	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
74-37	8	HCV	HCV	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
74-544	8		Check	16,352	7,590	69.029	1,207	1,980	12	0.01	0.02	0.03	0.04
74-545	8		Check	16,352	7,590	69.029	1,207	1,980	12	0.01	0.02	0.03	0.04
74-514	8		Check	15,624	11,040	74.662	793	2,305	1	0.02	0.04	0.07	0.09
74-515	8		Check	15,624	11,040	74.662	793	2,305	1	0.02	0.04	0.07	0.09
74-520	8	HCV	HCV	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
74-521	8	HCV	HCV	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
74-524	8	HCV	HCV	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
74-525	8	HCV	HCV	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
63-1	12	MOV	Gate	16,649	11,040	223.787	826	2,137	1	0.10	0.20	0.29	0.39
63-502	12		Check	16,649	11,040	223.787	826	2,137	0	0.06	0.11	0.17	0.22
63-72	18	MOV	Gate	19,671	11,040	368.134	1,059	2,150	2	0.17	0.34	0.50	0.67
63-73	18	MOV	Gate	19,671	11,040	368.134	1,059	2,150	2	0.17	0.34	0.50	0.67
72-40	8	MOV	Gate	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
72-41	8	MOV	Gate	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
63-8	8	MOV	Gate	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15
63-11	8	MOV	Gate	15,624	11,040	74.662	793	2,305	1	0.04	0.08	0.11	0.15

Table E.2-7. RHR Heat Exchanger Tube Sheet Gross Leak Pressures and Leak Areas

Note	Eff. Gasket Stress (psi)	Act. Gasket Stress (psi)	Gasket Deflect. (inches)	Gross Leak Pressure (psi)	Leak Rate at GLP (mg/sec)	Leak Rate at .25 GLP (mg/sec)	Leak Rate at .50 GLP (mg/sec)	Leak Rate at .75 GLP (mg/sec)	Leak Area at 1.25 GLP (sq in)	Leak Area at 1.50 GLP (sq in)	Leak Area at 1.75 GLP (sq in)	Leak Area at 2.0 GLP (sq in)	Bolt Stress at 2.0 GLP (psi)
(1)	18,689	16,500	0.055	1,078	0	0	0	0	0.58	1.16	1.73	2.31	58,397
(2)	21,025	16,500	0.055	1,078	0	0	0	0	0.58	1.16	1.73	2.31	61,571
(3)	23,361	16,500	0.055	1,078	0	0	0	0	0.58	1.16	1.73	2.31	64,745
(4)	21,025	14,025	0.055	917	0	0	0	0	0.49	0.98	1.67	1.97	52,336
(5)	21,025	12,375	0.055	889	1	0	0	0	0.43	0.87	1.47	1.73	46,178

Gasket: Outside Diameter = 41.5 inches, Inside Diameter = 40.0 inches, D_{max} = 0.055 inches; 52 1⅛ ϕ SA-193-B7 Studs, K = 300,000 psi/inch.

Notes:

(1) Initial Bolt Stress = 40,000 psi; Joint Relaxation = 0.0%
(2) Initial Bolt Stress = 45,000 psi; Joint Relaxation = 0.0%
(3) Initial Bolt Stress = 50,000 psi; Joint Relaxation = 0.0%
(4) Initial Bolt Stress = 45,000 psi; Joint Relaxation = 15%
(5) Initial Bolt Stress = 45,000 psi; Joint Relaxation = 25%

Table E.2-8. RHR Pump Gasket Gross Leak Pressures and Leak Areas

Note	Eff. Gasket Stress (psi)	Act. Gasket Stress (psi)	Gasket Deflect. (inches)	Gross Leak Pressure (psi)	Leak Rate at GLP (mg/sec)	Leak Rate at .25 GLP (mg/sec)	Leak Rate at .50 GLP (mg/sec)	Leak Rate at .75 GLP (mg/sec)	Leak Area at 1.25 GLP (sq in)	Leak Area at 1.50 GLP (sq in)	Leak Area at 1.75 GLP (sq in)	Leak Area at 2.0 GLP (sq in)	Bolt Stress at 2.0 GLP (psi)
(1)	43,346	12,000	0.05	2,210	2	0	0	1	0.09	0.18	0.27	0.36	58,470
(2)	50,570	12,000	0.05	2,579	3	0	1	1	0.11	0.21	0.32	0.42	68,215
(3)	57,795	12,000	0.05	2,947	3	0	1	1	0.12	0.24	0.36	0.48	77,960
(4)	42,985	10,200	0.05	2,192	6	1	1	3	0.09	0.18	0.27	0.36	63,233
(5)	37,928	9,000	0.05	1,934	11	1	2	5	0.08	0.16	0.24	0.32	59,911

Twenty-four 2-inch ϕ Bolts ≈ 3½-inch long; Gasket: Outside Diameter = 34 inches, Inside Diameter = 33 inches, D_{max} = 0.05 inches, K = 240,000 psi/inch.

Notes:

(1) Initial Bolt Stress = 30,000 psi; Joint Relaxation = 0.0%
(2) Initial Bolt Stress = 35,000 psi; Joint Relaxation = 0.0%
(3) Initial Bolt Stress = 40,000 psi; Joint Relaxation = 0.0%
(4) Initial Bolt Stress = 35,000 psi; Joint Relaxation = 15%
(5) Initial Bolt Stress = 35,000 psi; Joint Relaxation = 25%

Table E.2-9. Data Distribution Report

	NAME OF DISTRIBUTION	MEAN	5TH %ILE	MEDIAN	95TH %ILE
ZTVMOE	VALVE, MOTOR OPERATED -FAIL TO CLOSE WHILE SHOWING CLOSED	1.07E-04	2.10E-05	7.47E-05	3.07E-04
WBNCLK	CHECK VALVE RUPTURE OR LEAK (> 150 GPM)	4.80E-08	1.68E-09	1.75E-08	1.74E-07
WBNMLK	MOV RUPTURE OR LEAK (> 150 GPM)	4.80E-08	1.68E-09	1.75E-08	1.74E-07
WBNCRD	CHECK VALVE RUPTURE ON DEMAND	2.26E-04	2.66E-05	1.37E-04	6.82E-04
WBNMRD	MOTOR OPERATED VALVE RUPTURE ON DEMAND	2.26E-04	2.66E-05	1.37E-04	6.82E-04
WBNCOO	SWING CHECK VALVE FAILS TO OPEN ON DEMAND	1.83E-04	3.60E-06	4.91E-05	5.18E-04
WBNCOC	SWING CHECK VALVE FAILS TO CLOSE ON DEMAND	8.35E-04	1.65E-05	2.24E-04	2.37E-03
WBNHTO	MANUAL VALVES - TRANSFER OPEN	4.20E-08	1.57E-09	1.30E-08	1.19E-07
ZTVMCX	DISC CHECK VALVE OR MOTOR-OPERATED VALVE - RUPTURE	1.55E-08	1.40E-10	2.87E-09	5.87E-08
WBNRFO	RELIEF VALVES - FAIL TO OPEN ON DEMAND	2.42E-05	9.95E-07	9.49E-06	9.04E-05
WBVLK2	VALVE DISC RUPTURE - LEAK > 800 GPM	1.28E-08	4.48E-10	4.65E-09	4.65E-08
WBVLK3	VALVE DISC RUPTURE - LEAK > 1700 GPM	6.93E-09	2.43E-10	2.52E-09	2.52E-08

NUMBER OF VARIABLES: 12

Table E.2-10. ISLOCA Master Frequency File

SF Name...	Top.....	SF Value...	Split Fraction Description.....
VI1	IEVI	4.0074E-06	RHR INJECTION INITIATING EVENT
VI11	VI1	2.7803E-03	RHR PUMPS FAIL TO BE ISOLATED
VI21	VI2	5.6100E-03	MANUAL VALVE 74-34 NOT CLOSED
VI31	VI3	8.0690E-04	CHECK VALVE 63-502 NOT CLOSED
VI41	VI4	1.6040E-01	CONDITIONAL FREQUENCY OF LEAK > 800 GPM
VI4D1	VI4D	6.4450E-07	LEAK > RWST VENT CAPACITY (800 GPM)
VI5F	VI5	1.0000E+00	OPERATOR FAILS TO CLOSES MOV 63-1
VI61	VI6	4.9560E-05	1 OF 2 RELIEF VALVES FAIL TO OPEN
VI62	VI6	7.4640E-05	1 OF 3 RELIEF VALVES FAIL TO OPEN
VI71	VI7	1.6040E-01	CONDITIONAL FREQUENCY OF LEAK > 800 GPM
VI72	VI7	7.4990E-02	CONDITIONAL FREQUENCY OF LEAK > 1700 GPM
VI7D1	VI7D	5.0140E-07	LEAK > 800 GPM
VI7D2	VI7D	3.0276E-07	LEAK > 1700 GPM
VI81	VI8	5.0000E-02	PIPING DOWNSTREAM FAIL W/ 800 GPM RELIEF
VI82	VI8	1.0000E-01	PIPING DOWNSTREAM FAIL WITH NO RELIEF
VI83	VI8	7.0000E-01	RHR FAILURE WITH 1700 GPM RELIEF
VI91	VI9	1.0000E-01	OPERATOR FAILURE - 900 GPM TO PRT & LARGE LOCA OUTSIDE
VI92	VI9	1.0000E-01	OPERATOR FAILURE - NO FLOW TO PRT AND SMALL LOCA OUTSIDE
VI93	VI9	1.0000E-01	OPERATOR FAILURE - NO FLOW TO PRT AND LARGE LOCA OUTSIDE
VI94	VI9	1.0000E-01	OPERATOR FAILURE - 1700 GPM TO PRT AND SMALL LOCA THROUGH RHR PUMP SEAL
VI95	VI9	1.0000E-01	OPERATOR FAILURE - 1700 GPM TO PRT AND LARGE LOCA OUTSIDE
VI96	VI9	1.0000E-01	OPERATOR FAILURE - NO FLOW TO PRT AND LARGE LOCA OUTSIDE
VI97	VI9	1.0000E-01	OPERATOR FAILURE - < 900 GPM TO RWST, ISOLATION, VI13 = F
VI98	VI9	1.0000E-01	OPERATOR FAILURE - < 900 GPM TO RWST, ISOLATION VI12 = F
VI99	VI9	1.0000E-01	OPERATOR FAILURE - > 900 RWST RUPTURE, CORE DAMAGE WITHOUT BYPASS
VI9F	VI9	1.0000E+00	GUARANTEED FAILURE
VS1	IEVS	7.2120E-06	RHR SUCTION INITIATING EVENT
VS11	VS1	8.6510E-04	CHECK VALVE 63-502 NOT CLOSED
VS21	VS2	7.5940E-06	MANUAL VALVE 74-34 NOT CLOSED
VS31	VS3	3.5490E-02	CONDITIONAL FREQUENCY OF LEAK > RWST VENT CAPACITY
VS3D1	VS3D	2.5664E-07	LEAK > RWST VENT CAPACITY (900 GPM)
VS4F	VS4	1.0000E+00	OPERATOR FAILS TO CLOSE MOV 63-1
VS51	VS5	2.2860E-05	RELIEF VALVE 74-505 OPENS
VS61	VS6	5.3400E-05	1 OF 2 RELIEF VALVES FAIL TO OPEN
VS71	VS7	3.5490E-02	CONDITIONAL FREQUENCY OF LEAK > 900 GPM
VS7D1	VS7D	2.4924E-07	LEAK > 900 GPM
VS81	VS8	4.3320E-02	CONDITIONAL FREQUENCY OF LEAK > 1700 GPM
VS8D1	VS8D	3.1272E-07	LEAK > 1700 GPM
VS91	VS9	7.0000E-01	RCS DEPRESSURIZING AT 1700 GPM
VS92	VS9	8.0000E-01	RCS DEPRESSURIZING AT 900 GPM
VSA1	VSA	1.0000E-01	OPERATOR FAILURE - 1700 GPM TO PRT & SMALL LOCA THROUGH RHR PUMP SEAL
VSA2	VSA	1.0000E-01	OPERATOR FAILURE - 900 GPM TO PRT AND SMALL LOCA THROUGH RHR PUMP SEAL
VSA3	VSA	1.0000E-01	OPERATOR FAILURE - 1700 GPM TO PRT AND LARGE LOCA OUTSIDE
VSA4	VSA	1.0000E-01	OPERATOR FAILURE - 900 GPM TO PRT AND LARGE LOCA OUTSIDE
VSA5	VSA	1.0000E-01	OPERATOR FAILURE - NO FLOW TO PRT AND LARGE LOCA OUTSIDE
VSAF	VSA	1.0000E+00	GUARANTEED FAILURE

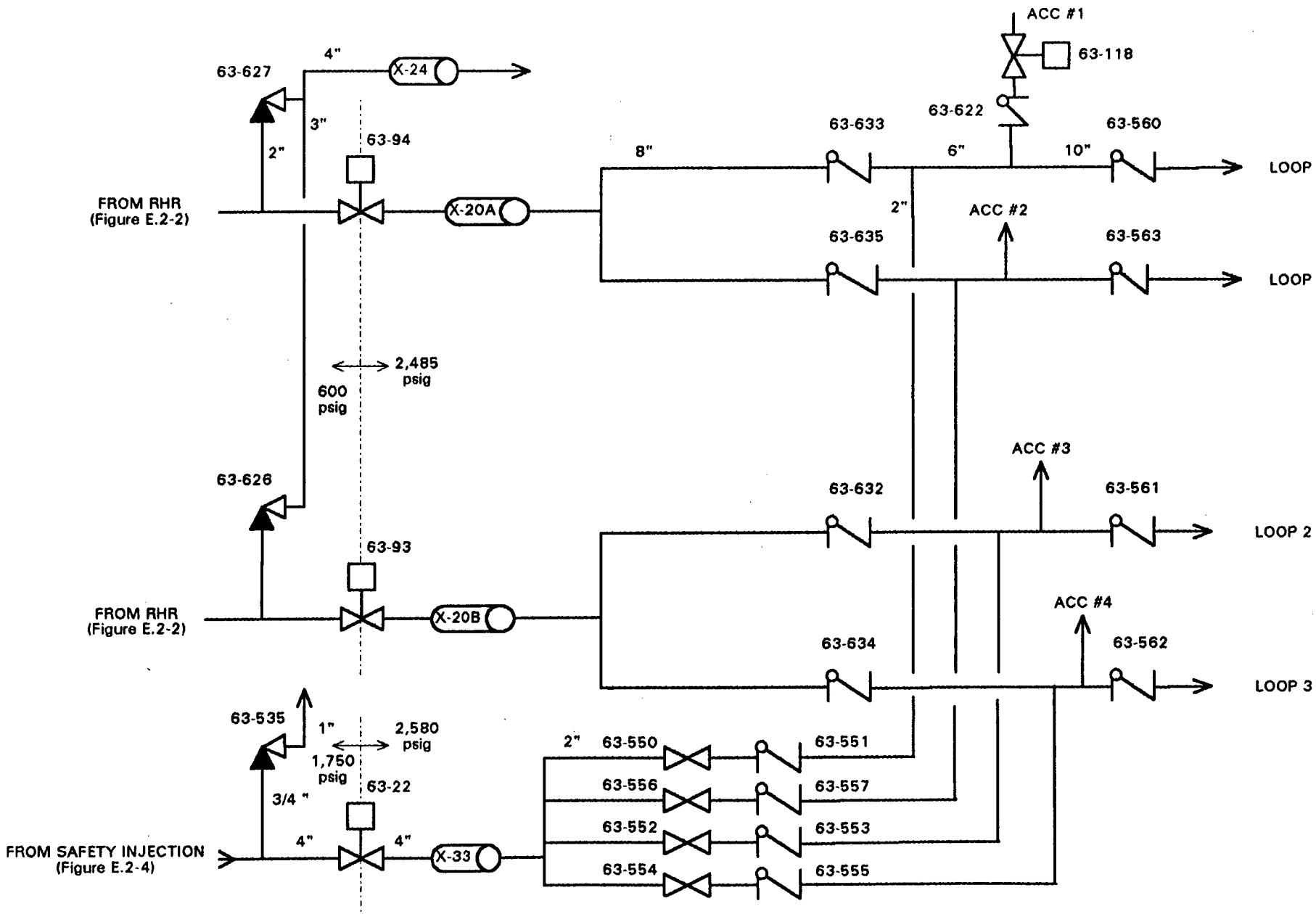

Figure E.2-1. Cold Leg Injection from RHR and Safety Injection

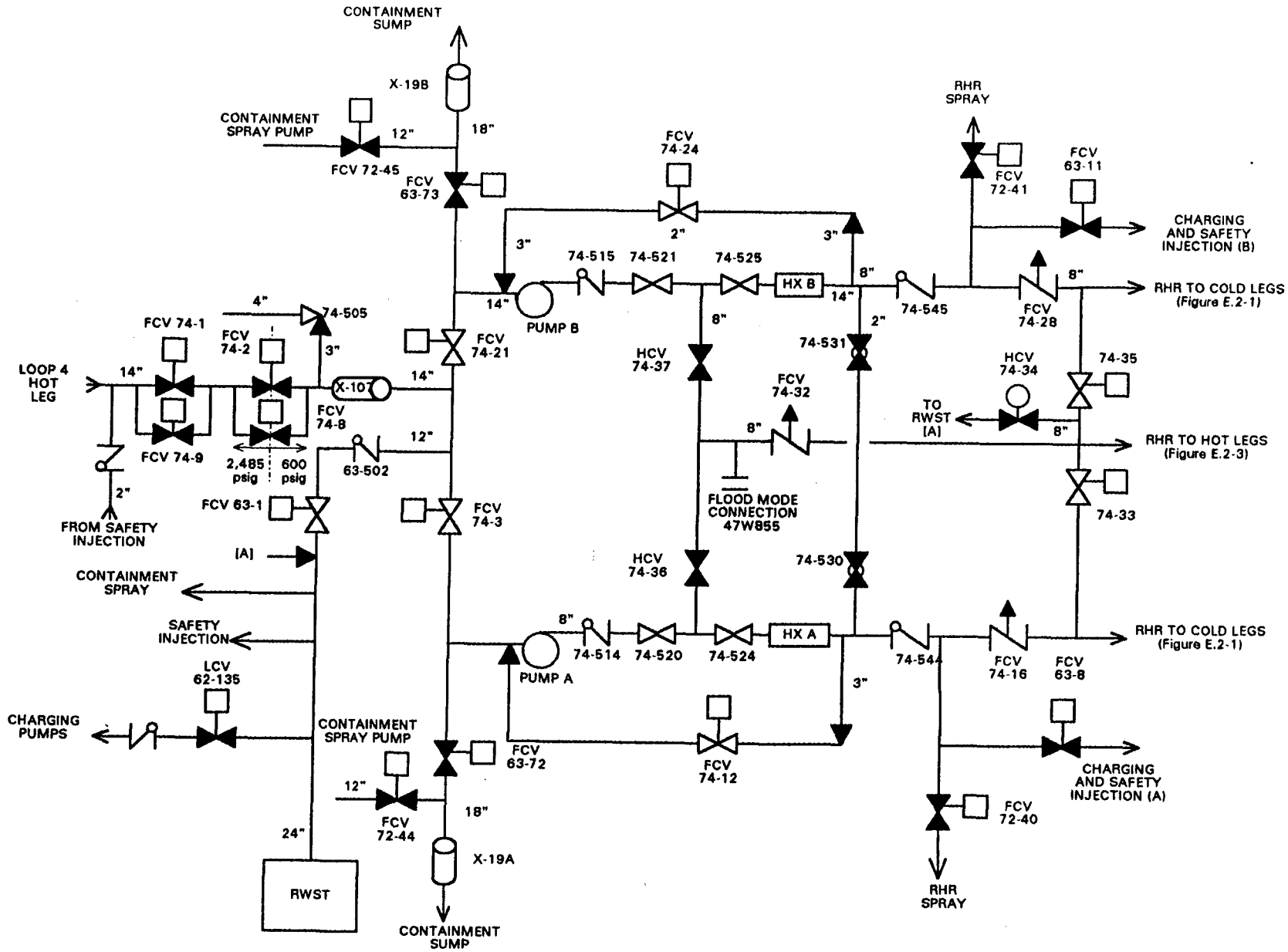

Figure E.2-2. RHR Suction Path and Pumps

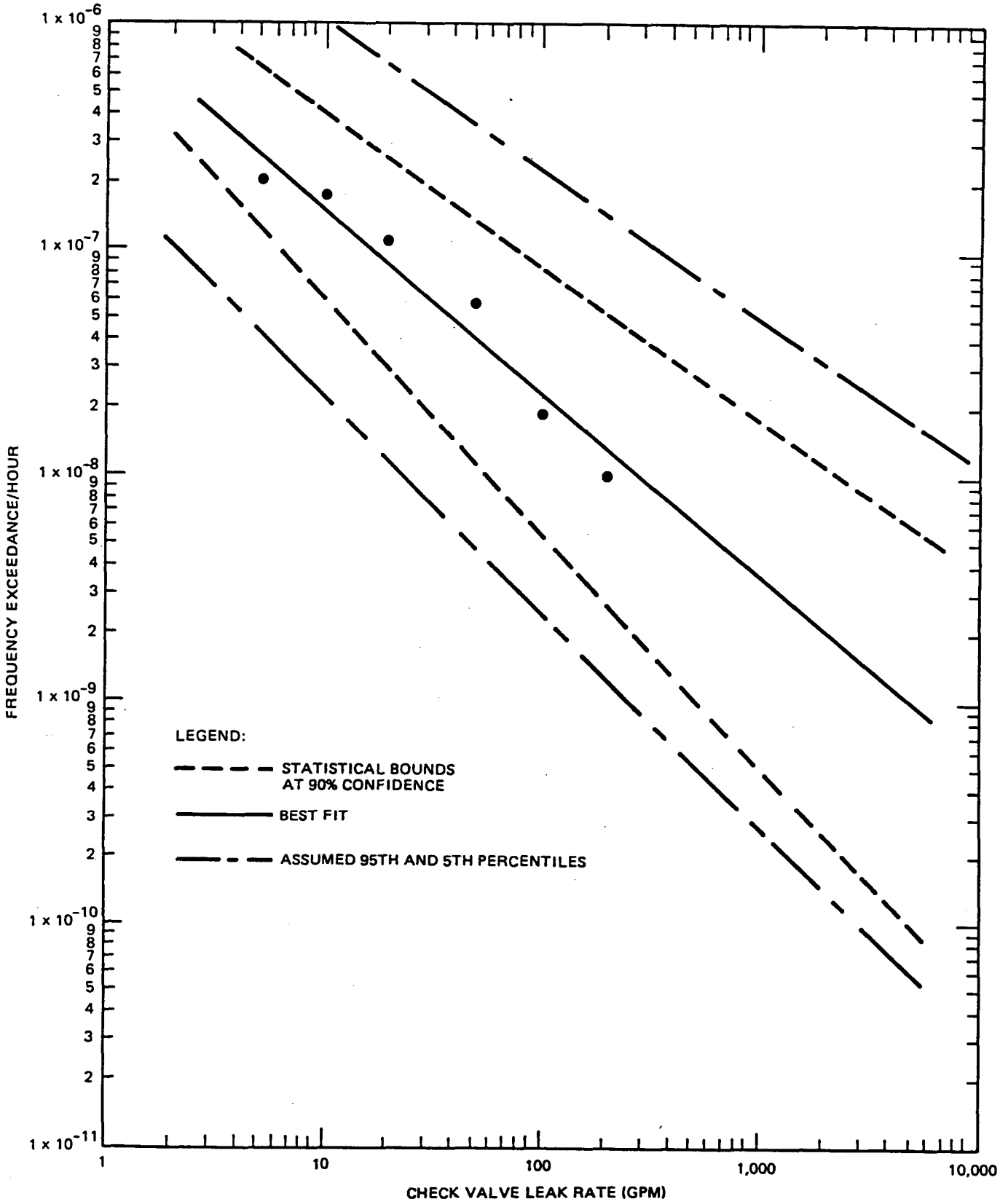

Figure E.2-3. Frequency of Check Valve Leakage Events (Reference E.2-7)

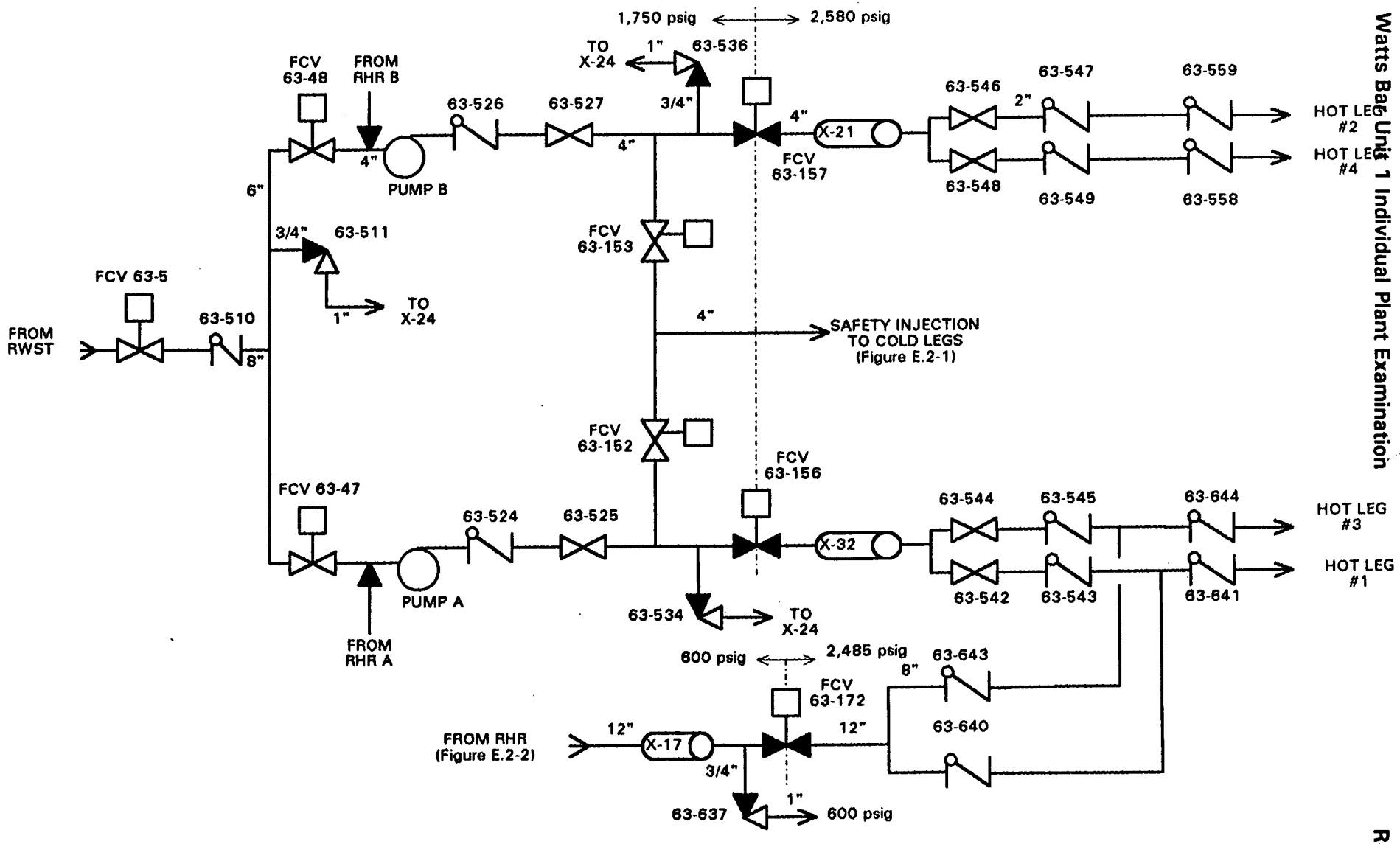

Figure E.2-4. Hot Leg Injection from Safety Injection and RHR

Table E.2-4. 300-Pound Flange Gasket Stress, Gross Leak Pressure, and Leak Rate

Flange Diameter (inches)	Initial Bolt Stress (psi)	Joint Relaxation (percent)	Eff. Gasket Stress (psi)	Act. Gasket Stress (psi)	Gasket Deflect. (inches)	Gross Leak Pressure (psi)	Leak Rate at GLP (mg/sec)	Leak Rate at .25 GLP (mg/sec)	Leak Rate at .50 GLP (mg/sec)	Leak Rate at .75 GLP (mg/sec)	Leak Area at 1.25 GLP (sq in)	Leak Area at 1.5 GLP (sq in)	Leak Area at 1.75 GLP (sq in)	Leak Area at 2.0 GLP (sq in)	Bolt Stress at 2.0 GLP (psi)
8	30,000	0	10,236	4,965	0.050	2,273	72	10	19	20	0.03	0.05	0.08	0.10	6,112
8	35,000	0	11,942	4,965	0.050	2,579	74	11	22	33	0.03	0.06	0.09	0.11	69,333
8	40,000	0	13,648	4,965	0.050	2,884	76	12	25	37	0.03	0.06	0.10	0.13	77,554
8	50,000	0	17,060	4,965	0.050	3,496	79	15	30	45	0.04	0.08	0.12	0.16	93,996
8	60,000	0	20,472	4,965	0.050	4,107	82	18	35	53	0.05	0.09	0.14	0.18	110,439
8	35,000	15	11,942	4,220	0.050	2,513	74	12	24	37	0.03	0.06	0.14	0.11	68,285
8	35,000	25	11,942	3,724	0.050	2,469	73	13	19	36	0.03	0.05	0.08	0.11	67,587
8	35,000	33	11,942	3,327	0.050	2,434	73	14	29	43	0.03	0.05	0.07	0.11	67,028
8	35,000	50	11,942	3,327	0.050	2,434	73	14	29	43	0.03	0.05	0.07	0.11	67,028
14	30,000	0	15,822	7,350	0.050	2,394	11	1	2	4	0.05	0.10	0.14	0.19	55,462
14	35,000	0	18,459	7,350	0.050	2,792	12	1	3	4	0.06	0.11	0.17	0.22	64,705
14	40,000	0	21,096	7,350	0.050	3,191	12	2	3	5	0.06	0.13	0.19	0.25	73,949
14	50,000	0	26,370	7,350	0.050	3,989	13	2	4	6	0.08	0.16	0.24	0.32	92,436
14	60,000	0	31,644	7,350	0.050	4,787	13	2	5	7	0.10	0.19	0.29	0.38	11,092
14	35,000	15	18,459	6,248	0.050	2,792	12	2	3	5	0.06	0.11	0.33	0.22	64,705
14	35,000	25	18,459	5,513	0.050	2,792	12	2	3	4	0.06	0.11	0.17	0.22	64,705
14	35,000	33	18,459	4,925	0.050	2,792	12	2	4	6	0.06	0.11	0.15	0.22	64,705
14	35,000	50	18,459	4,925	0.050	2,792	12	2	4	6	0.06	0.11	0.15	0.22	64,705

Bolt Yield Stress = 111,700 psi (SA-193-B7)
DGmax = 0.050 inches.

Table E.2-5. Bolted Bonnet Valve Gasket and Bonnet Bolting Data for 300-Pound Valves

Valve Number	Valve Size (inches)	Valve Operator	Valve Type	Gasket					Bolts					
				Outside Diameter (inches)	Inside Diameter (inches)	Width (inches)	Area (sq in)	DGI (inches)	Number	Diameter (inches)	Area (sq in)	Length (inches)	Torque (ft-lbs)	Stress (psi)
300# Valves														
74-3	14	MOV	Gate	18.080	16.880	0.600	32.949	0.048	16	1.000	0.6051	4.000	500.0	56,661
74-21	14	MOV	Gate	18.080	16.880	0.600	32.949	0.048	16	1.000	0.6051	4.000	500.0	56,661
74-33	8	MOV	Gate	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
74-34	8	HCV	HCV	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
74-35	8	MOV	Gate	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
74-36	8	HCV	HCV	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
74-37	8	HCV	HCV	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
74-544	8		Check	10.000	9.375	0.313	9.511	0.033	12	1.000	0.6051	2.000	189.0	21,418
74-545	8		Check	10.000	9.375	0.313	9.511	0.033	12	1.000	0.6051	2.000	189.0	21,418
74-514	8		Check	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	1.625	115.0	55,927
74-515	8		Check	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	1.625	115.0	55,927
74-520	8	HCV	HCV	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
74-521	8	HCV	HCV	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
74-524	8	HCV	HCV	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
74-525	8	HCV	HCV	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
63-1	12	MOV	Gate	18.080	16.880	0.600	32.949	0.048	16	1.000	0.6051	4.000	500.0	56,661
63-502	12		Check	18.080	16.880	0.600	32.949	0.048	16	1.000	0.6051	2.250	500.0	56,661
63-72	18	MOV	Gate	22.940	21.650	0.645	45.177	0.048	18	1.250	0.9985	6.000	900.0	49,446
63-73	18	MOV	Gate	22.940	21.650	0.645	45.177	0.048	18	1.250	0.9985	6.000	900.0	49,446
72-40	8	MOV	Gate	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
72-41	8	MOV	Gate	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
63-8	8	MOV	Gate	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927
63-11	8	MOV	Gate	10.560	9.750	0.405	12.921	0.048	16	0.625	0.2256	2.750	115.0	55,927

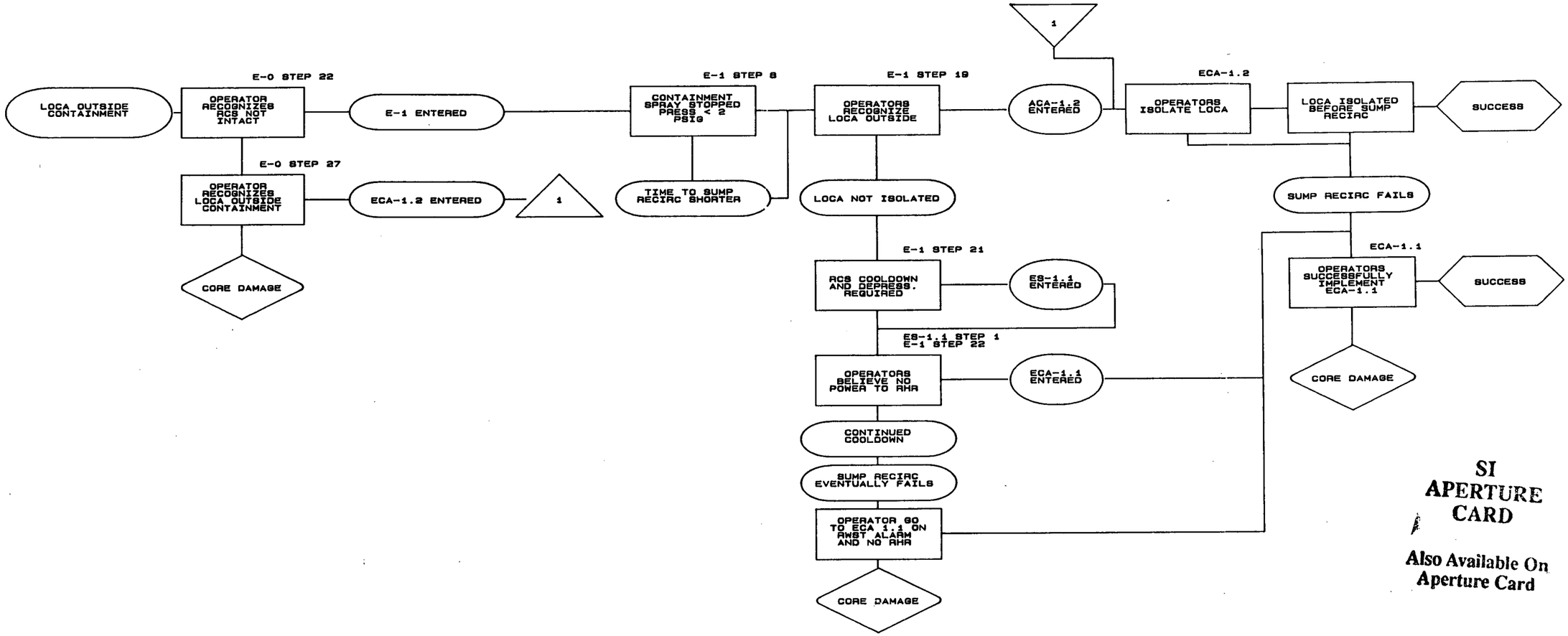

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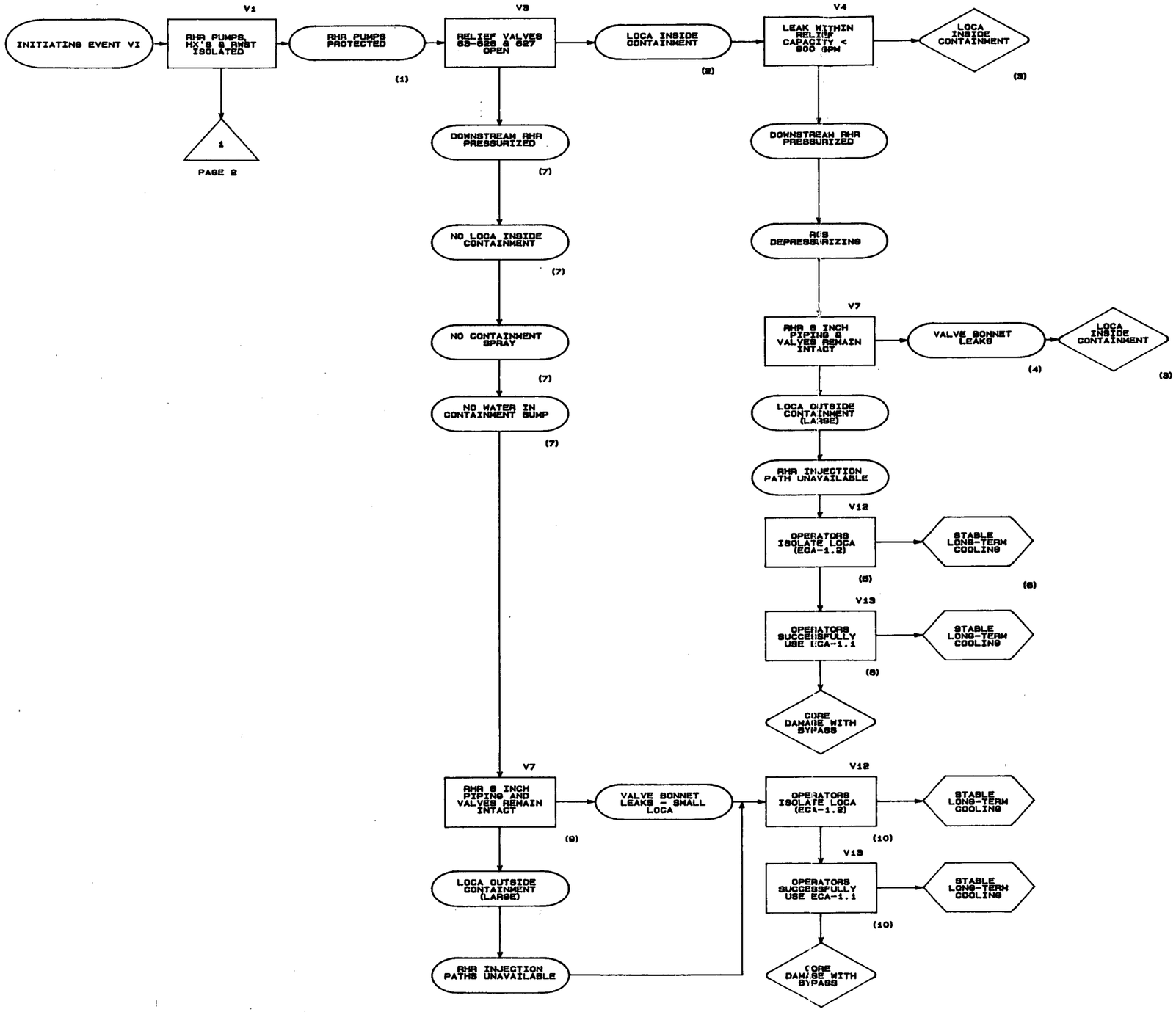
Figure E.2-5. Summary of Operator Response and EOIs — ISLOCA

9209030229-56



NOTES:

(1) RHR PUMPS AND REMAINING SYSTEM PROTECTED FROM OVERPRESSURE TRANSIENT

(2) LOCA THROUGH PRT WILL ACTUATE CONTAINMENT SPRAY AND QUICKEN TIME TO SUMP RECIRCULATION UNLESS SPRAY IS STOPPED

(3) LOCA INSIDE CONTAINMENT IS AN UNDEVELOPED ENDSTATE BECAUSE THIS FREQUENCY IS SMALL IN COMPARISON TO INITIATORS ALREADY IN THE IPE MODEL.

(4) VALVE BONNET LEAKS INCREASE UNTIL THE INITIAL PRESSURE TRANSIENT IS OVER. NO SUSTAINED HIGH PRESSURE AND TEMPERATURE WITH 900-1600 GPM RELIEF.

(5) OPERATORS ISOLATE LOCA PER ECA-1.2 BEFORE TRANSFER TO SUMP RECIRCULATION.

(6) IF LOCA IS ISOLATED BEFORE TRANSFER TO SUMP RECIRCULATION, THERE WILL BE SUFFICIENT RWST INVENTORY TO REFILL VESSEL AND AUXILIARY FEEDWATER CAN BE USED FOR HEAT REMOVAL. FAILURE OF THESE FUNCTIONS (EQUIPMENT) IS CONSIDERED SMALL IN COMPARISON TO THE OPERATOR ACTIONS.

(7) THE CASE WHERE 1 RELIEF VALVE OPENS IS NEGLECTED.

(8) IF THE OPERATORS RECOGNIZE THAT RHR WILL NOT WORK AND SUMP RECIRCULATION WILL FAIL, THEY MAY IMPLEMENT ECA-1.1 IN TIME TO PREVVENT CORE DAMAGE. NOTE THAT HIGH PRESSURE RECIRC IS POSSIBLE BECAUSE THE RHR PUMPS ARE ISOLATED AND INVENTORY IS ALSO GOING INTO THE CONTAINMENT THROUGH RELIEF VALVES AND CONTAINMENT SPRAY. THIS IS NEGLECTED.

(9) THE PROBABILITY OF PIPING FAILURES IS BASED ON SUSTAINED PRESSURE AND TEMPERATURE CONDITIONS. THESE CONDITIONS ARE ASSUMED TO CAUSE A SMALL LOCA OUTSIDE DUE TO FAILURE OF THE VALVE BONNET GASKETS.

(10) SIMILAR TO NOTES 5, 6 AND 8 EXCEPT FOR TIMING AND NO WATER IN CONTAINMENT SUMP. THERE IS MORE TIME FOR THE V7 SUCCESS CASE (IE, SMALL LOCA).

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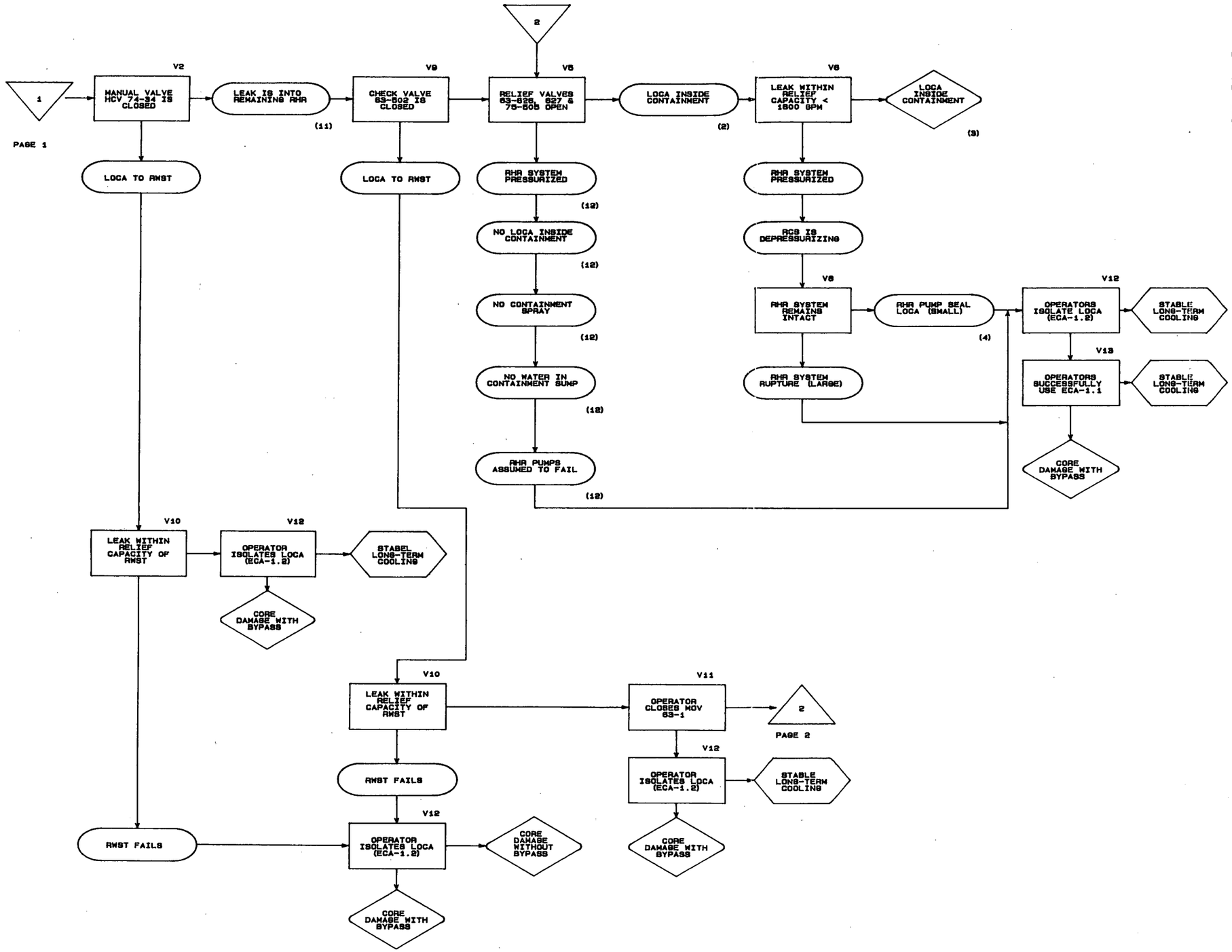
Figure E.2-6 (Page 1 of 2). Event Sequence Diagram for Initiator VI

9209030229 -57



NOTES (CONT.)

(11) EITHER CHECK VALVE 74-554 OR 559 OR MANUAL VALVE 74-36 OR 37 IS OPEN INTO THE REMAINING PORTION OF THE RHR SYSTEM.

(12) THE CASE WHERE 1 OR 2 RELIEF VALVES OPEN IS NEGLECTED. THE SUSTAINED PRESSURE AND TEMPERATURE TRANSIENT CAUSES PUMP SEAL FAILURES AND VALVE BONNET GASKET FAILURES. A LARGE LOCA OUTSIDE IS ASSUMED.

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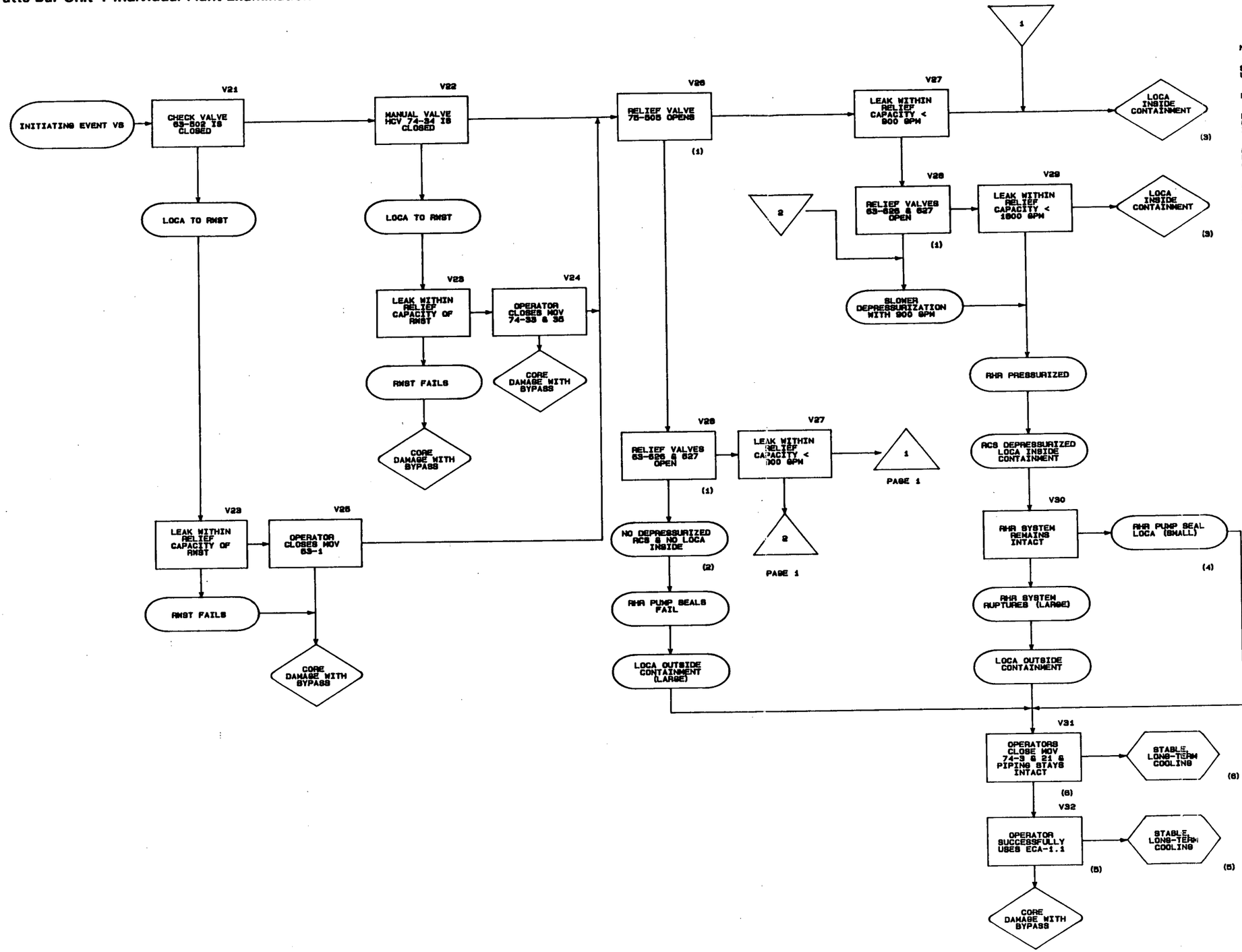
Figure E.2-6 (Page 2 of 2). Event Sequence Diagram for Initiator VI

9209030229-58



NOTES:

(1) LOCA THROUGH PRT WILL ACTUATE CONTAINMENT SPRAY AND QUICKEN TIME TO SUMP RECIRCULATION UNLESS SPRAY IS STOPPED

(2) THE CASE WHERE 1 RELIEF VALVE OPENS IS NEGLECTED

(3) LOCA INSIDE CONTAINMENT IS AN UNDEVELOPED ENDSTATE BECAUSE THIS FREQUENCY IS SMALL IN COMPARISON TO SIMILAR INITIATORS ALREADY IN THE IPE MODEL.

(4) VALVE BONNET LEAKS INCREASE UNTIL THE INITIAL PRESSURE TRANSIENT IS OVER. NO SUSTAINED HIGH PRESSURE AND TEMPERATURE WITH 900 TO 1800 GPM RELIEF.

(5) IF THE OPERATORS RECOGNIZE THAT RHR WILL NOT WORK AND SUMP RECIRCULATION WILL FAIL, THEY MAY IMPLEMENT ECA-1.1 IN TIME TO PREVENT CORE DAMAGE.

(6) IF THE OPERATORS RECOGNIZE THAT RHR IS UNAVAILABLE AND/OR THE LOCA IS THROUGH THE SUCTION PATH, THEY CAN ISOLATE THE LOCA BY CLOSING MOV 74-3 AND 21. IF THEY DO THIS AND PIPING REMAINS INTACT AND THIS IS ACCOMPLISHED BEFORE TRANSFER TO SUMP RECIRCULATION, HIGH PRESSURE INJECTION CAN REFILL THE REACTOR VESSEL AND AUXILIARY FEEDWATER CAN BE USED FOR HEAT REMOVAL. EQUIPMENT FAILURES ARE NEGLECTED BECAUSE HUMAN RELIABILITY IS JUDGED TO DOMINATE.

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Figure E.2-7. Event Sequence Diagram for Initiator VS

9209030229-59

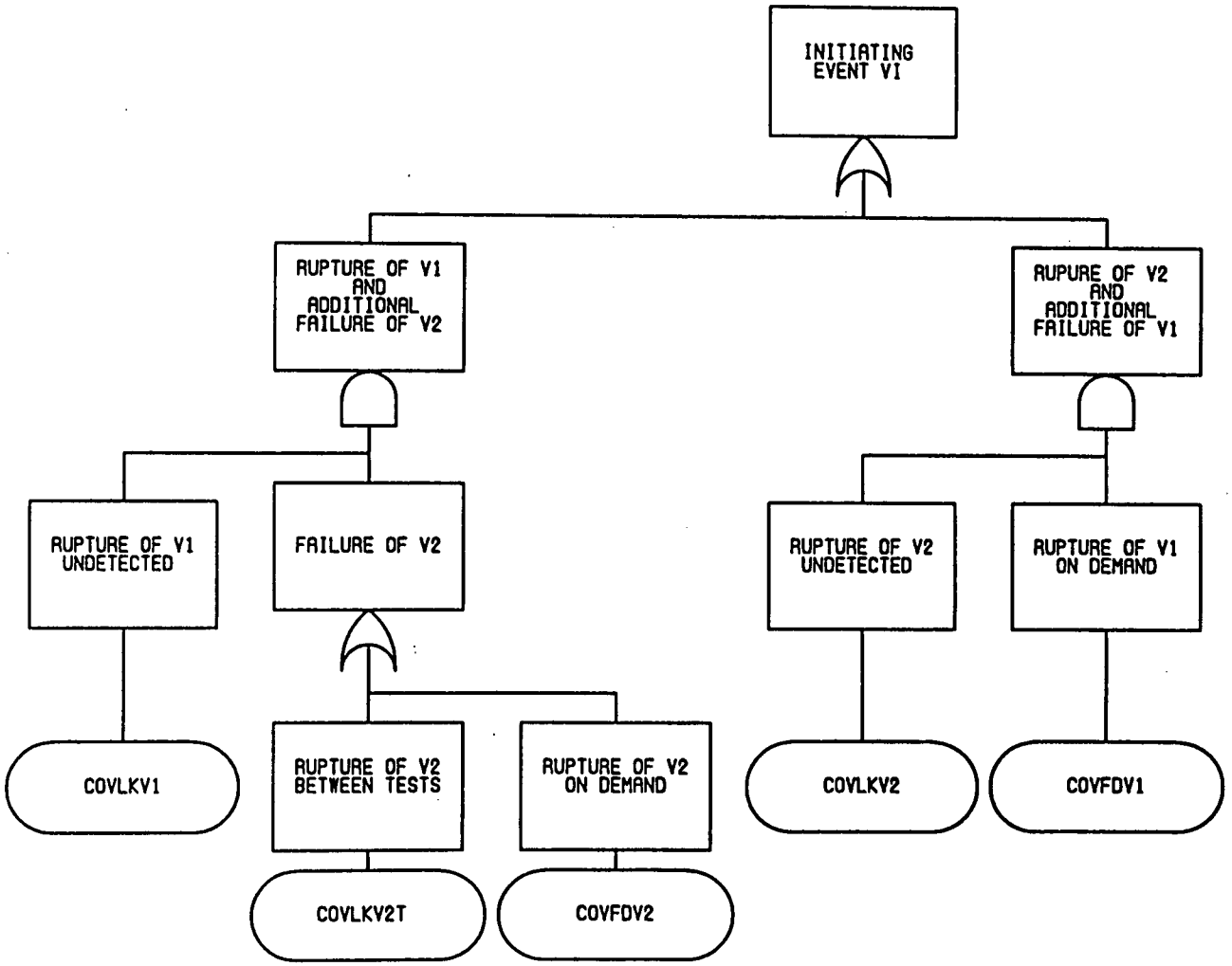

Figure E.2-8. Fault Tree for Initiating Event VI

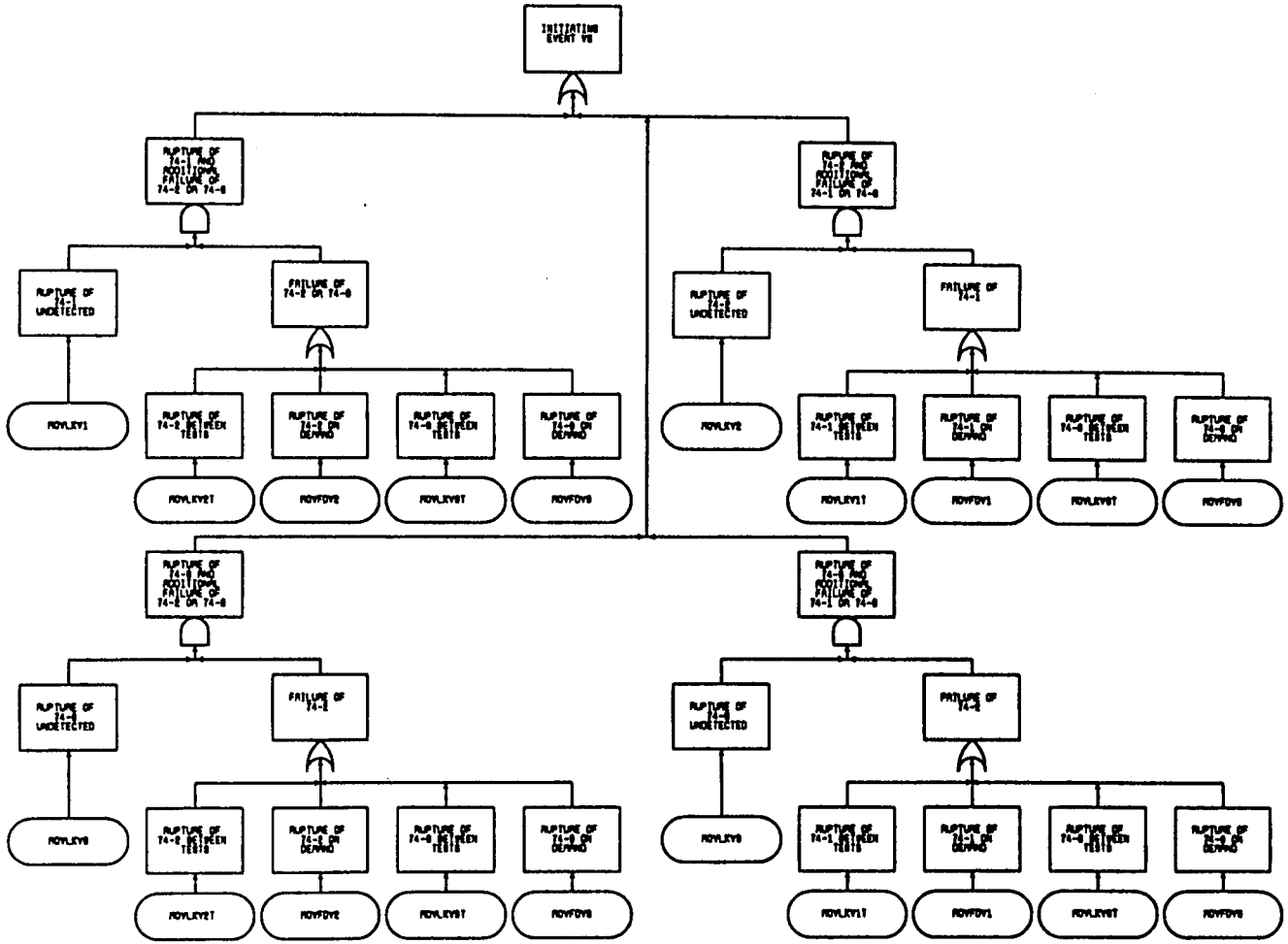

Figure E.2-9. Fault Tree for Initiating Event VS

```
Summary of Initiator Results          Binning Information
----------------------------          -------------------------

Initiating Event     VI               LOCA          3.9669E-06
Initiating Frequency 4.0000E-06       SUCCESS       2.9769E-08
                                      CDB           3.3088E-09
Tree Names VILOCA                     CD            1.0295E-11


Sequences Quantified 23
Sequences Saved      23
Seconds    1.92000000
Cutoff     0.0000E+00
Unaccounted For:0.0000E+00

Press [Enter] to continue or [Esc] to stop.
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Figure E.2-10 (Page 1 of 6). VILOCA Event Tree

MODEL Name: WBNVS
Sequences For Initiator: VI Sorted By Frequency

11:00:29 29 JUN 1992
Page 1

Rank.	Index....	Frequency.....	Failed and Multi-State Split Fractions.	End State.
1	1	3.3489E-06	/	LOCA
2	2	6.0780E-07	/VI71	LOCA
3	3	2.8790E-08	/VI71*VI81	SUCCESS
4	9	1.0220E-08	/VI11	LOCA
5	4	3.1989E-09	/VI71*VI81*VI91	CDB
6	12	5.2200E-10	/VI11*VI72*VI83	SUCCESS
7	10	2.2371E-10	/VI11*VI72	SUCCESS
8	5	1.6013E-10	/VI61	SUCCESS
9	13	5.8000E-11	/VI11*VI72*VI83*VI95	CDB
10	20	4.7144E-11	/VI11*VI21	SUCCESS
11	11	2.4857E-11	/VI11*VI72*VI94	CDB
12	6	1.7792E-11	/VI61*VI92	CDB
13	7	1.7792E-11	/VI61*VI82	SUCCESS
14	22	9.0066E-12	/VI11*VI21*VI41	CD
15	16	6.7428E-12	/VI11*VI31*VI5F	SUCCESS
16	21	5.2383E-12	/VI11*VI21*VI98	CDB
17	8	1.9769E-12	/VI61*VI82*VI93	CDB
18	18	1.2882E-12	/VI11*VI31*VI41	CD
19	23	1.0007E-12	/VI11*VI21*VI41*VI99	CDB
20	17	7.4920E-13	/VI11*VI31*VI5F*VI97	CDB
21	14	7.4229E-13	/VI11*VI62	SUCCESS
22	19	1.4313E-13	/VI11*VI31*VI41*VI99	CDB
23	15	8.2476E-14	/VI11*VI62*VI96	CDB

Figure E.2-10 (Page 2 of 6). VILOCA Event Tree

Page No. 1

MODEL Name: WBNVS
Event Tree: VILOCA

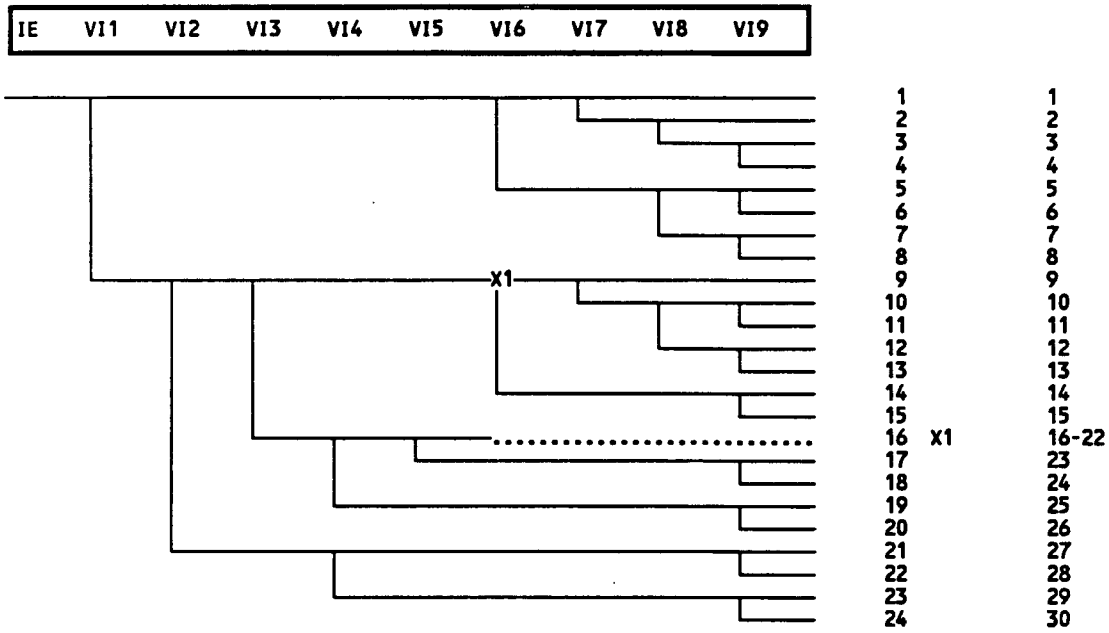

Figure E.2-10 (Page 3 of 6). VILOCA Event Tree

MODEL Name: WBNVS
Top Event Legend for Tree: VILOCA

15:02:43 26 JUN 1992
Page 1

Top Event Designator.....	Top Event Description.....
IE	Initiating Event
VI1	RHR PUMPS ISOLATED
VI2	MANUAL VALVE 74-34 CLOSED
VI3	CHECK VALVE 63-502 CLOSED
VI4	LEAK < RWST VENT CAPACITY
VI5	OPERATOR CLOSES MOV 63-1
VI6	RELIEF VALVES OPEN
VI7	LEAK < RELIEF CAPACITY
VI8	RHR SYSTEM INTACT
VI9	OPERATOR ISOLATES LOCA (ECA-1.2)

Figure E.2-10 (Page 4 of 6). VILOCA Event Tree

MODEL Name: WBNVS
Split Fraction Logic for Event Tree: VILOCA

14:53:49 26 JUN 1992
Page 1

SF.....	Split Fraction Logic.....
VI11	1
VI21	1
VI31	1
VI41	1
VI5F	1
VI61	VI1=S
VI62	VI1=F
VI71	VI1=S
VI72	VI1=F
VI81	VI1=S*VI6=S
VI82	VI1=S*VI6=F
VI83	VI1=F*VI6=S
VI91	VI1=S*VI6=S
VI92	VI1=S*VI6=F*VI8=S
VI93	VI1=S*VI6=F*VI8=F
VI94	VI1=F*VI6=S*VI8=S
VI95	VI1=F*VI6=S
VI96	VI1=F*VI6=F
VI97	VI1=F*VI3=F*VI4=S*VI5=F
VI98	VI1=F*VI2=F*VI4=S
VI99	VI1=F*VI4=F
VI9F	1

Figure E.2-10 (Page 5 of 6). VILOCA Event Tree

MODEL Name: WBNVS
Binning Logic for Event Tree: VILOCA

14:54:16 26 JUN 1992
Page 1

Bin.....	Binning Rules.....
LOCA	VI7=S + VI1=S*VI7=F*VI8=S
CDB	VI9=F
CD	VI4=F*VI9=S
SUCCESS	1

Figure E.2-10 (Page 6 of 6). VILOCA Event Tree

```
Summary of Initiator Results          Binning Information
----------------------------          -------------------------

Initiating Event     VS               LOCA          6.8916E-06
Initiating Frequency 7.2100E-06       SUCCESS       2.8085E-07
                                      CDB           3.7498E-08
Tree Names VSLOCA                     DEFAULT       0.0000E+00

Sequences Quantified 21
Sequences Saved      21
Seconds    1.82000000
Cutoff     0.0000E+00
Unaccounted For:0.0000E+00

Press [Enter] to continue or [Esc] to stop.
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Figure E.2-11 (Page 1 of 6). VSLOCA Event Tree

MODEL Name: WBNVS
Sequences For Initiator: VS Sorted By Frequency

11:00:44 29 JUN 1992
Page 1

Rank.	Index....	Frequency.....	Failed and Multi-State Split Fractions.	End State.
1	1	6.8911E-06	/	LOCA
2	4	1.9659E-07	/VS81*VS91	SUCCESS
3	2	8.4251E-08	/VS81	SUCCESS
4	5	2.1843E-08	/VS81*VS91*VSA3	CDB
5	3	9.3612E-09	/VS81*VSA1	CDB
6	20	6.0160E-09	/VS11*VS4F	CDB
7	6	3.7102E-10	/VS61	LOCA
8	21	2.2136E-10	/VS11*VS31	CDB
9	11	1.5882E-10	/VS51	LOCA
10	18	5.2764E-11	/VS21*VS4F	CDB
11	9	9.8294E-12	/VS61*VS71*VS92	SUCCESS
12	14	4.2077E-12	/VS51*VS71*VS92	SUCCESS
13	7	2.4573E-12	/VS61*VS71	SUCCESS
14	19	1.9415E-12	/VS21*VS31	CDB
15	10	1.0922E-12	/VS61*VS71*VS92*VSA4	CDB
16	12	1.0519E-12	/VS51*VS71	SUCCESS
17	15	4.6753E-13	/VS51*VS71*VS92*VSA4	CDB
18	8	2.7304E-13	/VS61*VS71*VSA2	CDB
19	13	1.1688E-13	/VS51*VS71*VSA2	CDB

Figure E.2-11 (Page 2 of 6). VSLOCA Event Tree

Page No. 1

MODEL Name: WBNVS
Event Tree: VSLOCA

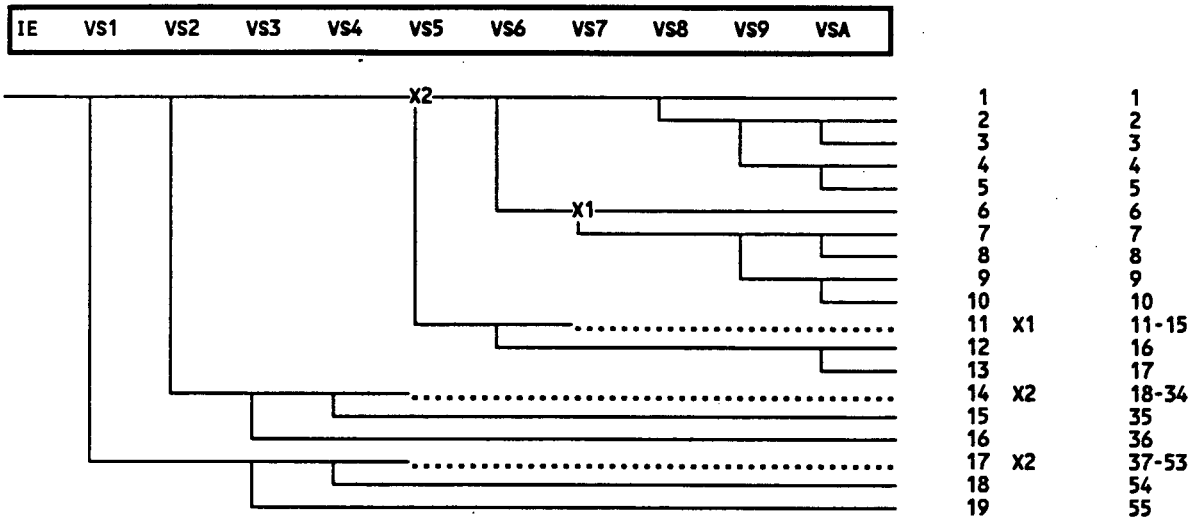

Figure E.2-11 (Page 3 of 6). VSLOCA Event Tree

MODEL Name: WBNVS
Top Event Legend for Tree: VSLOCA

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Top Event Designator.....	Top Event Description.....
IE	Initiating Event
VS1	CHECK VALVE 63-502 CLOSED
VS2	MANUAL VALVE 74-34 CLOSED
VS3	LEAK < RWST VENT CAPACITY
VS4	OPERATOR CLOSES MOV(S) TO ISOLATE RWST
VS5	RELIEF VALVE 75-505 OPENS
VS6	RELIEF VALVES 63-626 & 627 OPEN
VS7	LEAK < 900 GPM
VS8	LEAK < 1800 GPM
VS9	RHR SYSTEM INTACT
VSA	OPERATOR ISOLATES OR USES ECA-1.1

Figure E.2-11 (Page 4 of 6). VSLOCA Event Tree

MODEL Name: WBNVS
Split Fraction Logic for Event Tree: VSLOCA

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SF.....	Split Fraction Logic.....
VS11	1
VS21	1
VS31	1
VS4F	1
VS51	1
VS61	1
VS71	1
VS81	1
VS91	VS5=S*VS6=S
VS92	VS5=S+VS6=S
VSA1	VS5=S*VS6=S*VS9=S
VSA2	(VS5=S+VS6=S)*VS9=S
VSA3	VS5=S*VS6=S*VS9=F
VSA4	(VS5=S+VS6=S)*VS9=F
VSA5	VS5=F*VS6=F

Figure E.2-11 (Page 5 of 6). VSLOCA Event Tree

MODEL Name: WBNVS
Binning Logic for Event Tree: VSLOCA

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Bin.....	Binning Rules.....
LOCA	VS7=S+VS8=S
CDB	VSA=F + VS3=F + VS4=F
SUCCESS	VSA=S
DEFAULT	1

Figure E.2-11 (Page 6 of 6). VSLOCA Event Tree